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Energy transition and financial stability. Implications for the Spanish deposit-taking institutions

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ENERGY TRANSITION AND FINANCIAL STABILITY. IMPLICATIONS FOR THE SPANISH DEPOSIT-TAKING INSTITUTIONS

Abstract

In recent years, global warming and climate change have become highly prominent among society's main concerns. Most countries are adopting strategies to reduce greenhouse gas emissions as a way of mitigating their associated risks. The financial sector is also exposed to risks in this process. These risks are of two types: i) physical; and ii) energy-transition related. This paper focuses on the latter type of risk, which may impact the credit quality of exposures to the potentially most affected sectors. In the case of Spain, such exposures represent around 25% of the portfolio of loans for productive activities. A retrospective analysis shows that, following the global financial crisis, the non-performing loan ratio in these sectors has been lower than in others. However, this may be a consequence of specific factors that could disappear in an energy transition scenario, when the costs of pollution generated in these sectors are internalised in total costs and they face a more competitive environment. In addition, the question of whether financial regulation should play some role in this transition process is considered.

1 Introduction

The consequences of climate change associated with global warning and the quality of the air we breathe have, in recent years, become very prominent among society's main concerns. Indeed, such concern is no longer limited exclusively to the advanced economies, but also extends to emerging economies. Given that scientific evidence shows that this phenomenon is associated with economic (and human) activity and, specifically, with the emission of greenhouse gases into the atmosphere [IPCC (2013)],[1] many countries have agreed voluntarily to emission reduction targets.

From an economic perspective, the emission of pollutants is considered to be a "negative externality" [Pigou (1920)]. Since polluters do not take into account the cost to society of their emissions when they make their production decisions, the free market leads to a higher level of emissions than is socially optimal. This justifies regulatory intervention to internalise the social cost of emissions in the polluter's decisions.

The European Union (EU) is one of the political entities most involved in these reduction targets for greenhouse gas emissions and air pollutants. In fact, following

1 Greenhouse gas emissions are also the main cause of air pollution.

the logic of internalisation of the social costs of their emission, in 2005, it created the world's first international trading system for CO_2 emission rights [Convery (2009)]. European firms that emit greenhouse gases in their productive activity buy and sell such rights on this market, in order to be able to carry on their activity.

Historically, this cost internalisation process has tended to rely on the use of taxation measures, whereby the more one pollutes the more one pays [Climate Leadership Council (2018)]. However, more recently, it has begun to be recognised that these policies of increasing the costs of emitters have their limitations. This is because they mostly fall on the market price of the polluting intermediate inputs (e.g. petroleum products) and, naturally, these prices will be adjusted downwards precisely as a result of the reduction in demand caused by the fact that this tax makes the product relatively more expensive. For this reason, many new environmental regulations also impose quantitative limits on certain activities and establish new production standards. In addition, there are also many initiatives that subsidise less polluting alternatives or that encourage the development of non-polluting technologies [European Commission (2018)].

Greenhouse gas emissions and their climate-change implications are obviously a global problem and, therefore, to be effective, public policies need to be applied globally. This means that international cooperation is essential. However, air pollution and its associated health problems are local problems that can be resolved without the need for international cooperation and, consequently, effective regulatory intervention is easier to implement. In this respect, addressing the problem of air pollution is a natural starting point for environmental policy.

However, there are also two other factors that may be working in the same direction and are, probably, also global in scope.

First, technological change, the factor that may potentially drive, on a more permanent basis, the transition towards a more environmentally sustainable economy [Vermeulen et al. (2018)]. The development and adoption of less polluting productive technologies appears to be the most feasible alternative for businesses and authorities to achieve an ongoing reduction in particulate pollution in the atmosphere, leading to an ever cleaner economy.

Second, consumer preferences. If society is becoming increasingly aware of the risk of emissions, it is very likely that this will boost the demand for less polluting products, leading to a change in relative prices in favour of a more environmentally respectful ("greener") economy, more orientated towards producing more ecologically [Kok (2013)].

In the case of Spain, proposals from across the political spectrum coincide in the need for a set of initiatives addressing climate change to be developed and

implemented, by means of a law providing for the action that needs to be taken if the pollutant emission reduction targets established are to be achieved. These initiatives have been embodied in the draft climate change and energy transition bill. The actions proposed in the draft bill affect every economic sector and most regulatory and supervisory bodies. In the specific case of the Banco de España, Article 26, provides as follows:

> "The Banco de España, the National Securities Market Commission and the Directorate General of Insurance and Pension Funds, within the sphere of their respective competences, shall jointly prepare, every two years, a report on the assessment of the risk to the Spanish financial system arising from climate change and the policies to combat it, which will be coordinated under the auspices of the Spanish Macroprudential Authority - Financial Stability Board (AMCESFI). The report shall include any suggestions that may be considered appropriate to mitigate the risk and will be published and sent to the Parliament."

Moreover, the draft bill requires securities-issuing companies, credit institutions, insurers and other significant companies to provide more extensive information on the financial impact of the risks associated with climate change. Notwithstanding, the truth is that the financial sector as a whole and credit institutions in particular should actively involve themselves in this process of fighting climate change and energy transition. First, on account of the significant risks it poses to their activity, but also because there is a broad range of opportunities involved that they cannot afford to miss.

Many central banks and financial system supervisors are assuming a very active role in the environmental field. In December 2017, an international forum called *Network for Greening the Financial System* (NGFS) was set up, with the aim of boosting the role of the financial system in this process by means of coordination at international level [G-20 Green Finance Study Group (2016)]. Various working groups have been set up within this forum, to share experiences and discuss various related aspects, such as taxonomy definition, risk identification, scenario development, prudential regulation options, etc.[2] This momentum is also spreading to financial industry supervisors at the European (EBA, ESRB) and international levels (FSB).

The Banco de España is an active member of these fora and is beginning to design the framework for carrying out this analysis and the way it will transmit it to the institutions subject to its micro- and macroprudential supervision. In this respect, the starting point has to be an analysis of the financial risks arising from climate change and air pollution, from the policies to combat them, and from the technological innovations and demand-pattern changes mentioned above. These risks can be

2 For further information on the membership, organisation, functioning and work of the NGFS, see: https://www.banque-france.fr/en/financial-stability/international-role/network-greening-financial-system.

divided into two categories: physical risks and transition risks [Bank of England (2018)].

Physical risks are those that are more likely to materialise as the global temperature rises, i.e. when climate change has already begun to occur. This may generate extreme climate phenomena (droughts, floods and other natural disasters) with potential implications for the credit, market and operational risks of deposit-taking institutions. For example, an increase in sea level may mean that some coastal housing is no longer habitable and thus its value as mortgage collateral disappears. These climate events may also severely affect certain economic sectors (e.g. agriculture and tourism), raising the probability of default on credit exposures or reducing the value of collateral, and ultimately impacting banks' profit and loss accounts. In general, these risks are more difficult to measure and will presumably only materialise if the policies to reduce greenhouse gas and pollutant emissions are unsuccessful. Accordingly, if they do arise, they can be expected to do so over a longer horizon.

Transition risks, for their part, can arise from the process of adjustment towards a low-carbon economy. That is to say, they would appear as a consequence of the implementation of policies to curb climate change, the emergence of new "greener" technologies that are disruptive of the currently dominant ones, or changes in consumer preferences towards less polluting products. If these measures are adopted progressively, so that agents can gradually adapt to the changes, the costs of implementing them will be lower. However, the later they are adopted the more aggressive they would have to be, which would multiply their adverse impact.

In any event, this will mean that certain economic sectors or activities will be penalised, while others are boosted. Accordingly, there is a credit risk for financial institutions associated with their financing (granted loans and bonds) for those companies more adversely affected by these changes, and also arising from the value of collateral items, such as housing and vehicles, that do not comply with new emissions standards. There is also a market risk associated with the yields required from more polluting economic activities and a reputational-type risk. In this context, the cost of the transition will also be lower the more readily resources can be reallocated across sectors and firms.

Although there are, admittedly, certain methodological challenges involved in measuring these environmental risks, institutions should already be considering the transition risk. In this respect, the analysis of potential changes in the business environment that may affect company solvency is clearly an essential part of risk assessment and management within the financial system, regardless of whether the changes originate from technology, customer behaviour, regulation or the natural environment.

At the same time, we should not lose sight of the fact that the environmental transition is planned and has been announced. As we know, the European Commission has established the target of attaining a zero-carbon economy by 2050. Evidently, achieving this objective will necessarily involve regulatory and structural changes in the economy that will particularly affect certain sectors. Accordingly, this transition cannot be said to be unannounced or a surprise.

In conclusion, banks should currently be capable of evaluating and measuring these transition risks. Naturally, the appropriate measurement of such environmental risks should itself boost the transition towards a more sustainable economic model. Indeed, an essential element of any viable business model is the need for banks to identify, quantify and reflect in prices and capital all the costs and risks incurred. Therefore, if banks incorporate climate risks into cost and capital they will indirectly become "facilitators" of change, by reducing the cost of financing for those activities that contribute most to the sustainable transformation of the economy, while discouraging the most polluting activities.

Redirecting flows of financing towards more environmentally sustainable activities is a pre-requisite for the success of the transition process and for exploiting the attendant opportunities. It is in this context that discussions in international fora are focusing on whether prudential regulation has an additional role to play and the most effective way of doing so.

In line with the European Central Bank [ECB (2019)], this article explores the transition risks. The challenge is very complex, for various reasons. First, there is a serious lack of data, as firm-level information on CO_2 emissions is not available. This means that the analysis can only be performed at sector level. Thus, the results presented here should be interpreted with great caution, given the significant heterogeneity existing within each sector. In this respect, it seems clear that not all the firms in each sector will be favoured or prejudiced to the same extent. There is also a lack of information at the individual household level on the environmental classification of housing, so that the analysis of this sector is very limited.

A second difficulty arises from the fact that identification of the sectors potentially most affected cannot be static, since the adoption of measures or technological changes that may arise will foreseeably mean that they adjust and, in consequence, reduce their emissions. For this reason the analysis presented here should be understood as the initial phase of an evolving process.

The third difficulty arises from the fact that the sectors most affected by these risks will foreseeably be subject to processes akin to an industrial regeneration, which they have obviously not yet experienced, so that their past credit record can be no guide to their future risk behaviour.

According to the findings of this paper, the exposures of Spanish banks to sectors potentially exposed to energy transition risks, albeit with different degrees of intensity, represent approximately 20% of the portfolio of loans for productive activity.[3] At the same time, according to the evidence available, from the global financial crisis onwards, these exposures are seen to have had a lower non-performing loan (NPL) ratio than other economic sectors. However, this may be partly explained by the elevated mark-ups in some of these sectors, although there is a high degree of heterogeneity among them. This capacity to generate profit partly arises from the fact that they are regulated activities, since they are natural monopolies, and also that, to date, they have only had to assume a small part of the costs of the emissions they generate. Consequently, these favourable mark-ups may be reduced in an energy transition scenario.

The rest of this article is organised as follows. The second section analyses the CO_2 emissions of the Spanish economy, with an international comparison and disaggregated information for the various economic sectors.[4] Within this framework, those sectors that generate higher CO_2 emissions, which may be the ones most affected by possible technological innovation in the generation of energy in favour of renewable sources, as well as changes in agents' preferences, are identified. The third section focuses on Spanish deposit-taking institutions' exposures to these sectors, studying some of their characteristics, such as their non-performing loan (NPL) ratios. The fourth section analyses the possible regulatory initiatives being discussed in this context, while bearing in mind that, from a prudential standpoint, any measure adopted must necessarily be consistent with the financial risks related thereto. Finally, the fifth section summarises the main conclusions of this paper.

2 CO_2 emissions in Spain

According to Eurostat, Spanish CO_2 emissions into the atmosphere in 2017 totalled 285 million tonnes, accounting for 7.5% of total European Union emissions and ranking sixth among the EU members. The country with most emissions was Germany, with 858 million tonnes (22.8% of the total), while Malta, with 3 million tonnes (0.1%), had the fewest.

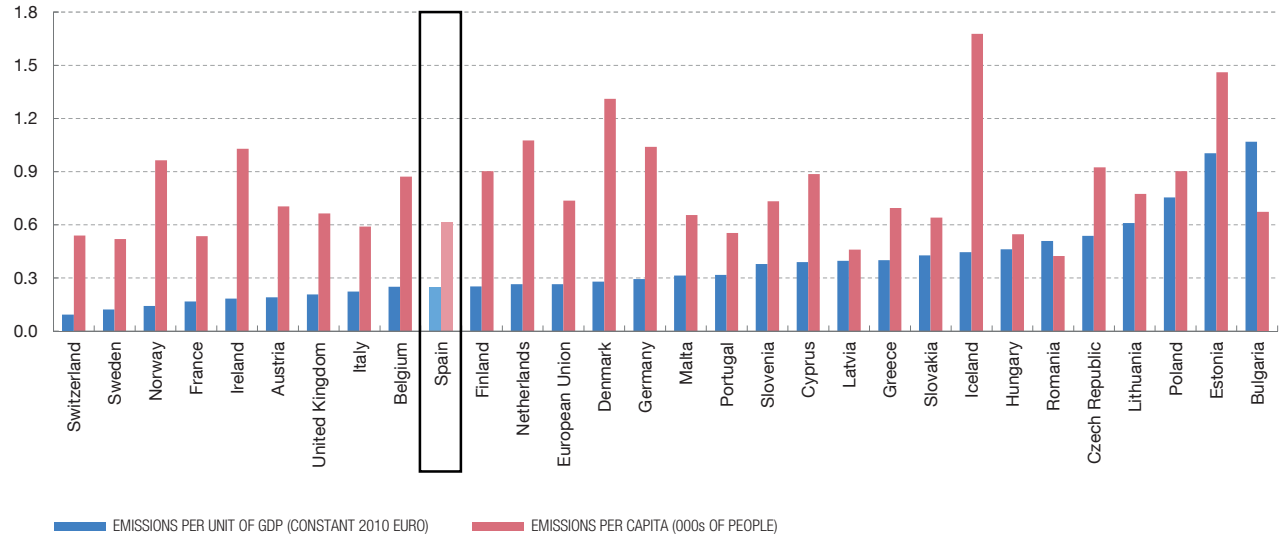
When emissions are viewed relative to the size of the economy or of the population, Spain is in an intermediate position in the European ranking (see Chart 1). Specifically, Spain emitted 0.25 kg of CO_2 per euro of GDP produced

3 Bank loans to finance productive activity account for around 50% of total financing to the resident private sector.

4 To simplify the analysis, the study focuses on CO_2 emissions, although environmental policy should address all types of pollutants (other greenhouse gases: methane, nitrogen oxide and fluorinated gases; and air pollutants: sulphur and nitrogen oxides, SOx and NOx, particulate matter and carbon monoxide).

Chart 1

CO_2 EMISSIONS IN EUROPE PER UNIT OF GDP AND PER CAPITA. 2017



SOURCE: Eurostat.

(at constant 2010 prices), far below the figure for Bulgaria or Estonia (1 kg), but twice that for Switzerland and Sweden (0.1-0.12 kg). Over recent years, emissions per unit of value added have fallen by 14% in Spain since 2012, practically the same figure for the European Union as a whole. Taking emissions relative to population, the conclusions are very similar. Spain emitted 6.1 tonnes per capita, up on Romania (4.1 tonnes) and Latvia (4.6 tonnes), but less than half the figure for Iceland (16.8) and Estonia (14.6). Here Spain stands somewhat below the European Union average, which was 7.3 tonnes per person in 2017.

Within Spain, households are the biggest direct emitters of CO_2 (68 million tonnes). This is both as a consequence of home acclimatisation and of the use of vehicles. As regards the sectors of activity, the biggest polluter is that supplying electricity, gas, steam and air conditioning (NACE group code 35), with 65 million tonnes, followed by various transport sectors (49-51), which overall contribute 47 million tonnes.[5] Other notable sectors in this respect are oil refining (19) and basic metals (24). Conversely, the sectors with fewest emissions are sports, recreational and entertainment activities (93), along with certain industrial sectors that show a low level of activity.

5 Households and the transport sector are, along with agriculture, waste management, fluorinated gas production and other less significant activities, what are known as diffuse sectors, which are excluded from the European market for the acquisition of emissions rights. In Spain, the CO_2 emissions of these sectors account for more than 60% of the total.

2.1 Emissions by the productive sectors

However, for a more complete picture of the most polluting goods and services, two factors should be borne in mind. First, a sector's emissions may be high because the size of the sector is big (extensive margin) or because its emissions per unit of value added are high (intensive margin). Indeed, viewing the direct emissions of each sector relative to value added generated shows that the most polluting activities are once again related to transport (49-51) and energy production, both electricity (35) and oil derivatives (19) (see Chart 2).[6] But, among others, the manufacture of other non-metallic mineral products (23), fishing (03) and paper manufacture (17) also emit more CO_2 than the average for the economy. Only slightly below the average are the textile (13-15) and food (10-12) industries. Several services activities and other sectors such as construction (41-43) show practically zero emissions relative to value added.

Placing the cut-off point at emissions of 0.11 kg of CO_2 per euro of value added (half the average emission per sector), the sectors selected as most polluting would be the 15 detailed in the annex. The emissions of these sectors account for 85% of total emissions (excluding those of households). Individually, each of these sectors emits at least 1% of the total.

Second, the statistics currently available record exclusively the emissions that are added at each stage of the productive process. Given that any finished product includes goods and services produced in other phases of the process (imports), it would be necessary to assign to each final product the emissions generated in the production of the imports incorporating it. This is what is known as incorporated emissions, which should be the basic element for calculating the environmental costs that each product generates. Bear in mind that if, for instance, pollution costs are internalised by taxing the polluting energy products that firms purchase and these costs are passed through to the following link of the productive process, the total increase in the price of a final product will not depend only on the emissions made in the final stage of this process, but also on the previous stages. We should not forget that it is the changes in the relative prices of final products that will determine the change in consumers' consumption patterns and, therefore, in each sector's production.

To perform this assignment exercise, information is drawn from the latest Input-Output Tables (IOT) of the Spanish economy for 2015. This source, since it details the acquisitions of inputs by each sector from the other sectors, allows an estimate to be made of the emissions of CO_2 that each final product incorporates.[7]

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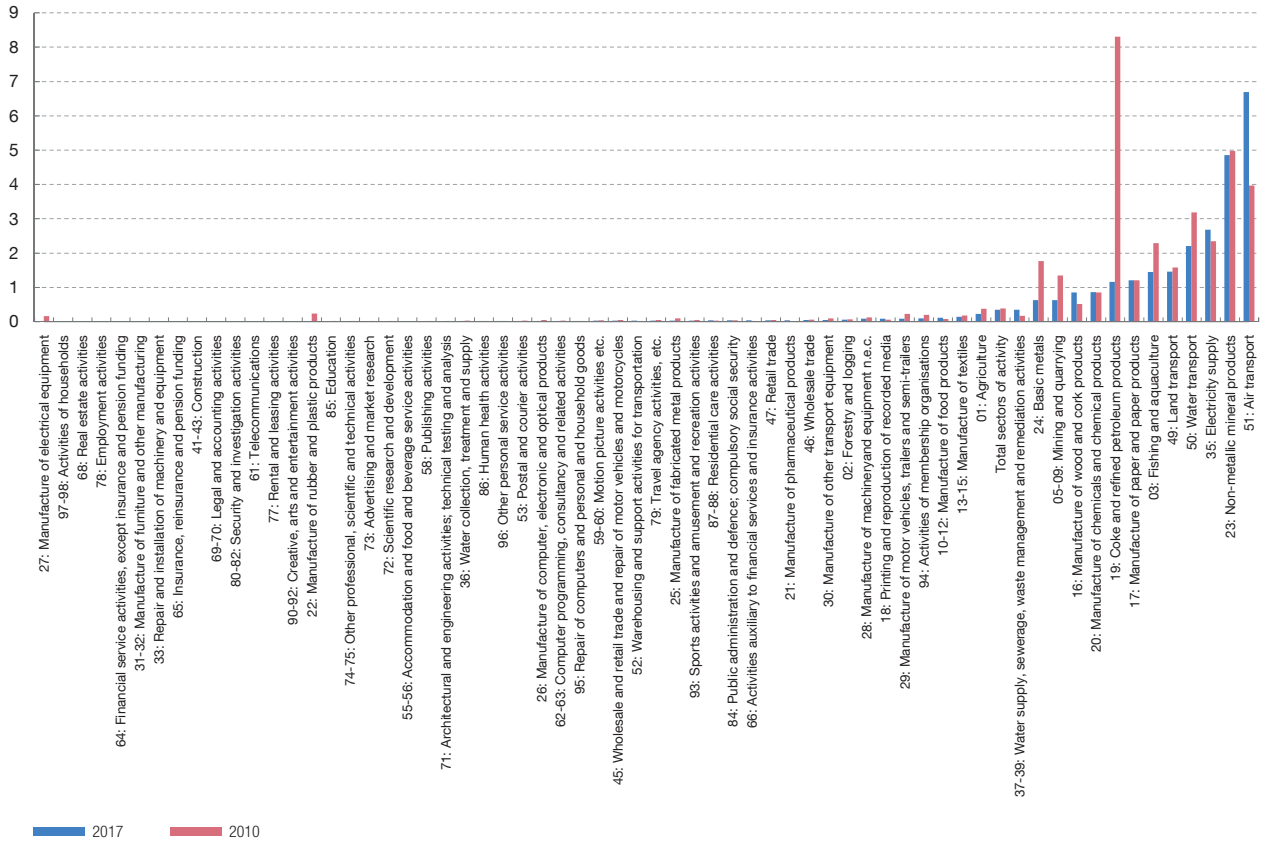
6 Logically, households are excluded from this part of the analysis since they are end-consumers of the goods and services produced.

7 This procedure implicitly assigns the same CO_2 emissions to both imported and domestic inputs. Wiebe and Yamano (2016) use input-output tables and emissions data from all the developed countries so as to

Chart 2

CO_2 EMISSIONS IN SPAIN BY SECTOR. PER UNIT OF VALUE ADDED



SOURCES: Instituto Nacional de Estadística and own calculations.

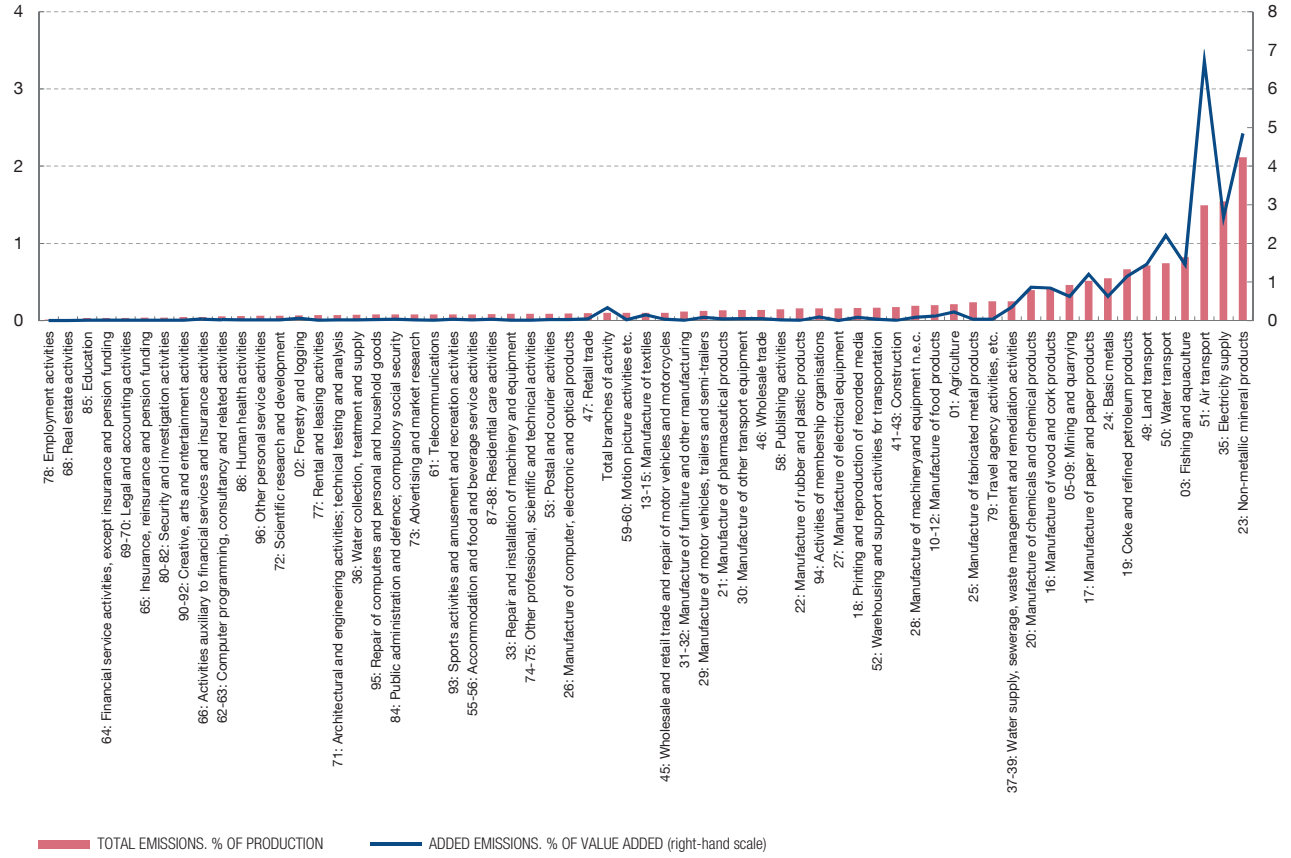
These estimates are in Chart 3. As can be seen, the assignments made in this way provide for a more homogeneous distribution of emissions among final products. Indeed, the difference in unit emissions between the most and least polluting product is much less than the difference between the most and least polluting sector. There are some highly significant cases. For example, the construction process (41-43) per se pollutes very little; however finished buildings are moderately polluting since they incorporate construction material whose production is highly polluting. Conversely, transport activities (49-51) notably reduce their emission intensity when it is taken into account that a most significant portion of these services are included in the transport of finished goods and, therefore, form part of these products. Notwithstanding, the list of the 15 most polluting products matches the sectors previously identified as having the highest emission intensity.[8]

be able to assign to each imported product the emissions that correspond to it according to the country in which it was produced.

8 Logically, the products/sectors with higher emission intensity might be expected to be more effective, but this differentiation is left for subsequent studies.

Chart 3

CO_2 EMISSIONS BY SECTOR AND BY PRODUCT. 2017



SOURCES: Instituto Nacional de Estadística and own data.

Policies for reducing greenhouse gas and polluting emissions can also be geared to promoting the development and use of "green" technologies. Specifically, they can give priority to those technologies that generate energy through renewable sources and which, therefore, do not use fossil fuels as a primary energy source. Clearly, this may have most significant consequences for the sectors of activity directly involved in the extraction (05-09) and refining of fossil fuels (19). But it will also affect the electricity sector (35) which, foreseeably, would increase its size but would in turn face a far-reaching structural change so that the scale of renewable sources in electricity generation might amply exceed the figure of 40% recorded in 2018.

Other sectors might also be affected by the need to replace machinery that runs on fossil fuels with electricity. That entails both direct and indirect adaptation costs. In this respect, the sectors most affected would be those linked to transport (49-51), the chemical industry (20), fishing (03), and manufacture of other transport equipment (30), metallurgy (24), agriculture (01),

sale or repair of motor vehicles (45), water collection (36) and manufacture of rubber and plastic products (22). Finally, the sectors producing motor vehicles as transport equipment (29), machinery and equipment (28), and the repair of these products (33) might also be affected by this technological change. As can be seen, some of these sectors were also the most polluting either directly or through their incorporation, but some additional sectors showed moderate emission intensity.

The very changes in consumer preferences about the treatment of the environment, the quality of the air they breathe and the consequences of climate change may also lead specific sectors to lose significance compared with others. Evidently, this would especially affect products that account for the bulk of households' CO_2 emissions. In particular, individual transport vehicles and machinery that uses combustion engines may be replaced by others that use electricity, or by mass modes of transport. The sectors dedicated to repairs of this type of machinery may also be adversely affected. Further, this change in preferences may affect other goods and services-producing sectors that make intensive use of natural resources or livestock (the food, textile and paper sectors) or that produce non-recyclable or heavily polluting goods (plastic, nuclear energy).

As mentioned in the introduction, the intensity and speed with which these changes come about will influence the costs entailed for the economy as a whole. Possibly, specific sectors will ultimately increase their size in the wake of the process, but that would be after having undergone a deep-seated transformation, which will boost firms that use low-polluting technologies and weaken those that are more polluting. In any event, it is worth attempting to characterise the relevance of all these sectors for the Spanish economy as a whole.

Table 1 shows the weight of these groups of sectors in the aggregate value added of the economy[9] in three different years. The figures are broken down in terms of whether the sectors would be affected on the basis of being highly polluting, of technological changes or of changes in consumer preferences. As can be seen, the weight of these sectors was somewhat higher than 23% in 2018, there having been something of a rise between 2012 and 2018.

The sectors potentially affected by technological changes are the biggest ones (18.4%) and, moreover, they have been gaining weight in a sustained fashion in the past decade. For their part, the significance of the heaviest greenhouse gas-issuing sectors (17.3%) diminished following the global financial crisis, but their importance has increased once again in recent years. Given that, as highlighted in the previous section, total CO_2 emissions per unit of value added

9 Excluding rentals of owner-occupied housing.

Table 1
WEIGHT OF SECTORS POTENTIALLY AFFECTED BY TRANSITION RISKS IN THE SPANISH ECONOMY'S AGGREGATE VALUE ADDED (%)

	2007	2012	2018
Polluting sectors	16.2	15.9	17.3
Technological change sectors	16.1	16.7	18.4
Changes in preferences sectors	7.7	7.6	7.4
Total sectors affected	**21.9**	**21.8**	**23.1**

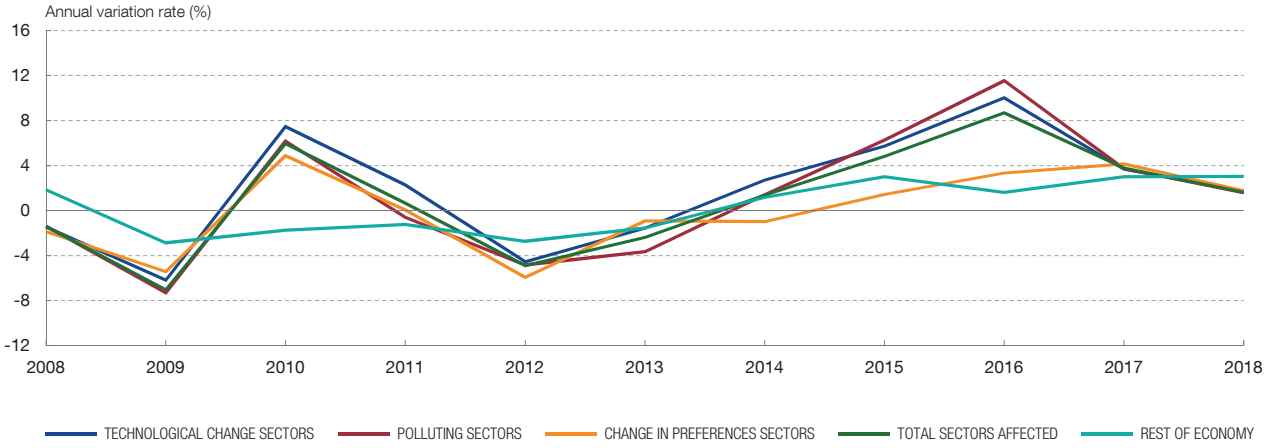
SOURCES: Instituto Nacional de Estadística and own data.

have fallen in recent years, this suggests that the sectors must have incorporated significant improvements in energy efficiency into their productive processes. Last are the sectors potentially affected by changes in consumer preferences, the weight of which was 7.4% in 2018. Unlike the other two groups, their significance in respect of aggregate economic activity has tended to diminish in the past decade.

Given the changes in the weight of these sectors, their average growth in the past decade has, unsurprisingly, exceeded that of the rest of the economy (1% versus 0.3%). In terms of groups, those potentially affected by technological change are those that have most grown on average (1.8%), followed by the most polluting groups (1.2%) and, some distance further back, those potentially affected by changes in consumer preferences (0.1%). Moreover, as Chart 4 shows, these sectors show greater volatility; indeed, they are much more procyclical than the rest of the economy. In fact, just as they fell much more during the global financial crisis, they are now also recovering more sharply. This is especially the case in the group of the most polluting sectors, but it is also seen in the other two groups.

The results on the significance of these sectors for aggregate employment in the economy are similar, though some qualifications are in order. As Table 2 shows, their weight in 2018 stood slightly below 19%, lower, therefore, than the weight in terms of value added. This means that the average apparent labour productivity of these sectors is higher than that of the rest of the economy. This seems logical if regard is had to the fact that industrial activities are over-represented. Moreover, the importance of these sectors has tended to diminish in the past decade; indeed, during the global financial crisis they destroyed more employment than the rest of the economy, and in the subsequent recovery they also created less employment. It is also worth noting that it is the most polluting sectors that concentrate most employment (13.9%), closely followed by those potentially affected by technological innovation (13.7%) and, at a much greater distance, by those subject to a change in preference (7.1%).

Chart 4
REAL VALUE ADDED



SOURCES: Instituto Nacional de Estadística and own data.

Table 2
WEIGHT OF SECTORS POTENTIALLY AFFECTED BY TRANSITION RISKS IN TOTAL HOURS WORKED IN THE SPANISH ECONOMY (%)

	2007	2012	2018
Polluting sectors	14.9	14.8	13.9
Technological change sectors	14.2	14.3	13.7
Changes in preferences sectors	7.2	7.1	7.1
Total sectors affected	**19.8**	**19.7**	**18.8**

SOURCES: Instituto Nacional de Estadística and own data.

2.2 Household emissions

To conclude this section, we should remember that a significant portion of the CO_2 emissions recorded were those emitted directly by households. Specifically, this amounted in 2017 to 68 million tonnes of CO_2, approximately 25% of the total. A portion of these is related to the use of private transport which, in one way or another, has already been addressed in the previous sections. Another portion concerns the acclimatisation of the houses in which they reside. Logically, depending on the quality and, above all, on the degree of the construction's thermal insulation, more or less energy consumption will be required to acclimatise the dwelling and, as a consequence, CO_2 emissions will be higher or lower.

Accordingly, houses might also be affected by the risks of energy transition, risks associated both with regulation and with technology or changes of preference. From the standpoint of financial stability, we should not forget that mortgages, the collateral for which is the house, account for almost half of banks' portfolio of loans to the non-financial private sector. Very few households could afford a house were they not able to mortgage this collateral. Moreover, a house is also a most relevant collateral for other loans related directly to productive activity (that of sole proprietors, for example).

For some years, newly constructed buildings have been obliged to include an energy performance certificate as part of the relevant information to be provided to purchasers and public institutions. At present over 3 million buildings and houses have such a certificate, with the median standing in group E (50.7%), only two categories above the level characterising maximum emissions [see Ministerio de Energía, Turismo y Agenda Digital (2017)]. The most sustainable buildings from this environmental perspective (groups A, B and C) account for only 5% of all classifiable buildings. Fortunately, the situation changes drastically when new buildings are analysed. As these are constructed in keeping with the new building code (2006), they show better climatic insulation and, therefore, produce fewer emissions. Specifically, only 23% of newly constructed buildings show worse energy ratings (groups E, F and G) and over half are positioned in the best three categories.

Regrettably, only aggregate information is available on this matter for the moment; accordingly, it is impossible to conduct a more detailed analysis. However, some recent empirical papers show that a house's energy certificate can have significant consequences for the quality of mortgage loan portfolios.[10]

3 Spanish deposit-taking institutions' exposures to sectors potentially affected by energy transition

As indicated earlier, almost all economic sectors produce some form of polluting emissions in the course of their productive activity. In consequence, as described in section 2, for the purposes of analysis a threshold has been set over which it is considered that an activity causes "sufficient" pollution. Similarly, thresholds have been set to classify sectors as sufficiently affected by technological change or changes in preference.

10 For example, Guin and Korhonen (2018) show how the energy efficiency of housing is a predictor of the risk of the mortgages associated with such housing. They find that those mortgages arranged on more efficient properties in energy terms are less risky.

In the analysis in this section, all the sectors that exceed these thresholds will be treated together, that is, as if the energy transition process had the same impact on each of them. But this is a simplification, as the impact is expected to be greater on the sectors that cause the most pollution or that make the most intensive use of combustion engines. In addition, within each sector, emissions will also vary by company, according to their production volume or the technology they employ (for example, coal-fired plants or wind farms for electricity generation).

However, as complete firm-level data are not available either on CO_2 emissions or the technology used in the production process, this analysis cannot go beyond the sector level. This means that the data presented here constitute the upper bound of energy transition-related risks. This lack of granular data also means that nor is it possible to take into account the potential risks associated with banks' exposures secured by real estate (housing) according to their environmental classification. There are, therefore, statistical and data constraints that impede a more precise analysis. This means that the conclusions drawn should be taken as a first exploratory analysis to be completed in the future.

Bearing the aforementioned in mind, a first group has been established comprising all the sectors potentially affected by the energy transition: those believed to cause the most pollution (CO_2 emissions over 0.11 kg per euro of value added), those subject to technological change and those potentially affected by changes in consumer preferences.[11]

The second column in Table 3 shows the financing that these sectors have received from Spanish deposit institutions, as a proportion of total lending extended to non-financial corporations and sole proprietors. In the period 2009 to 2018, it ranged between 20.1% and 24.6% at December 2018.[12] This is a very similar proportion to the share of these sectors of the value added of the economy. Accordingly, the bank debt ratio of these sectors – just over 50% at the end of 2018 – is very similar to that of the other sectors.

The share of bank financing extended to these sectors has risen by more than three percentage points (3 pp) over the past decade, in all three groups analysed. This increase is similar to the increase in value added, which implies that the debt of these sectors has evolved similarly to that of the rest of the economy. Specifically, the bank debt-to-GDP ratio of non-financial corporations has fallen by 54 pp of GDP in the decade: a decline of 47 pp for the sectors potentially

11 A list of these sectors is included in the Annex.

12 As mentioned in the previous section, the energy generation sector includes renewables. As it is not possible to separate renewables from the other forms of electricity generation at NACE code level, it must be noted, for a complete analysis, that the total percentage of bank financing received by companies and sole proprietors engaged in the renewable energy business is less than 1% of the system-wide financing granted.

Table 3

BANK FINANCING RECEIVED BY SECTORS POTENTIALLY AFFECTED BY ENERGY TRANSITION AND NPL RATIOS (%)

Date	Exposure of sectors affected by energy transition risks/total exposure	NPL ratio of sectors affected by energy transition risks	NPL ratio of total productive activities	NPL ratio of total excluding construction and real estate development
2009	21.1	5.1	7.3	5.1
2010	21.7	6.2	10.2	6.5
2011	21.3	7.9	14.1	8.2
2012	22.6	11.1	20.0	12.5
2013	23.0	14.9	26.2	16.9
2014	23.8	14.6	25.7	17.4
2015	23.6	13.9	26.2	16.1
2016	22.4	6.7	13.0	9.6
2017	23.1	5.9	11.0	8.6
2018	24.6	5.1	8.7	7.2

SOURCES: Banco de España and own calculations.

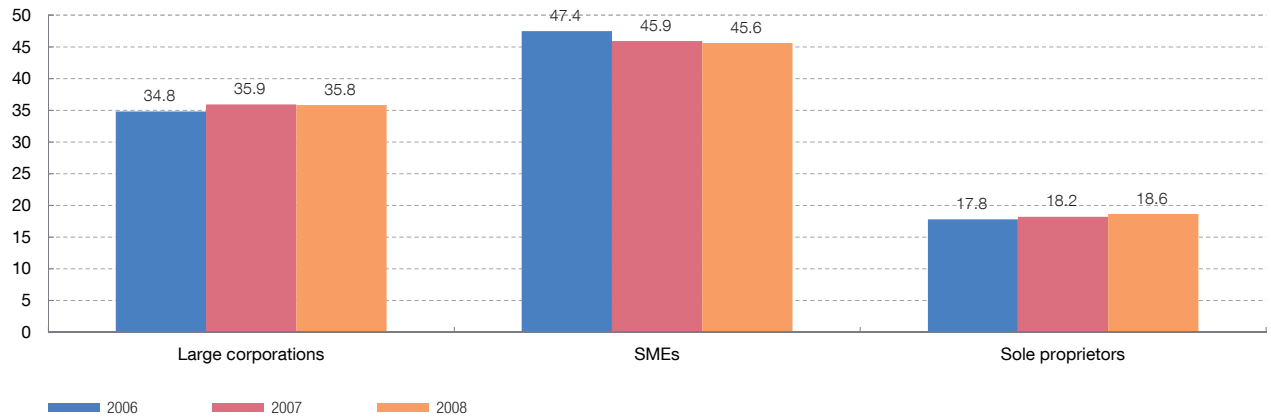
affected by energy transition risks and of 56 pp for all other sectors. At a more disaggregated level, the bank debt ratio of the sectors that cause the most pollution has fallen the most (57 pp), followed by that of the sectors potentially affected by technological change (46 pp) and, much farther behind (10 pp), by that of the sectors potentially affected by a change in consumer preferences.

The third and fourth columns of Table 3 show how non performing loan (NPL) rates have evolved in these sectors and in the system overall. In 2009 the NPL ratio was significantly lower for the sectors potentially affected by energy transition risks (5.1% compared with 7.3% for the system overall). In the global financial crisis years, the ratio rose substantially in both cases, but less so for the sectors potentially affected by energy transition risks (9.5 pp compared with 18.9 pp for the system overall). Since then, NPL ratios in both groups have declined very significantly. Specifically, for the sectors affected by the energy transition, the rise observed during the economic crisis has been fully reversed and the NPL ratio has returned to its levels of ten years ago (5.1%). By contrast, the NPL ratio for the system overall stands at 8.7%, 1.4 pp above the 2009 level. Accordingly, since the crisis the differences have tended to widen.

Nevertheless it is important to note that construction and real estate development are not identified as sectors potentially affected by energy transition risks. Given the nature of the global financial crisis in Spain, these sectors in particular suffered widespread default and this may distort the comparison. Accordingly, in the fifth column of Table 3 they have been excluded from the calculations for the system overall. The differences are now much less marked, as the NPL rate of the system overall (ex-construction and real estate development) is considerably lower.

Chart 5

DISTRIBUTION OF BANKS' CREDIT EXPOSURES BY BORROWER SIZE (TOTAL PRODUCTIVE ACTIVITIES) (%)



SOURCES: Banco de España and own calculations.

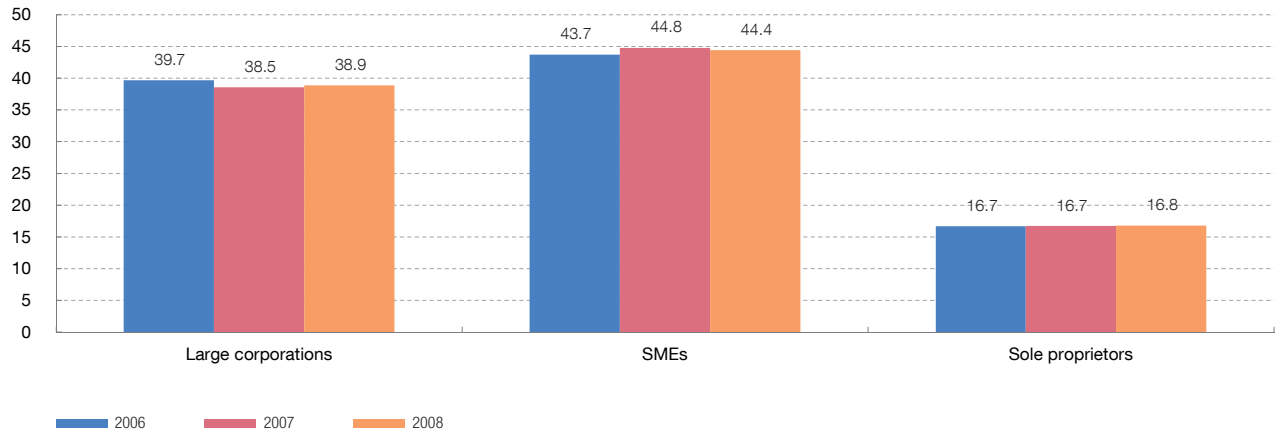
The starting point in 2009 is very similar in both cases. The increase in the NPL rate is still higher for the system overall in the crisis years, but its peak is a bit more than 2 pp higher than that of the sectors potentially affected by energy transition risks (compared with a difference of more than 11 pp) including construction and real estate development). The subsequent decline is very similar, which means that the NPL rate of the system overall (excluded construction and real estate development) is now higher than that for the sectors under study. In consequence, on the experience of the last cycle, it seems that in economic downturns the NPL rate of the sectors potentially affected by energy transition risks is less cyclically sensitive than that of the other sectors, despite the higher procyclicality of their value added as shown in the previous section.

This differential performance of the NPL ratios of the two groups of economic sectors may be explained by a variety of factors. First, average firm size may differ. As a general rule, large firms, as they have more highly diversified income sources than their smaller counterparts, are able to better cushion idiosyncratic and aggregate shocks and, therefore, present lower NPL rates [see, for example, Altman et al. (2011) and Saurina and Trucharte (2004)]. Indeed, available data by firm size for Spain show that, in the economy overall, NPL rates have always been much lower at large corporations than at SMEs, with sole proprietors in an intermediate position between the two. These differences are practically identical in the case of companies in the sectors potentially most affected by the energy transition.

In the sectors under study, the share of financing extended to large corporations (to the detriment of SMEs) is greater than in the economy overall. Accordingly, the composition of the business sector could explain part of the difference in the NPL rate. However, as Charts 5 and 6 show, the differences in share between the two

Chart 6

DISTRIBUTION OF BANKS' CREDIT EXPOSURES BY BORROWER SIZE (SECTORS AFFECTED BY ENERGY TRANSITION RISKS) (%)



SOURCES: Banco de España and own calculations.

groups of companies are small, so this factor would explain only 0.2 pp of the total. Moreover, there appears to have been no substantial change in composition over time, so this factor alone cannot explain why there were no differences in the NPL rates pre-crisis.

Another reason is that there is a measure of inertia in default, or in other words, a company is more likely to default if it has past experience of similar situations [see, for example, Repullo et al. (2010)]. Accordingly, the simple fact of the global financial crisis having a greater impact on the rest of the economy would be sufficient for the pace of the subsequent fall in default to have been slower. But this would still not explain why the crisis had more impact on the other sectors than on those potentially affected by transition risks.

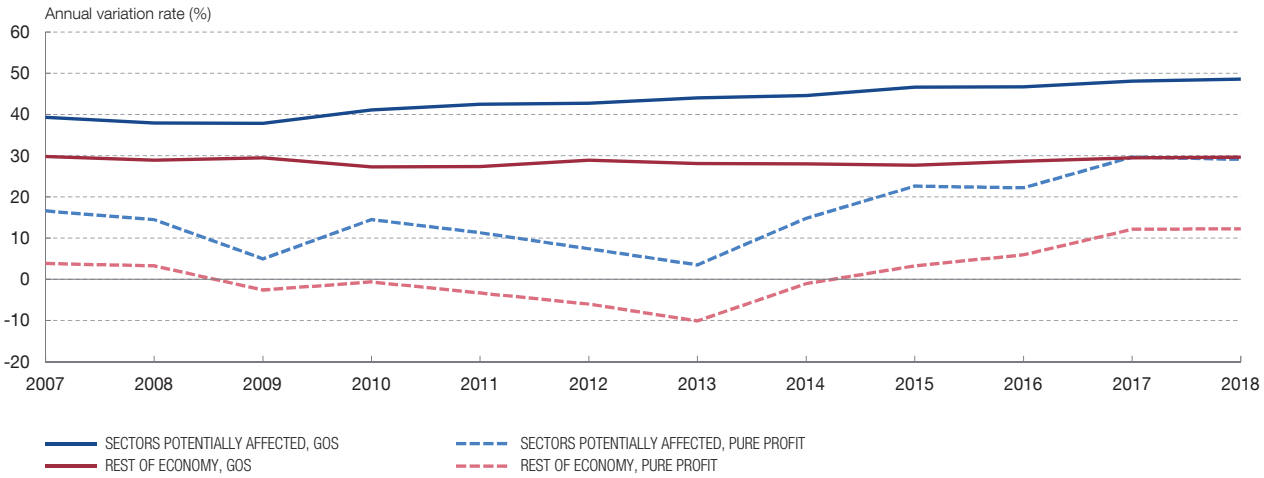
Lastly, the empirical evidence also shows that there is an inverse relationship between NPL and a company's profitability [see Trucharte and Marcelo (2002) for the case of Spain]. This could also explain the difference in NPL rates between the two groups. For this purpose, drawing on Spanish National Accounts data, both the gross operating surplus as a percentage of value added and an approximation of the price mark-up on the marginal cost for each sector were obtained (subsequently aggregated into the groups being compared).

Gross operating surplus is defined as value added produced minus labour costs incurred.[13] This would be the income available to a company for capital remuneration,

13 These costs include the imputed wage of self-employed workers in each sector, equivalent to the average net wage of employees in that sector.

Chart 7

GROSS OPERATING SURPLUS AS PERCENTAGE OF VALUE ADDED AND MARK-UP



SOURCES: Instituto Nacional de Estadística, EU-KLEMS and own calculations.

to be used therefore to service its debts and its bank borrowings. Clearly this income must be positive (at least when counted over a sufficiently long period), and the more capital intensive the sector, among other factors, the higher it will need to be. In consequence, another profit measure is obtained – the mark-up – that subtracts capital remuneration[14] from the gross operating surplus.

This variable may be interpreted as the monopoly power of the sector, as in perfect competition conditions the mark-up should be zero. If it remains positive over time, this could mean that companies are able to charge a price for their products above the marginal cost of producing them, thus generating income in excess of remuneration of the factors of production. In consequence, the mark-up measures the degree of sectors' allocative inefficiency, since if the price charged is higher than the perfect competition price, the amount produced will be lower than under competition [see Estrada (2009) for an in-depth study of this issue for Spain].

As Chart 7 shows, the gross operating surplus to value added ratio for the sectors potentially affected by energy transition risks is much higher than for the rest of the economy. In addition, the differences have widened in the past decade, from somewhat less than 10 pp to almost 20 pp. Indeed, there would appear to be a change in cyclical behaviour, as while this ratio decreased in all other sectors during

14 Capital remuneration is calculated by multiplying each sector's capital stock by its user cost. In turn, user cost is obtained by multiplying the investment deflator by the real return (risk-free interest rate plus risk premium plus rate of depreciation of capital stock minus inflation). These sector-level variables are taken from the Fundación BBVA and IVIE database and are extended to 2018 using aggregated data imputation techniques.

Table 4

NPL RATIO OF SECTORS AFFECTED BY ENERGY TRANSITION RISKS. DISAGGREGATED ANALYSIS (%)

Date	NPL ratio of sectors that cause the most pollution	NPL ratio of sectors affected by technological change	NPL ratio of sectors affected by changes in preferences
2009	4.8	3.9	7.3
2010	5.7	4.8	9.2
2011	7.3	6.2	11.3
2012	10.6	8.7	13.7
2013	14.7	12.4	16.8
2014	14.7	12.0	16.7
2015	14.2	11.6	14.8
2016	6.8	5.6	6.6
2017	6.1	4.9	5.7
2018	5.3	4.5	4.8

SOURCES: Instituto Nacional de Estadística and own calculations.

the global financial crisis, in the sectors under study it increased and this growth path has continued in the subsequent economic recovery.

However, the reason for these differences may be that the sectors potentially most affected by transition risks are also much more capital intensive than the rest of the economy (with a capital stock to value added ratio of around 230, compared with 210 for the remainder). Indeed, when the cost of capital is subtracted from the surplus, the mark-up decreases for both sector groups. Yet the differences between the two remain unchanged. In the case of the rest of the economy, the ratio fluctuates around zero (1.3% on average in the decade), which suggests a situation close to perfect competition. It also seems to be markedly procyclical, recording very negative values during the international financial crisis and the sovereign debt crisis, followed by a return to positive territory in the recovery. By contrast, in the case of the sectors potentially affected by transition risks, positive values were recorded throughout the period (15.9% on average), with a much less procyclical profile. These persistently positive values suggest that these sectors include some dominant companies.

It seems reasonable to believe that the higher profits generated by these sectors and their lack of sensitivity to the global financial crisis explain a substantial part of the differential impact the crisis had on their NPL rate compared with that of the rest of the economy and also part of their subsequent development. These higher profits may be associated, in part, with the dominant position of some of the corporations in these sectors, with the fact that in many cases these are regulated activities, and with the fact that these corporations are not bearing some of the costs they incur,

specifically atmospheric pollution costs that are being borne by society as a whole.[15] In any event, the sectors potentially affected by transition risks are very diverse: they include some of the sectors with the highest mark-ups in the economy (such as electricity generation and transmission), and others with some of the lowest (overland transport).

A final point to note here is that when the three groups of sectors potentially affected by energy transition risks are analysed separately, the highest credit quality is observed in the sectors potentially affected by technological change, compared with those that cause the most pollution and those potentially subject to changes in consumer preferences (see Table 4). Until 2007 the highest increase in NPL rates was observed in the sectors potentially affected by changes in consumer preferences. However, in 2019 this is the only group whose NPL rate is lower than in 2009 (although the figures for the other two groups are very close).

4 Possible application of regulatory measures within the framework of the energy transition process

The bulk of the instruments required to internalise pollution costs and stimulate a "green" technological change are in the hands of governments, the repositories of the popular will. Consequently, it should be governments that lead the drive for protection and care of the environment and for the energy transition towards a sustainable economy.

As analysed in previous sections, this will involve a structural change in the economy, with a significant transfer of resources between sectors and businesses. The fewer the frictions in this process the more effectively it will be carried out, allowing all the opportunities that may arise to be fruitfully exploited. Also, the sooner it is implemented the more the time there will be for adaptation and the lower the costs that will be incurred, in comparison with a climate change scenario. Given their central role in channelling the financial resources necessary for economic activity, financial institutions will have to be part of this process.

Accordingly, prudential regulation may also potentially contribute to this process, but always keeping in mind that such regulation must not interfere with the

15 Considering the estimated social cost of CO_2 (between €46 and €68 per tonne according to the US Environmental Protection Agency), the cost of this externality in 2017 would be between €8.7 billion and €13.1 billion for the group of productive sectors classified as causing the most pollution, after deducting the emission rights bought in the year. This cost accounts for 4 pp to 7 pp of their value added; if internalised it would reduce their average mark-up significantly (by up to 11.7%-9.1% of their value added). Higher CO_2 price scenarios than those considered currently ($100-200 per tonne) would practically eliminate these sectors' average mark-up.

correct measurement of the credit risks associated with these activities. In short, this would mean addressing the possibility of attributing the negative externalities of pollutant emissions to those responsible, always in a manner consistent with the correct assignment of climate change risks.

As already mentioned, a first step is to integrate environmental considerations into financial-system operating procedures and regulation. This integration requires awareness on the part of both institutions and regulators and supervisors, to adopt and promote best practices in risk management, in conjunction with an active, effective and efficient focus on environmental issues.

For this purpose, it is absolutely necessary to have appropriate data to know the true situation of economic agents and the potential impact of their economic and financial decisions on the environment and, thus, to be able to perform a complete and appropriate analysis of such decisions. This is a challenge that requires the authorities to act rapidly and decisively, so that the problem we are facing can be put into context.

Financial institutions are also starting to take the first steps towards using products and financing activities that are environmentally sustainable. The inclusion of the energy and environmental dimension in risk and project-viability evaluation is a task that still needs to be worked on further. The energy transition is akin to a structural change, and will therefore render past experience of little relevance for explaining the risks that arise in future. Accordingly, much more attention will have to be given to the simulation of potential scenarios resulting from the measures that may be adopted in this area, possible technological innovations and changes in agents' preferences.

With respect to regulators, environmental risk must be integrated into regulation as part of a global approach to systemic risk and its effects in the financial system. It should not be forgotten that a large part of regulation is based on features and models that use past information to determine requirements, while this type of risk would arise from structural change and resource reallocation across sectors and businesses.

A pioneering initiative that sought to give a different treatment to a particular type of borrower, in order to boost the flow of bank credit to such borrowers, is contained in the European regulation on capital requirements [Regulation (EU) 575/2013 of 26 June 2013 on prudential requirements for credit institutions and investment firms, known as the CRR].[16] This different regulatory treatment is based on the introduction of a supporting factor (in the form of a lower capital charge) for credit to small and medium-sized enterprises (SMEs) [see EBA (2016)].

The purpose of this measure was to recognise the singularity of this type of borrower and boost the bank credit they receive, by means of regulatory-capital-consumption

16 This initiative was limited to the European level and was never extended to the Basel international level.

relief for banks. It should not be forgotten that the cost of supervising SMEs is much greater than that of supervising large firms, and moreover SMEs have fewer possibilities of obtaining funding outside the banking circuit. In fact, the empirical evidence shows that SMEs, the main source of an economy's job creation, are more financially constrained than large firms [see Beck and Demirguc-Kunt (2006)].

As mentioned in the previous section, the NPL rates of SMEs at sector level are higher than those of large firms, but as the individual loans involved are smaller they allow banks to build more diversified portfolios that reduce their exposure to shocks to specific sectors or firms. As a result, the discrimination in favour of SMEs and against large firms, as regards the treatment of their exposures in terms of capital, i.e. in terms of risk (credit losses, basically, probability of default and loss given default) is justified by borrower granularity and diversification.[17]

Many analyses have been performed both with regard to the suitability of the measure and its impact. In particular, the Banco de España's *Financial Stability Report* (2014) showed the impact on SME funding of such measure, which, in the Spanish case, was preceded by the application of the law on support for entrepreneurs (Law 14/2013). The results of the analysis suggest that the regulatory changes introduced in 2013 by means of the law on support for entrepreneurs had a relatively favourable impact on the growth of credit to SMEs, in comparison with that of credit to large firms.

In this respect, it might be thought that the appropriate consideration of environmental risks in regulation has similarities with the case of SMEs. As indicated in the previous section, the current credit risk of less polluting sectors exceeds that of the different groups of industries potentially affected by these risks, especially after the crisis. As a result, at the present time, on the basis of past information, there would be no justification, from a regulatory-capital viewpoint, for a more favourable treatment for firms which, in terms of credit risk, should be considered as poorer quality. Nor would there be justification for the introduction of a factor penalising more polluting firms which, on the basis of past experience, would have lower credit risk.

However, as already mentioned, the measures governments may implement for the energy transition, or technology or preference changes may mean that the potentially affected sectors will see a deterioration in their earnings, when the costs of pollution are internalised and they lose some of their monopoly advantages, so that their credit risk may rise while for other firms it falls. From this perspective, regulation could favour these potential changes. In this case it would not be a matter of recognising that the greater diversification of portfolios reduces total risk, as in the

17 The EBA document cited [EBA (2016)] states that an analysis of the capital requirements under the advanced approach, IRB, and the standardised approach, SA, showed that the supporting factor for SMEs could be justified, given that the current calibration tended to be conservative compared to the riskiness of these exposures.

case of SMEs, so much as of anticipating a situation that may alter the currently observed credit risk at the same time as the social cost entailed by pollution, that has not hitherto been considered, is assigned to those responsible. However, the measures should be temporary, remaining in force only until the transition process has been completed, since the advantages of the more polluting firms would have disappeared then.

Basically, two alternatives have been proposed for possible regulatory action. First, reducing the capital requirements for less polluting activities ("green supporting factor") and, second, increasing them for more polluting activities ("brown penalising factor"). Both factors would meet the objective of modifying the relative weightings of bank exposures to favour the internalisation of economic and social risks associated with the energy transition process, but there are certain differences that should be mentioned.

The "brown penalising factor" would raise aggregate capital requirements, making banks more solvent, so that this seems to be the most appropriate alternative from a prudential viewpoint. Also, from an operational standpoint, it is much easier to identify polluting sectors/firms than non-polluting ones. Notwithstanding this, the penalising factor has been criticised by some authors for its possible ineffectiveness [see Boot and Schoenmaker (2018)]. In contrast, the "green supporting factor" would reduce aggregate capital requirements, and thus boost the flow of credit between sectors and firms, allowing for a less costly reallocation of financial resources. This would therefore be the best alternative from the standpoint of the efficiency of the adaptation process.

As mentioned throughout this article, measures designed to encourage care for the environment should certainly be welcomed. However, those that may affect solvency regulations must be closely scrutinised before being applied in order to determine their effectiveness and, above all, their impact in terms of credit-risk measurement and recognition, certainly the most relevant aspect for banks. Capital is the ultimate resource banks have available to cover the losses that may arise from their activity, so that any measure that affects their solvency must be exhaustively examined and tested before implemented.

In this connection, the revised capital requirement regulation, CRR2, adopted in May 2019, mandates the EBA to assess the technical justification for, and the potential effects on financial stability of, the introduction of this type of discrimination of the environmental and social risk on credit exposures. The CRR2 requires the EBA to submit a report on its findings to the European Commission by 28 June 2025. The CRR2 itself empowers the Commission to make a legislative proposal to the European Parliament and the Council, should it consider this appropriate in the light of the report's conclusions.

Accordingly, the debate regarding whether "green" or "brown" factors should be introduced into the calculation of capital remains unresolved in the EU, although the timeframe for proposals is lengthy. Irrespective of the option eventually chosen, this treatment should be temporary until the desired transition has been achieved. Any permanent measure of this type should be much more specific, so as not to affect the sectoral composition of activity. It should only favour firms that are more energy-efficient within each sector, using something like the experience rating that some firms use to determine benefits for their employees [Burton (2001)].

5 Conclusions

There is great concern in society over the consequences of climate change, associated with the emission of greenhouse gases and environmental pollution. Unsurprisingly, at the institutional level, awareness of this has also begun to be been raised. Attempts are being made to implement emissions-reducing measures so as to mitigate the global rise in temperature and prevent the harshest version of climate change from materialising.

While finance is one of the lowest greenhouse gas-emitting sectors, it may also be significantly affected by this phenomenon. The risks this sector takes on arise from its exposures to sectors or individuals that would actually be more directly affected. Such risks are twofold: i) physical; and ii) arising from the energy transition process. This article focuses on the second type of risk, derived from the policies implemented to reduce emissions, technological innovations that significantly lower the cost of energy production with non-polluting renewable sources and changes in consumer preferences towards "green" products.

The upshot of all these scenarios (and, almost certainly, the combination thereof) will be the reallocation of productive activity from more polluting to less polluting sectors. And within sectors, from firms generating more emissions to those generating less. This reallocation of productive activity will have consequences for the credit risk of financial institutions' credit portfolios.

Throughout this article emphasis has been placed on the lack of available information at present for building on and thoroughly analysing the previous point, in particular from the household angle. The non-availability of statistical information on household energy efficiency certificates prevents any analysis allowing the financial implications of the potential environmental impact of households to be assessed. In terms of productive activity as a whole, the lack of information at firm level only allows an aggregate analysis by sector; it is not possible to analyse the characteristics of banks' exposures in respect of real estate collateral on the basis of the environmental classification of the latter.

Given the information available, as far as the analysis of Spanish deposit-taking institutions' exposures to the sectors potentially affected by the energy transition is concerned, the financing extended has been shown to account for around 25% of the total granted to overall non-financial corporations and sole proprietors. It has also been shown that these sectors are more creditworthy (they have a lower NPL ratio) than the other sectors, at least in the wake of the global financial crisis.

The analysis has highlighted the fact that this may be due to different reasons, including, among others, the size of the borrower. The presence of large corporations in a higher proportion, with the potential consequences that this entails (diversification of sources of revenue and higher profitability, for instance), has a bearing on the lower NPL ratios. Also, the fact there is notable inertia in NPLs, along with high business concentration, which would provide for higher profits than the normal return on capital, accounts for a significant part of these differences. Nor should it be forgotten that the most polluting sectors do not assume a portion of the costs they incur, specifically those relating to atmospheric pollution, which fall on society as a whole. That is clearly affecting their profitability and justifying a better position in relation to other firms. In any event, it is important to bear in mind that there is high cross-sector heterogeneity, and across the firms within these sectors, and that generalising these reflections calls for the necessary qualifications to be made.

However, what the energy transition is actually seeking is to internalise those costs so that those who actually generate them assume them. Moreover, the new technologies might lead to the concentration of activity falling significantly and to firm-size also becoming smaller. Under an energy transition scenario, these elements would lead the credit risk associated with these exposures to also possibly be affected.

This is a possibility that financial institutions and supervisors should bear in mind. In this respect, the combination of a greater current quality of the credit portfolios of the sectors potentially most affected by transition risks and their potential impairment when the transition process takes place suggests that the possibility of including regulatory changes to accompany this process might be assessed. Logically, such measures, especially if they affect banks' solvency, should be analysed and scrutinised in depth from a prudential standpoint of the proper measurement of the risk the measures incorporate before application, since capital is the last element banks have to withstand the losses that may arise.

Specifically, the debate surrounding the so-called "green supporting factor" and "brown penalising factor" turns on concern to maintain the system's solvency. Such discussion would, in turn, seek to assign the social cost (hitherto not considered) that pollution entails, ultimately providing for the transition process. It seems reasonable to think that such measures should be temporary and confined to the duration of the transition process.

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Table 1

LIST OF ECONOMIC ACTIVITY SECTORS POTENTIALLY AFFECTED BY THE ENERGY TRANSITION

NACE group code	NACE code description (Economic Activity Sectors)
01	Agriculture
03	Fishing
05-09	Mining and quarrying
10-12	Food products, beverages and tobacco products
13-15	Textiles, leather and footwear
16	Wood and cork
17	Paper
19	Coke and refined petroleum products
20	Chemicals and chemical products
22	Plastics and rubber
23	Non-metallic minerals
24	Basic metals
28	Machinery
29	Manufacture of motor vehicles
30	Other transport equipment
33	Repair of machinery
35	Electricity
36	Water supply
37-39	Waste management
45	Sale and repair of vehicles
49	Land transport
50	Maritime transport
51	Air transport

SOURCE: Own data.

Table 2

MOST POLLUTING SECTORS WHOSE EMISSIONS PER EURO OF VALUE ADDED EXCEED 0.11 KG OF CO_2

NACE group code	NACE code description (Economic Activity Sectors)
01	Agriculture
03	Fishing
05-09	Mining and quarrying
10-12	Food products, beverages and tobacco products
13-15	Textiles, leather and footwear
16	Wood and cork
17	Paper
19	Coke and refined petroleum products
20	Chemicals and chemical products
23	Non-metallic minerals
24	Basic metals
35	Electricity
37-39	Waste management
49	Land transport
50	Maritime transport
51	Air transport

SOURCE: Own data.

Table 3

SECTORS SUBJECT TO TECHNOLOGICAL CHANGE

NACE group code	NACE code description (Economic Activity Sectors)
01	Agriculture
03	Fishing
05-09	Mining and quarrying
19	Coke and refined petroleum products
20	Chemicals and chemical products
22	Plastics and rubber
24	Basic metals
28	Machinery
29	Manufacture of motor vehicles
30	Other transport equipment
33	Repair of machinery
35	Electricity
36	Water supply
45	Sale and repair of vehicles
49	Land transport
50	Maritime transport
51	Air transport

SOURCE: Own data.

Table 4

SECTORS SUBJECT TO CHANGES IN CONSUMER PREFERENCES

NACE group code	NACE code description (Economic Activity Sectors)
10-12	Food products, beverages and tobacco products
13-15	Textiles, leather and footwear
17	Paper
22	Plastics and rubber
29	Manufacture of motor vehicles
30	Other transport equipment
45	Sale and repair of vehicles

SOURCE: Own data.

The energy transition and the financial system

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Abstract

After briefly setting out the scientific evidence on climate change (CC), particular emphasis is placed on characterising the problem from an economic standpoint. Then the strategies the different lobbies have used to hamper the energy transition are reviewed and as is confirmed have been successful since, as will be argued, this transition has not yet begun. Afterwards the attempts within international coalitions to arrive at agreements to define a carbon price that takes into account its social costs and provides for the transition to another decarbonised energy system are analysed. The causes for the meagre results obtained are set out, these arise from the fact that none of these agreements met the three basic requirements needed: to be effective, to be fair and to be credible.

The second part of the article refers to the risks and opportunities that the energy transition poses for the financial system. The potential problems that delayed decision-making can cause for financial stability are particularly underscored, both on the publication of financial information by CC-related agents and on the consideration of the risks derived from the energy transition. It is noted that most financial institutions, regulators and regulated alike, have accepted the account of the seriousness of the CC problem. Also evident, however, is the little progress achieved in practice to resolutely and rigorously address this critical problem. Finally, it is concluded that, in the current circumstances, it does not seem reasonable to expect the financial system to play a significant role in channelling the considerable economic resources needed to finance a new energy infrastructure.

1 Introduction

The average temperature of the Earth's surface is today 1 ºC higher than it was before the industrialisation of our economies, taking as a reference the average value over the 1850-1900 period. Our growth model needs deep-seated changes if we are to succeed in keeping this rise below 2 ºC. Once this limit is surpassed, science warns us of the high likelihood of our natural environment undergoing drastic and irreversible changes, endangering the well-being of future generations. Worse, the latest studies and empirical findings signal that the reality of climate change exceeds the most pessimistic forecasts and that the threshold would need to be set at 1.5 ºC. Tackling this problem unavoidably requires breaking, or drastically weakening, the strong link between economic activity and the emission of a series of gases behind the so-called "greenhouse effect".

The “greenhouse effect” is the natural phenomenon caused by several gases present in the atmosphere. These condition the Earth’s temperature which, without such gases, would be approximately 21 ºC colder, making it uninhabitable. Along with steam, the main greenhouse gases (GHGs) are: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6), perfluorocarbons (PFCs) and hydrofluorocarbons (HFCs). Admittedly, the atmospheric concentration and characteristics of each of these gases differ, particularly their capacity to absorb terrestrial radiation; but their overall effect can be converted into CO_2 equivalents. In any event the main GHG is, it should be stressed, CO_2. And in the past two centuries it has contributed around 80% of the greenhouse effect.

The greenhouse effect process can basically be described as follows: the Earth receives energy from the sun in the form of high-frequency waves that pass easily through the atmosphere and are reflected on the Earth’s surface, which sends them back towards space, but at an appreciably lower frequency, owing to the fact their temperature is lower. However, not all this radiation returns to space. The GHGs absorb a substantial portion, insofar as such radiation has a lower penetrative capacity than that coming directly from the sun. Thermal equilibrium is achieved when the energy from the sun is offset by that irradiated out to space.

Evidently, this thermal equilibrium may be seriously affected if, for whatever reason, the concentration of GHGs in the atmosphere increases. That would bring about a greater absorption of the radiation reflected on the Earth’s surface and a reduction in the heat expelled to space. The upshot would be a greater heating up of the planet, what we know as the “greenhouse effect”. Such global warming is at the source of CC, understood as a significant and lasting change in global and local climate standards. This is manifest in the atmosphere and oceans warming, in the changes in the water cycle, in ice and snow loss, in rising sea levels and in the emergence of new, extreme climate phenomena. The stock of GHGs built up in the atmosphere will largely influence the dynamics of increased global warming. This effect will be durable and last for centuries, even if GHG flows were to drop drastically from a certain point in time.

2 Evidence of climate change

It was in the 1820s that the French physicist Jean-Baptiste Fourier analysed GHG properties, and it was the Swedish chemist Svante Arrhenius, the 1903 Nobel prize-winner, who asserted for the first time in 1896 that the levels of CO_2 affect the Earth’s thermal balance. Science, then, has been abreast of this grave problem for over 120 years.

The latest Nobel prize-winner for Economics, William D. Nordhaus (2018a), stressed this fact in his Nobel Banquet speech on 10 December last year, noting that "The science of climate change was founded in 1896, the very year that Alfred Nobel died and established these prizes. In that year, the Swedish chemist Svante Arrhenius provided the first numerical prediction of the impact of doubling atmospheric carbon dioxide. His estimate of 5.1 °C is remarkably close to the figures produced by the highest-resolution models today".

The analysis of economic activity over recent centuries highlights the clear causal relationship between economic growth and GHG emissions, whereby their atmospheric concentration has gradually and uninterruptedly increased in step with emission flows. These flows have varied in accordance with the related economic cycles, with the transformation of the electricity generation industry and with the changes in land use. Undeniable technological developments have, over time, meant that each unit of GDP requires fewer GHG emissions, i.e. what we call the "carbon intensity in the economy" has slightly decreased. However, there is no improvement whatsoever in the indicator we know as "carbon intensity in energy supply" (CO_2 emissions/total primary energy supply), which has held virtually constant. Clearly, there is much room for improvement in this indicator, or expressed otherwise, it is necessary to supply primary energy that generates fewer CO_2 emissions.

The NOAA (US National Oceanic and Atmospheric Administration) website [see NOAA (2019a)] states that the average GHG concentration in the atmosphere, in terms of CO_2 equivalents, was 496 parts per million (ppm – the units in which these types of concentrations are expressed) in 2018, whereas in 2000 it was 441 ppm. In terms of the annual average concentration exclusively for CO_2, the attendant figure was 408.5 ppm for 2018, and 369.5 ppm for 2000.

It is particularly disappointing to see that, in the years in which we are discussing how we should be reducing CO_2 emissions, the amount we are sending up into the atmosphere is clearly accelerating. Indeed, three of the last four increases in CO_2 have been the highest directly recorded since 1959 at the Hawaii Mauna Loa observatory [see NOAA (2019b)]. This concentration has increased by 46% from the pre-industrial era level of 280 ppm.

As reflected in the recent September 2019 report, "State of the Climate in 2018" [see NOAA (2019c)], GHG levels are the highest recorded in the last 800,000 years. The records are direct measurements from the last 60 years and correspond to the values calculated drawing on samples in the air bubbles trapped in successive layers, at different depths, in the Antarctic and Greenland ice platforms, which can be dated at up to 800,000 years. This is an annual report that has been drafted for the last 29 years, under the leadership of NOAA scientists, and published in the Bulletin of the American Meteorological Society. More than 500 scientists from 65 different countries contribute to its content.

As a result of the progress in recent decades, CC science enables a distinction to be drawn between which part of global warming is due to human activity and which to a process of natural evolution. There are of course other natural factors that also affect changes in temperature, such as the relative position of the Earth's orbit around the sun, and changes in volcanic activity and in solar activity. But what is true is that scientific results state, for example, that in the last 50 years these natural effects taken as a whole have contributed, albeit very weakly, to global cooling and not to warming [see the Global Warming Index, GWI (2019), jointly published by the Universities of Oxford and Leeds].

Since the analysis of CC requires the use of complex and calibrated models including numerous and diverse natural sciences-related aspects, a certain lack of transparency is usually attributed to it. And this is frequently used in the public debate domain to question its results. Consequently, and for those economists interested in this problem, the papers by Stock (2019a and b) may be of interest. By means of a rigorous and readable econometric analysis, the papers validate the findings of these types of more complex models. Indeed, James H. Stock also reaches the conclusion that, essentially, all of the temperature increase since the pre-industrial era is anthropic and that two-thirds of it has been after 1975.

Recall that in the absence of GHGs the average temperature of the Earth would be –6 ºC, whereas with these gases present today in the atmosphere it is 15 ºC, i.e. 21 ºC higher. Evidently, then, temperature is enormously sensitive to GHG concentration levels. This is why the increases in GHG concentration since before industrialisation are so worrying. The problem is not simply one of an increase in temperature, but also of a drastic change in the conditions in which humanity and ecosystems have evolved over time. However, the expressions "climate change" and "global warming" are usually used interchangeably to describe this phenomenon.

At present it is now impossible to include in an article such as this the vast amount of published and substantiated scientific information, as is also the case with the analyses by institutions and organisations that confirm that the CC taking place has an anthropic origin. Indeed, this is not the place to refer in detail to such solid scientific evidence. The reports by the Intergovernmental Panel on Climate Change [IPCC; see IPCC (2014)] do so with the utmost rigour. Specifically, their synthesis reports include and summarise the activities of Working Group I, which is responsible for updating the CC scientific base, and of Working Groups II and III, which are responsible for assessing the impact of CC on human and natural systems, and the means with which to tackle the challenge posed.

The IPCC was created in 1988 by the United Nations Environment Programme and by the World Meteorological Organisation. It does not conduct its own research but rather uses in its reports material from the most accredited and reviewed scientific

literature. That same year, the United Nations General Assembly endorsed the decision to create the IPCC. The first Working Group report was published in 1990, followed by those in 1995, 2001, 2007 and 2013-2014. In 2007 the Group received the Nobel Peace Prize. Currently, 195 countries are IPCC members. The Panel meets at least once a year in plenary sessions.

3 The economics of energy transition

At the above-mentioned Nobel award ceremony, Professor Nordhaus stressed that "Over the last half-century, the full implications of climate change and its impacts have been illuminated by the intensive research of scientists in different fields. These studies depict an increasingly dire picture of our future under uncontrolled climate change. The signal contribution of economics is to recognize that climate change is a harmful unintended side-effect of economic growth, known in economics as an external effect or externality".

In fact, externalities may arise when not all the costs or benefits of an activity can be assigned exclusively to the economic agents undertaking such activity and, therefore, they may not take them into account when taking decisions on the allocation of their resources. Generally, the presence of externalities gives rise to the attainment of equilibrium under a competitive system not being optimal. Hence, inefficiencies arise since, as it considers exclusively its own costs, the producer of the good giving rise to the externality produces a smaller/greater amount of this good in the case of positive/negative externalities than an optimal situation would warrant. Clearly, in the case of CO_2 emissions, those responsible generate external negativities, since they inflict harm on other economic parties. The cause of this harm lies in the fact that the prices assigned to these types of goods do not reflect the costs of having emitted GHGs.

This externality has four basic characteristics. First, its global nature, i.e. GHG emissions arising in China have the same effect as those generated in Spain. Second, its long-lasting impact; once in the atmosphere these types of gases stay there for a very long time, for centuries even, meaning that the climate in 50 years' time is already influenced by today's emissions and levels of GHG concentration. Third, uncertainty; i.e. the problems of CC cannot be tackled in a determinist environment, since there is no certainty as to what the final effects are. In any event, scientific progress in recent years enables a set of predictions within reasonable confidence intervals to be formulated. And fourth, its potential to cause radical and irreversible changes and harm. As stated over ten years back in April 2008, in the first paragraph of the International Monetary Fund World Economic Outlook's chapter on CC [IMF (2008)], "climate change is a potentially catastrophic global externality and one of the world's greatest collective action problems".

Insofar as the negative externalities that fossil fuel use generates – especially GHG emissions – are not taken into account, this energy is in fact doubly subsidised. First, because environmental costs are not reflected. And further, on the figures provided by the International Energy Agency (IEA) [see IEA (2019a)], because fossil fuels directly received more than $400 billion in subsidies to the end-consumer and as inputs to electricity generation in 2018. Of this latter figure, around 30% still relates to the G20 countries. The changes that can be seen in these figures from one year to the next are, essentially, associated with the decline in international energy prices and not with a change in subsidy policy. And this despite the reiterated calls at G20 meetings, since 2010, to "rationalize and phase out over the medium term inefficient fossil fuel subsidies that encourage wasteful consumption" [see IEA (2010a and b)].

The economic policy instruments designed to address the problems of CC have different theoretical fundamentals and different levels of sophistication. Their complexity stems from the fact they have to take into account many economic sectors and countries with very different levels of development, and, ultimately, they have to accommodate the so-called stakeholders (the various authorities and pressure groups represented by agents with interests in this process).

Three criteria should underpin the assessment of CC policies. Firstly, effectiveness, i.e. they must result in levels of GHG emission that maintain the risks derived from CC at acceptable levels. Secondly, efficiency, i.e. they should minimise the costs associated with the ongoing reduction of emissions. Thirdly, equity, which in this case is no minor requirement since the developed countries are responsible for most past emissions and the under-developed countries are those which will suffer the consequences of CC to a greater extent.

Economic measures may be grouped into two broad categories: first, the mandate and control instruments; and second, market instruments.

The mandate and control regulations require specific behaviour on the part of economic agents that normally translates into setting maximum gas emission ceilings and penalising non-compliance. Initially, the certainty provided by such methods is an advantage since, by making compliance with regulations obligatory, the proposed emission targets are met. However, in terms of economic efficiency, they only ensure static efficiency and, moreover, they do so only under the assumption – one that is unreal in practice – that all agents affected by the regulations have the same marginal costs curve in respect of emission reductions. In theory, these types of regulations treat all agents equally. In practice, however, certain exemptions usually break the principle of equity. The lack of efficiency and the few incentives generated for innovation are sufficient arguments for them not to be used. These regulations may be warranted when the optimum level of emissions is zero or very low, or when agents operate in non-competitive environments and, therefore, are not sensitive to price changes.

The market instruments are those that generate incentives for economic agents to reduce their emissions or develop less polluting technologies. GHG emissions have been seen to give rise to negative externalities, generating a divergence between the private costs and the social costs of emissions that leads to economic inefficiency.

Elementary economic principles indicate that the sole means of mitigating GHG emissions involves equalling both types of costs (private and social), which is equivalent to passing the related cost on to the user. The same principles also state that it is rather unrealistic to expect substantial reductions by appealing only to a sense of responsibility on the part of citizens that lead to changes in their consumption habits towards less carbon-intensive products.

Against this background, two theoretical approaches are used to address negative externalities: the setting of taxes, following the pioneering work by Pigou (1920), and creating markets for transferable emission permits along "cap and trade" lines, with the support of Coase's theorem (1960). See Terceiro (2009) for a more detailed outline. In any event, adopting either of these solutions is a secondary issue here, which does not question the basic principle of having the private costs of emitting GHGs equal the social costs.

The highly superficial criticism usually levelled at subsidies for renewable energies often lack any economic fundament. Unlike fossil fuels, renewable energies generate positive externalities. This is because the developments by one specific firm can be swiftly emulated by others, which do not even belong to the same sector, and therefore this firm does not appropriate all the benefits from its investment. This process is known as "technological spillover", which is no more than the external benefit arising when the knowledge derived from the initial investment spreads to other firms and individuals. This possibility of appropriation by third parties leads to a lower than socially desirable level of investment. Just like the use of taxes in the case of negative externalities, the related subsidies are warranted, usually taking the form of legal regulations that encourage specific technologies and that set the appropriate institutional frameworks.

The solution to the problem of CC necessarily involves simultaneously correcting the two types of market failings in this situation: the negative externalities generated by GHG emissions and the positive externalities generated in the development and roll-out of renewable energies.

Evidently, although this theoretical approach is impeccable, practical difficulties arise when it comes to assessing the positive externalities. Compounding this are the problems that arise on setting the complementarity or substitutability of public and private investment. It should therefore come as no surprise that there are as many successes as there are failures in this area. However, let us focus on the proposal to pave the way for an appropriate

energy transition. The fact that the problem to be tackled is chiefly characterised by its above-mentioned globality, long-term nature, uncertainty and irreversibility, coupled with the fact climate stability is a public good, means that public policies should play a more relevant role than in other situations of negative externalities. It should be considered as a circumstance akin to that which arises with the positive externalities generated by education, which justifies the public funding education receives, even when they are also very difficult to evaluate.

Once again, the interests of fossil fuels have been better represented here not only in governments, but also in the media. This is because public opinion has an overinflated idea about the subsidies for renewable energies, when the truth is they do not total half of what fossil fuel energies receive. And this without bearing in mind, as earlier indicated, that the price of solid fuels is implicitly subsidised, on a far greater scale than cited here, since the cost of the negative externalities they generate is not included.

4 Lobbies and merchants of doubt

It is a well-known fact in today's world that there has been an exponential increase in the circulation of myths, illusory promises and unsubstantiated scientific facts, and the denial of proven facts. In some cases it is a question of simple lies, which are spread in numerous areas and at many different levels. Naturally, this is not only happening in the case of CC; it is also affecting many other aspects of social and natural sciences.

For example, in June 2017 the United States pulled out of the 2015 Paris Agreement on CC, with the following statement by its president: "In order to fulfil my solemn duty to protect America and its citizens, the United States will withdraw from the Paris Climate Accord". And he did so in a speech giving 18 reasons justifying this decision. It is worth analysing the document released, two months later, by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, refuting each and every one of these 18 reasons. In light of the texts approved at the Paris Conference, 12 of these alleged reasons are false and the other six are, simply, equivocal statements.

As Pinker (2018) rightly states in his recent book Enlightenment Now, "Yet today the beauty and the power of science are not just unappreciated but bitterly resented. The disdain for science may be found in surprising quarters: not just among religious fundamentalists and know-nothing politicians, but among many of our most adored intellectuals and our most august institutions of higher learning".

It is then worth summarising the types of strategies behind these behaviours. For several decades now they have been setting back the possibility of addressing a true energy transition resolutely and rigorously. Such moves are placing us in a dangerous position, where much is at stake, and which Professor Nordhaus (2015) has called the "climate casino".

It should first be said that most affirmations in CC science are made in terms of probability, and as such no statements on the results provided by CC science can be made with absolute certainty. In this situation marked by a lack of certainty, those who question scientific achievements are peddling doubt as a product to public opinion. This is the opinion put forward by Professor Oreskes and Professor Conway (2010) in their original book Merchants of Doubt. With numerous examples, they highlight how the strategy used and continuing to be used by the fossil fuel industry is almost identical to that employed earlier by the tobacco industry.

The response of the international community to this matter is set out in Article 3 of the United Nations Framework Convention on Climate Change [see UNFCCC (1992)], in force since 1994. Among other statements it maintains that "where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures [to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects]".

This attitude of waiting for uncertainties to dispel and meanwhile addressing more pressing problems has two serious disadvantages. The first is the fact that, while waiting, the problem continues to worsen and the stock of GHGs carries on increasing at very significant rates, with the risk of specific and dangerous concentration thresholds being breached. The second is that, also in the meantime, fossil fuel infrastructure continues to be constructed and investment and capital committed in tremendously high amounts. This behaviour will exacerbate the problem of the overall fossil fuel energy-related assets, which form part of our growth model and which, necessarily, will not be usable in the process of energy transition. These types of assets, known as "stranded assets", will be evaluated in the final section of this article.

When the argument used is the high costs that combating CC entails, one mistake should be avoided. This is, namely, considering the investment to mitigate CC as an exercise that involves subtracting a specific amount of resources from social welfare. Rather, it should be considered as the choice of a different path for technological and economic development, which will lead to the use of renewable energies with the aim of avoiding immense and eminently likely risks. In any event, the investment is relatively modest. For example, the cost for the United States of fulfilling the Paris Agreement (COP21) has recently been estimated by Heal (2017) as between 0.2% and 0.7% of annual GDP. This would be the cost of reducing 80% of 2005 emissions by 2050. It should be stressed that whatever the figure taken in respect of the cost

of acting against CC, within the natural uncertainty a problem of this nature entails, the cost will always be several orders of magnitude below what, for example, the last financial crisis involved. Furthermore, this latter figure should not be confined simply to the assistance of financial system has received from governments. To characterise it as a whole, regard should be had to the negative externalities it has generated and that the other economic and social agents have undergone. Many of the consequences have not been simply static in nature; rather, they will run for years and some others will be permanent. Under this approach, many different papers have quantified the cost of the financial crisis. Annex 1 of the paper by the Bank for International Settlements [BIS (2010)] gives a summary of this literature to date. The numerous studies analysed provide an average cost of 106% of global GDP prior to the crisis, and the median stands at 63%. In particular, the work by Haldane (2010), the Chief Economist at the Bank of England, quantifies this cost at between 90% and 350% of global GDP in 2009. This significant interval of variation depends on the assumption made regarding which portion of the costs incurred in 2009 are permanent. As is well known, when the dynamic nature of this annual sequence of losses is considered, a fundamental variable in the final result is the rate of discount used, which in this case is 2.5%.

Another type of opposition to the energy transition is the fact that experience shows that seeking to correct market failings, through public intervention, has occasionally worsened the starting position. Examples of ill-executed public interventions are at the source of much of the reluctance to combat CC, given the belief that the regulator's mistakes always exceed the market's failings. This way of thinking tends to be against any type of public intervention and is wary of them, sometimes – no doubt – with good cause. Since there is awareness that accepting the free use of fossil fuels entails costly and global negative externalities and, consequently, that resolute public intervention is required that many are wary of, an attempt is made to avoid the issue by taking the easiest way out, which is calling into question what science has affirmed. Given that public intervention is not acceptable, the relevance of the scientific results is denied. From this standpoint, we could state that the opposition to the evidence of CC has more to do with ideology than with science.

However, the energy status quo, which this rationale seeks to maintain at any cost, is not characterised by a lack of public intervention. We need only acknowledge, as the *World Energy Outlook* [IEA (2018)] does, that over 70% of the $2 trillion of annual investment in energy worldwide – in all activities and sectors – is carried out by government-run entities or others whose revenues are supported and backed by public regulation.

It might thus seem that the defence of the energy status quo has no justification whatsoever when adopted by those positions allergic to public intervention. The justification of this apparent contradiction is as follows. Any fledgling economist knows that if resources are to be efficiently allocated in a market economy, certain

conditions must be met. If some of them are not fulfilled, a market failure arises. Naturally, correcting such failures requires public intervention. Two types of government intervention in the economy may occur: the first corrects the market's failures and enables it to work better; the second, on the contrary, protects specific private interests to the detriment of the economy's competitiveness. The first type promotes and is in favour of the market economy, and the second simply favours specific firms, which in the energy sector almost always protect the status quo. This is why economic policies favouring the market should be clearly differentiated from those others favouring firms, in this case fossil fuel companies.

Lastly, mention should be made of the stance, in the face of CC, of those who, while accepting the predominant scientific interpretation, limit themselves to highlighting what they think are its positive aspects. They suggest routing investment against CC towards other economic activities that generate greater economic growth today, so as to be better placed to face the costs of adapting to future increases in temperature. These agents are known as "lukewarmers" [see Michaels and Knappenberger (2016)]. They thus take the line, for instance, that reasonable increases in temperature will be bearable, and will even generate benefits such as better harvest yields in many developed countries. Or they point to other types of advantages, such as the fact that the Arctic melt will enable an increase in maritime trade and traffic as the Arctic becomes more navigable. As is well known, control over an international trade route is a most valuable asset. This is why there are powerful incentives not to be concerned about the climatic catastrophe this loss of ice mass involves. These are, then, the types of benefits the "lukewarmers" perceive. While not rejecting CC, they assure that its intelligent management will bring benefits of this type. That enables them to continue playing in Nordhaus's "climate casino" (2015). Yet they do, in their discourse, make a special point of distancing themselves from the out-and-out deniers. That is to say, they are the diplomatic advocates of the status quo.

5 The energy non-transition

In the past ten years the costs of solar and wind energy have fallen by 90% and 70%, respectively, and this trend will no doubt continue. Yet even today fossil fuels – coal, oil and gas – provide 80% of energy worldwide. Going somewhat further back in time, it is worth noting that when the incandescent light bulb was developed in the late 1870s, its cost was four times greater than that of gaslight. Today, light costs 200 times less than in those days, although for a long time it was cheaper to use candles and oil lamps. These two examples of a drastic reduction in the prices of energy sources might suggest that technological changes of this nature should lead to authentic energy transitions. But we will see below that this is not the case.

Economists usually think it is not always a good idea to extend the life of old technologies, in regulated markets, with the aim of hampering the entry of future technologies. But this is what is happening. It would seem more logical to propose that new technologies replace old ones. That is when we would see a real transition. But such a transition has never taken place in the history of energy, and the CC challenge will no doubt require this. We can justify this statement by citing the figures set out by Newell and Raimi (2018).

The world has never undergone a genuine energy transition. What has actually happened is that new energy sources have added to the old ones already in place. They never replaced them. This has been the reality over the past 200 years, which is no doubt reflected in the records of GHG concentration levels in the atmosphere and in their annual growth rates.

Let us take the four basic fuels used over this period: biomass (chiefly wood), coal, oil and natural gas. These are at the root of the serious CC problem. In 1800 biomass provided almost 100% of the world's energy; today this figure is only 10%. Coal, the driving force behind the Industrial Revolution, accounted for 44% of global energy in 1925, and this figure has today dropped to 28%. Oil and natural gas began to be pivotal after the Second World War, and together rose to represent 62% in 1973, a figure that has since fallen to 53%. The course of these figures marks the narrative of the so-called "global energy transition". But properly viewed, this transition has never taken place. Let us see the developments from another angle.

Neither the consumption of biomass or of coal has actually diminished. From 1800 to the present day, biomass consumption has increased by approximately 275% and it continues to be the main source of energy for billions of people. Since 1900, the use of coal has increased more than eightfold; and since 2000, by over 60%. Nor have oil and gas consumption declined; indeed, it has approximately doubled since 1973. Clearly, then, the emergence of new fuels has never crowded out the old ones, since the latter have continued to grow at most considerable rates. Instead of ousting the former fuels, oil and natural gas, then nuclear power, and more recently wind and solar energy, have added to those already in place. There has been no substitution, only addition.

This non-transition is all the more worrying when we look at the latest figures for investment in the different types of energy, old and new alike. Indeed, according to the latest report by the International Energy Agency [see IEA (2019b)], investment in renewable power in 2018 amounted to $304 billion. While a respectable amount, it remains far off the figure of $933 billion for investment in fossil fuels. Expressed more specifically, only one-third of what has been invested in fossil fuel energy was invested last year in renewables. For a genuine energy transition we need a fossil fuel-replacement process, not merely a simple addition of renewable energies. Otherwise, it will hardly be possible to reduce the current flows of GHG emissions.

There is an enormous contradiction between what governments say they are going to do and what they actually do. And then in turn, too, between what they do and what the world needs to move to an energy system with the aim of decarbonising the production of electricity and reducing the energy obtained from fossil fuels heeding the criteria of effectiveness and economic equity. The question then is the following. Why are we stuck in this situation?

We must acknowledge that the characteristics of the negative externalities that were outlined in detail hamper any solution enormously. This is because neither the tools nor the institutions to solve problems of this nature are at present available. At issue are global long-term losses set against necessarily local and immediate investments. Against this background, the Governor of the Bank of England talked in a landmark speech about the "tragedy of the horizon" [see Carney (2015)].

Years earlier, this dilemma was admirably summed up in the first paragraph of Chapter 1 of *The Oxford Handbook of Climate Change and Society* [see Dryzek et al. (2013)], in which its three editors state that: "Climate change presents perhaps the most profound challenge ever to have confronted human social, political, and economic systems. The stakes are massive, the risks and uncertainties severe, the economics controversial, the science besieged, the politics bitter and complicated, the psychology puzzling, the impacts devastating, the interactions with other environmental and non environmental issues running in many directions. The social problem solving mechanisms we currently possess were not designed, and have not evolved, to cope with anything like an interlinked set of problems of this severity, scale, and complexity. There are no precedents. So far, we have failed to address the challenge adequately. Problems will continue to manifest themselves – both as we try to prevent and as we try to adapt to the consequences of climate change – so human systems will have to learn how better to respond. One of the central social, political, and economic questions of the century is: how then do we act?".

6 International agreements: effectiveness, equity and credibility

The global nature of the negative externality CC represents and scientific forcefulness regarding the anthropogenic character of CC have led to attempts to create international coalitions to define a carbon price that takes into account its social costs, and smooths transition to another energy system. However, as the 2014 Nobel Prize winner Professor Tirole (2017) acknowledges, the results forthcoming to date have, in practice, been disappointing.

The United Nations Framework Convention on Climate Change (UNFCCC) was signed in 1992 as part of what is known as the Rio de Janeiro Earth Summit. The Kyoto Protocol, adopted in December 1997, gave binding force to what had not been

achieved five years earlier. It is the first attempted international agreement aimed at reducing GHG emissions. It did not come into force until February 2005. In 2009, 187 states had ratified it, although the United States never did, despite the fact that until its entry into force this country was the biggest GHG emitter; since 2005 China has been the main emitter.

The "Parties to" or members of the Convention met several times in successive years. Notable among these meetings was the XV International Conference on Climate Change in Copenhagen in 2009, known as COP15 (Conference of the Parties). The aim was the "conclusion of a legally binding agreement on climate, valid worldwide, to be applied as from 2012". However, this summit was promptly declared a failure, as actually came to light years later in practice.

As a result of the limited participation in the Kyoto Protocol, and given the lack of agreement at the Copenhagen 2009 summit, the European Union (EU) forged an extensive and ambitious coalition of 195 developed and developing countries, that had been present at the December 2015 Paris Conference. An initial binding agreement to reduce GHG emissions was signed, establishing a transition between current policies and the climatic neutrality that should be in place at the end of the current century. This transition should lead to GHG emissions peaking as soon as possible, although they acknowledge that in the developing countries the process will be longer. Subsequently it should be possible to apply rapid reductions based on the improved scientific criteria available. A global action plan has been determined to maintain the cap on global warming far below 2 ºC above pre-industrial levels, with the aim of achieving a maximum of 1.5 ºC. In this connection, before and during the Paris Conference, known as COP21, countries unveiled their related national action plans against CC.

At the Paris Conference the IPCC was invited to prepare a report which, on the latest scientific evidence, would analyse the impacts of global warming of 1.5 ºC above pre-industrial levels. This report [IPCC (2018)] was presented in October 2018. Among other conclusions, it warns that on current GHG emission trends an increase of 1.5 ºC between 2030 and 2052 is very likely. This would assume there is an appreciable risk of not meeting the more ambitious Paris Agreement target in little more than a decade. One of the conclusions of this latter report, as indicated at the outset of this article, is that the reality of climate change exceeds the most pessimistic forecasts. The energy transition required is on a large scale and unprecedented. It will need to have a bearing on electricity generation, transport, industry, agriculture and cities.

The most notable outcome of the COP24 in Katowice (Poland), in December 2018, was to have agreed on the rules regarding transparency and the calculation of gas emissions and the reduction commitments assumed by each country under the Paris Agreement. In any event, three years later after the signing of

this agreement, it has still not been possible to finalise all the rules to be applied. The outcome is actually rather paltry. It highlights the difficulty of the international fight against CC. Moreover, and unfortunately, it should be stressed that at the Katowice Summit four countries of great significance in GHG generation, namely the United States, Russia, Saudi Arabia and Kuwait, prevented the acceptance of the aforementioned IPCC report commissioned four years earlier at the Paris Conference. Once again, fossil fuel interests stand above scientific evidence.

The Paris Agreement was very ambitious and considers the correct solution. Undoubtedly, it was a notable diplomatic success. Yet as Tirole (2017) indicates, to be really successful in practice and promote the necessary energy transformation, such agreements should be effective from the economic standpoint, and equitable and credible. That is to say, there must be incentives in place so that what was agreed may be observed. Let us see to what extent this latest major agreement on the energy transition meets these three requirements.

Regarding effectiveness, the reality was that the diplomatic objective of reaching a unanimous agreement among the 195 delegations ignore the pressing need to set a carbon price. As earlier indicated, this carbon price is the basic recommendation for the internalisation of the negative externalities of GHGs.

If an agreement binding all countries is not reached, those who do not feel bound act as free-riders, i.e. they would have the rest resolve the problem without they themselves being prepared to do anything. This situation is not exclusive to the problem of CC; it also arises in those cases in which what are known as “common goods” are present, and climate stability is one such good. One of the characteristics of this type of good is non-excludability, meaning that there is free access to the use of this good whereby nobody may be excluded without prohibitive costs.

To avoid this situation, many economists have proposed an alternative to and more realistic solution than the unanimity of all countries. Two recent Nobel Prize winners are among them: Tirole (2017) and Nordhaus. Professor Nordhaus (2018b) revisited the issue in his above-mentioned lecture on 8 December at the University of Stockholm, on the occasion of the Nobel Prize award. The solution consists of creating an “international climate coalition”, which he calls the “climate club”. This club would initially bring together a significant number of countries based on the GHGs they emit. They would all commit to setting a carbon price. Countries that did not participate in this initial phase would be encouraged over a limited period of time to join the coalition. These types of coalitions have three basic characteristics: their members benefit from certain economies of scale by advancing together; they all pay to belong to the coalition;

and, finally, they have the capacity to exclude from the coalition those countries that are not prepared to pay to join it, and whose behaviour would be tantamount to commercial dumping. As a result, the coalition members should have the capacity within the World Trade Organization (WTO) to impose a tariff on the exports of non-member countries. The WTO, it should be recalled, has over 160 member countries accounting for 98% of world trade. The pillars on which it rests are the agreements negotiated and signed by member countries and ratified by their respective parliaments.

Regarding problems of fairness, it should be borne in mind that the more prosperous countries are those that have most contributed to the stock of GHGs. For example, since the Industrial Revolution, the United States and the EU are responsible for half of the emissions. That said, various other nations such as China, Russia and India are increasingly contributing to this stock. In particular, China's emissions last year represented 30% of the total. Accordingly, the Paris Agreement is committed to annually providing funds to developing countries, amounting to $100 billion in 2020, and to increasing this figure before 2025. However, an explicit and detailed allocation of these amounts to the various developing countries is lacking. Over three years since this agreement was signed, it now seems clear that the developing countries will not receive next year the $100 billion agreed on.

Moreover, as Chancel and Piketty (2015) have highlighted, there is not only a problem of inequality in emissions among countries, but also among individuals. These authors estimate that 10% of the world's wealthiest population is responsible for 45% of global emissions. Approximately, this same ratio holds for each of the countries considered individually. Accordingly if, when setting a price for GHG emissions, the different carbon footprints of citizens are not taken into account, those with the lowest income levels may wrongly be penalised. The solution to this problem is not complex and the idea is that of the "double dividend": the setting of a price which, in addition to reducing GHG emissions (first dividend), allows, using all or a portion of the revenues raised by this tax, for the reduction of other types of taxes, in particular those on the lowest incomes (second dividend). This redistribution process is readily applicable in a most transparent way through income tax. Even if the refund were total and equal for all citizens, without taking into consideration their level of income, this transfer would have a progressive effect.

Similar situations can be presented when other types of decisions needed in the energy transition process are applied. This is the case of the elimination of the subsidies or tax benefits that the majority of the most polluting fossil fuels enjoy today. Frequently, the political justification for this type of subsidy is the protection of low-income citizens. In practice, exactly the opposite occurs, i.e. they have clearly regressive consequences. Indeed, a recent paper by Gass

and Echeverria (2017) drawing on several international studies indicates that only 7% of fossil fuel subsidies are targeted on the lowest distribution quintile, i.e. the 20% of the population with the lowest income. Meantime, the 20% of the highest incomes receive 40% of the subsidies.

When evaluating the social effects of specific measures aimed at smoothing the energy transition, the starting disparities which were just referred must be borne closely in mind. Naturally – and essentially – this is for reasons of fairness, but also to avoid, or to explain more rigorously, such spontaneous and clear-cut movements as the "yellow vests" in France. This movement arose against increases in the duties on certain types of fossil fuels. As indicated, it is not exactly those who took part in these protests who are the main beneficiaries of the low duties and subsidies on the fossil fuels that they use in their productive activity.

Finally, regarding the credibility of the agreements adopted in Paris, we should acknowledge that the only mechanism envisaged for all countries to meet the objectives to which they have committed is to name and shame those that do not comply with them within the periods established. Clearly, this must be done, and it is a necessary condition. However, such "stigmatising" of countries is not sufficient, as is shown by the experience stemming from the Kyoto Protocol more than 20 years ago. Non-compliant countries always have the possibility of brandishing all types of excuses to justify their failure to comply, e.g. an economic recession, budgetary problems or corporate and employment difficulties in the fossil fuel sectors affected by the commitments acquired.

Despite the failings – or rather shortcomings – of the international agreements to define and implement a genuine energy transition, not everything is a reason for pessimism. Some years ago James Hansen, ex-director of the NASA Goddard Institute for Space Studies (today part of the University of Columbia), and one of the scientists most active in transmitting to society the need to change our energy model, said that the scientific consensus on CC was not passing through properly to public opinion. He stated that society was receiving the message that a low carbon-emissions economy would mean all sorts of deprivation, which is obviously not true. Since then, public awareness that this is the most serious and complex collective action problem in the history of humanity has increased notably. Examples and surveys substantiating this statement abound. Moreover, several dozen countries, including most notably some in Europe, have taken and implemented in practice, with differing levels of success, the decision to set a carbon price. The EU has also pursued a series of initiatives and proposals since the early 1990s. The most recent of these was unveiled on 28 November 2018. It represents the long-term strategic view for an economy to be prosperous, modern, competitive and climate-neutral in GHG emissions by 2050. It is a proposal in line with the Paris Agreement, whose weaknesses have been discussed above.

7 The financial system in the energy transition

The economic and social problems currently addressed by both the developed and the developing countries – many of which stem from the last financial crisis – might lead us to believe that there are more important issues to be prioritised, ahead of the possible impacts that CC may have on the levels of well-being of future generations. However, we should remember that the financial crisis, the effects of which we are still suffering, was basically a consequence of over-emphasis on the short term for too long when setting profit targets and the incentives for economic agents. Moreover, prices and risks were mismanaged and wrongly valued. The result has been an excess of toxic assets and over-indebtedness of governments, businesses and households.

Similar mistakes are now being committed in relation to CC, with an over-emphasis on short-term problems and the use of excessively high discount rates for others, the full extent of which, as in this case, will only become apparent over a longer time horizon than that of a financial crisis. For some time the financial system has been generating too many toxic assets. Similarly, the current energy infrastructure has for decades been producing excessive GHGs. These situations both illustrate once again that when the price of a good does not reflect the costs and risks entailed by its use it will be consumed excessively. And that is precisely what has happened in the financial system and what is happening in the energy system.

Likewise, risks are being wrongly valued today, given the basic characteristics of the negative externalities that GHG emissions generate: they are global, their impact is in the long term, they are uncertain and the damage generated may be radical and irreversible. This misvaluation leads, as indicated, to fossil fuel prices failing to reflect environmental costs, especially the costs of GHG emissions and therefore sends the wrong signals to the market regarding the true cost of their production.

On 21 March 2019, the European Commission organised a conference on a global approach to sustainable finance [see EC (2019a)]. It was recognised that developed and developing countries today face a serious investment gap in delivering on the Paris Agreement. In fact, as referred to by the Commission, the Organisation for Economic Co-operation and Development (OECD) [see OECD (2018)] estimated that $6.9 trillion of annual investment in energy, transport, buildings and water infrastructure will be required up until 2030. We are clearly far from being able to ensure financing of this volume over the 15-year horizon since the Paris Agreement. Even greater investment will be required if, instead of 2 °C above pre-industrial levels, it is intended to cap global warming at 1.5 °C, as recommended by the ICCP. An unprecedented transformation of current infrastructure is required to achieve the proposed targets. During this conference it was made clear that the financial sector needs to play a fundamental role in mobilising private investors to finance projects of this type. This situation presents the financial system with a significant set of

opportunities. Even so, this transition process also involves major, real risks, which by their nature are not readily quantifiable.

In an acclaimed, and already mentioned, speech in 2015 Carney put great stress on the fact that the potentially catastrophic effects of CC will only become fully and brutally apparent over time horizons beyond those considered by financial institutions in their strategic planning exercises. These costs will basically fall on future generations, so that today there are no direct incentives to address possible solutions. Moreover, monetary policy horizons are usually two to three years, while those for financial stability are linked to the credit cycle and may stretch to 10 years. However, the most serious problems arising from CC will only become fully apparent over longer time horizons. Hence, Mark Carney's "tragedy of the horizon".

But, the problem is that the type of risks that arise from CC only materialise over long horizons, while they would be all the more manageable the sooner that a true transition begins to a low carbon economy begins. This would follow predictable patterns, based on scientific results and specified in binding, credible agreements.

Basically there are three types of risk that the financial system needs to consider in the CC process. First, there are physical risks, arising from adverse climate-related phenomena, such as floods and storms, which may damage property and even disrupt production and commercial activity. Insurance companies began to recognise this type of risk some years back [see Lloyd's (2014)].

Second, there is the risk arising from the compensation that may be sought from businesses and activities responsible for GHG emissions. These are known as liability risks.

Third, there are so-called transition risks, which arise from the implications for the financial system of the transition to a lower carbon economy. This process will necessarily lead to a significant change in the value of some of the assets of fossil energy intensive businesses, the activity of which will be replaced by new renewable energy technologies. The reduction in the value of many of these assets will occur as a consequence of the regulations that eventually fix a price for GHG emissions and of the fall in the demand for fossil energy, given the more competitive prices of renewable energy.

A number of professional and academic institutions have analysed the maximum amount of GHGs that may be emitted before the year 2050 for the temperature rise to remain within the limits envisaged in the Paris Agreement. This maximum amount is known as the "carbon budget". The various models and hypotheses used for this calculation are summarised in a Carbon Tracker Initiative (CTI) paper [see CTI (2018)]. We need to be aware of these as they are one of the reasons for the differences between figures published. For example, the carbon budgets published by the IEA

and the IPCC are not directly comparable. The IEA only calculates the carbon budget for the energy sector, the major source of GHG emissions. By contrast, the IPCC budget takes into account all anthropic sources of GHG. At all events, the existence of this "carbon budget" constraint has a significant impact not only on the value of the fossil energy reserves recognised in the financial statements of energy businesses, but also has a significant impact on many of the assets of businesses that transform or use fossil energy. Among other institutions, the IEA, the IPCC and the Grantham Research Institute on Climate Change and the Environment have been warning about this situation for years.

McGlade and Ekins (2015) point out in an article in *Nature* that only about one third of the GHGs contained in the estimated coal, oil and gas reserves can be used if the Paris Agreement are to be complied with. Carney (2015) stresses this fact, noting that 19% of FTSE 100 companies are in natural resource and extraction sectors, and a further 11% in power utilities, chemicals, construction and industrial goods sectors.

In any case, these "stranded" or unusable assets in fossil energy reserves only affect "upstream" activities, i.e. exploration and production, and not "downstream" refining and processing activities. However, as mentioned above, the assets in other sectors that may be stranded in the energy transition process are also very important. Analysis taking this into account has been carried out by, among other institutions, the International Renewable Energy Agency (IRENA), commissioned by the German government at the time of its presidency of the G20 leaders' summit in 2017. The IRENA (2017) study extends to 70 countries accounting for 80% of global fossil energy use. It considers for these countries, not only the assets related to upstream activity but also those related to downstream activities, industry and construction. These sectors are responsible for approximately 75% of GHG emissions. The analysis is based on two scenarios: first, the one envisaged by the Paris Agreement; and second, business as usual. Under certain assumptions, it is found that delaying measures to undertake the energy transition would double the amount of "stranded assets", from $10 trillion to $20 trillion. The latter is equivalent to 6.3% of global wealth, according to Credit Suisse (2018) data, and of the same order of magnitude as US GDP.

These figures clearly illustrate the potential risk of an abrupt energy transition having destabilising effects on the financial system. It is not enough, however, simply to be aware of the economic magnitude of stranded assets; a feasible energy transition process also needs to be defined, based on a credible policy that can help businesses pursue long-term strategies to ensure the adjustment in the value of their assets is gradual rather than sudden. The European Systemic Risk Board (ESRB) is aware of this situation. In its February 2016 report [see ESRB (2016)] it warns of the risks that the transition will be carried out late and abruptly. It points out that this adverse scenario could jeopardise financial stability, for three reasons in particular: the

macroeconomic impact of sudden changes in energy use; the revaluation of carbon-intensive assets; and a rise in the incidence of natural catastrophes.

Apart from the figures already discussed, public and private economic agents clearly lack the appropriate information to tackle this problem. For the markets to anticipate and facilitate the energy transition, in accordance with the Paris Agreement, they need to have accurate information on the basis of which to define appropriate risk management within a credible and consistent public policy framework.

To this end, in December 2015, the Financial Stability Board (FSB) announced the setting-up of the Task Force on Climate-related Financial Disclosures (TCFD). The current supporters of the TCFD include more than 70% of systemic banks, eight of the top 10 global asset managers, the leading pension funds and insurers, major credit rating agencies and the Big Four accounting firms. In total, these financial firms manage around $110 trillion of assets. In September 2018, the TCFD published its first status report on the recommendations for voluntary energy transition-related financial disclosures, which it presented in July 2017 to the Hamburg G20 Leaders' Summit.

In his speech to the above-mentioned European Commission conference on sustainable finance on 21 March 2019, Carney (2019) recognised that, three years after the announcement of the creation of the TCFD, the results presented in this status report fell well short of what was required to assess the CC-related risks of the firms evaluated. Specifically, the financial implications of the energy transition are often not disclosed, disclosures are often made in multiple reports – so that comparisons between firms and sectors were very difficult to make – and disclosures vary greatly by industry and region. He also said that higher percentages of European firms, and higher shares of those in the energy sector, had most disclosed information aligned with the TCFD's recommendations. The second report of the TCFD was presented to the 2019 Osaka G20 summit. Once again, there was evidence of the slow incorporation of fossil fuel-related firms into this initiative to disclose CC-related financial information. There was also renewed insistence that the information provided by those that had joined the initiative was far from useful for channeling the investment needed to meet the Paris Agreement targets. In view of the disappointing results to date, substantial improvements in the quantity and quality of the information of this nature that the markets should have at their disposal are not to be expected. It should be recalled that these are voluntary decisions and the TCFD's initiatives merely seek to create a virtuous circle that encourages the firms in question to comply with its recommendations.

In these circumstances, it is hard for the banking sector to manage CC-related risks on the basis of quality information. It should be recognised that, in practice, we are a long way not only from starting to consider the impact of extreme weather phenomena on sovereign risk, but also from rigorously taking into account transition

risks. These include, for example, the risk of exposure to carbon-intensive sectors or simply transactions relating to transport systems that use diesel. The truth is that, as of today, these types of risks are mentioned by banks solely in relation to corporate social responsibility and are very far from being recognised as genuine financial risks. Based on a recent pilot study, Lautenschläger (2019) concludes that European banks are aware of the risks CC entails, but this is nevertheless an issue that they only consider within the realm of corporate social responsibility.

Following the particularly useful criterion of Professor Diebold et al. (2010), risks may be classified into three categories: known, unknown and unknowable. From this perspective, a known risk is one that can be identified and modelled. By no means is a known risk certain to occur, but it can be characterised by a probability distribution function of potential profits and losses. An unknown risk is one that is known to exist, but cannot be satisfactorily modelled. Finally, an unknowable risk is one that simply cannot be known in advance and that becomes an unknown risk when it occurs. The latter – called "black swans" by Taleb – have a very low probability, but may give rise to huge losses. For these risks we have no generally accepted theory to enable us to foresee them.

A large part of the development of risk management techniques in recent decades has consisted in converting unknowable risks into unknown risks and the latter, in turn, into known risks. Owing to the process of constant innovation and change in the social and economic environment, the boundaries between these risks are not immovable. In fact, there may be certain situations in which known risks become unknown risks and others that result in new unknowable risks eventually becoming decisive. In this context, when science confirms that the origin of CC is anthropic, it will no longer be appropriate for financial risks arising from the energy transition to be categorised as unknowable risks. Instead they should be categorised as unknown risks, to the extent that we will know they definitely exist, even though the uncertainties still present in the course of the energy transition, under the Paris Agreement, may mean that their probability distribution function cannot be determined. This is a characteristic they share with operational risks, which include, inter alia, legal and other risks arising from human error or system or process failures. Obviously this type of risk is not readily quantifiable from a statistical point of view, but that is no reason for not taking it into account. Risk assessment, as is well known, must be based on both quantitative and qualitative criteria if it is to be feasible and accurate.

Evidence that climate risk is not taken into account in the actual management of financial risks is the increase in the financing that the banking system as a whole continues to provide to businesses strongly linked to GHG emissions. For example, between the signing of the Paris Agreement and the end of 2018, the 33 major global banks lent $1.9 trillion to the fossil fuel companies [see BankTrack (2019)]. This flow of resources is of course consistent with proposals such as that made by the giant ExxonMobil, which announced, when presenting its results of 2018, an ambitious

growth plan, based on the assumption that oil and gas production in 2025 will be 25% higher than in 2017 [see The Economist (2019a)]. Admittedly, this activity is made, in many cases, to square with clear pronouncements in favour of sustainable finance in their public reports on corporate social responsibility.

Since the adoption of sustainable development targets in February 2015 and, naturally, since the signing of the Paris Agreement in December 2015, the EU has been placing special emphasis on the commitments arising from compliance with such targets for the public sector and private sector. An up-to-date summary of all those relating to the sustainable financing strategies can be consulted at EC (2019b).

Central banks have been aware of the impact that CC can have on their microprudential and macroprudential responsibilities. This lay behind the creation of the Network for Greening the Financial System (NGFS), which at the outset comprised eight central banks and supervisory authorities and which now boasts 42 members and eight observers from all five continents. The most notable absence is that of the Federal Reserve. The aim of this project is to help reinforce the global response needed to meet the Paris Agreement targets and, specifically, to strengthen the role of the financial system in the management of CC risks and to promote the routing of resources towards green and low-carbon investment. The Network published its first report in April 2019 [see NGFS (2019)].

Also, the three main credit rating agencies have integrated environmental risk and green certification into their ratings. And international organisations such as the Climate Bonds Initiative [CBI (2019)] and the International Capital Markets Association (ICMA) have developed frameworks for definition, certification methods and validation for green or ecological financing.

The asset management industry, both in individual and collective initiatives, has been incorporated in recent years into investment in projects that comply with environmental, social and governance (ESG) criteria. A notable initiative is that of the Principles for Responsible Investment [PRI (2019)], which has more than 2,000 signatories who manage a total of $80 trillion.

In theory, as pointed out by Carney (2019), firms that comply with ESG criteria may be more profitable for three reasons: they are better placed to anticipate risks and opportunities of the energy transition; the market recognises their long-term planning and thinking criteria; and they may be favoured by the tendency of investors, especially the younger generations, to commit more strongly to economic sustainability values.

The question to be asked, therefore, is whether in the current situation the markets are taking into account climate risks and the banking system is adequately financing the energy transition process. A sign of the growing sensitivity of the market to

climate risks might be considered to be the relatively rapid growth in the issuance of so-called green bonds. The funds raised by these bonds are used to finance or refinance assets related to the energy transition or projects to improve the environment. Specifically, they must comply with the principles that some of the above-mentioned institutions, such as the Climate Bonds Initiative or the International Capital Markets Association, have developed.

This idea seems attractive, and their boom in recent years would confirm that. In 2017, issuance of green bonds amounted to $173.5 billion. In 2018, all analysts had predicted a substantial increase, but total issuance amounted to $174.9 billion. Thus, the market for green bonds, created barely more than 10 years ago, was worth over $500 billion at the close of last year. All of these figures were provided by Environmental Finance (2019).

The green bonds are not the only green financing instrument, but they are by far the most successful ones. The market currently includes a broad range of issuers, notably governments, but also private companies have a relevant share, especially energy businesses. In 2018, the banking sector issued 30% of the total and increased its share with respect to 2017, when it was 22%. To analyse the importance of this market in the annual financing requirements, it suffices to point out that total green bond issues in 2018 accounted for only 2.5% of the annual financing required by the energy transition. And such annual financing, as stated and acknowledged by the European Commission amounts to $6.9 trillion. It would be illusory to think that this financing instrument, as currently designed, can play an important role in the energy transition, despite the greater attention afforded to it by institutions and markets.

There are a number of grounds for this claim. Firstly, the commercial strategy of asset managers and the market of analysts surrounding them. As noted by an editorial in The Economist (2019b), given the collapse of their traditional business, they more than happy to be involved in the sale of green instruments for which they expect to obtain higher commissions. The truth, however, is that very few large institutional investors have ruled out continuing to invest in companies connected with fossil fuels. Also, despite the large amount of publicity they pour into the market, the commitment of the major oil companies to the energy transition is irrelevant.

In today's market, it is still not easy to state when an issue of green bonds can be characterised as such. Several criteria and standards are applied in practice. According to Schoenmaker and Schramade (2019), it is legitimate to ask to what extent green bonds issued by countries such as Indonesia, Poland or China comply with the restrictions observed by those of other countries and businesses. It is sufficient to recall that 80% of Poland's energy is coal-based and that Indonesia, which is the fifth largest CO_2 emitter in the world, generates half of its electricity using coal power stations. Moreover, the guidelines and standards set by the National Development and Reform Commission of China [see NDRC (2019)] reveals

they apply little strictness in the characterisation of their green bond issues. Note that in 2018 China was the second most active country in this market, with issuance of $33.1 billion.

In the current situation, numerous criticisms may be levelled about whether, in reality, green bonds meet the targets they announce or whether, simply, they offer an evidence as to the financial system's understanding of CC.

If we consider outstanding green bonds, it should be noted that their risk is determined by the issuer's credit rating, and this will be the same as that for any other type of bond issued. This is why no difference in the prices of these and other types of bonds should be expected. For example, a study by Morgan Stanley (2017) based on a broad sample of bond issues concludes that, having adjusted for their different characteristics, green bonds have the same price as conventional ones. Similar findings were obtained by the study of NN Investment Partners (2018). There are other analyses which, in their attempt to justify that the capital markets adequately quantify the carbon risk, provide different conclusions. But the truth is they are only so in appearance, since statistically these differences are not conclusively significant. It seems clear that the markets, with regard to the energy transition, do not believe what science says. This is not the first time, nor will it be the last.

The funds raised by green bond issuers are fungible, i.e. their source is irrelevant for their subsequent use. Accordingly, it cannot be ruled out that funds raised from this type of issue may have ended up financing fossil fuel projects. Avoiding this situation would require detailed disclosure of the investment flows of the issuer, which would not only involve more time, but also additional cost.

Mindful of this scenario, the High-Level Expert Group on Sustainable Finance set up within the European Commission published in June this year a report laying down the criteria for future European legislation for the classification or taxonomy of sustainable projects [see EC (2019b)]. This is an essential requirement for the proper channeling of financial resources to the energy transition. As a result of this taxonomy, standards and labels will be created for green financial instruments, in order to give them greater visibility and to transmit greater confidence to investors. Also linked to this process is the debate on the incentives for sustainable investments ('green supporting factor'), and the penalisation of carbon-intensive investments ('brown penalising factor'). Ultimately, this process of project taxonomy will allow the capital requirements of financial institutions for both types of investment to be set and differentiated.

However, the EU should go a lot further. As De Grauwe (2018) rightly indicates, the budgetary constraints imposed on the Monetary Union (MU) countries do not allow for ready financing of the energy transition. They oblige any costs arising from the investment needed to fall on current generations, either through an increase in taxes

or through a reduction in spending. Misgivings here are understandable, since governments are aware of the electoral cost they will incur if they take either decision, or both simultaneously.

This situation has led, in practice, to the investment needed being postponed or to its amount being drastically reduced. As De Grauwe indicates, the issuance of bonds is the appropriate procedure for distributing costs among successive generations, given that the interest payments are distributed in horizons lasting several years. Since current expenditure accounts for approximately 95% of the MU countries' budget, De Grauwe proposes that the aforementioned constraints be confined to the budget for such expenditure; in that way a specific budget not subject to such constraints is defined to address the investment needed for the economic transition. In light of the current climate situation characterised in this article, it would be desirable for the initiative posited to be within the EU framework. Unquestionably, investments of this type would meet the basic principle whereby the expected return should exceed the cost of capital. A recent paper by Blanchard (2019) on fiscal policy with low interest rates allows for grounded discussion of the conditions of public finances sustainability and also for the justification of financing the energy transition with the issuance of green public debt.

Public policies will be called on to play a pivotal role in the energy transition: not by regulating more, but by doing so better. For example, by avoiding extending the life of old fossil fuel technologies, in markets that are already highly regulated, with the aim of hindering the entry of future technologies. Theory and experience show that it is not reasonable to transfer to the market economic and political responsibilities that are incumbent upon democratic governments, and that markets' known failures should be corrected, since the final result is a deterioration in the market and in the basic rules underpinning its workings.

8 Epilogue

Clearly, a description of the activity and agendas of the many organisations playing an active role in combating CC might have merited more space. And so too might too those of the various international financial agencies acting diligently in this area. They all give a good account: they accept the seriousness of the situation and make a set of sensible proposals from the economic and financial standpoint. Yet as may be inferred so far from this article, the results obtained have, in practice, been very disappointing if, for instance, we take the 1992 Rio de Janeiro United Nations Framework Convention on Climate Change as our reference. Returning to the core of this text, it is not reasonable to expect the financial system to play a key role in the necessary routing of financial flows towards non-carbon-intensive activities if the problem posed by the negative externalities of GHG emissions is not being tackled

rigorously and definitively. The solution to this problem is well-known: a price must be set on each unit of CO_2 emitted. This basic economic principle has been recalled in the public statement by more than 3,500 of US-based economists on 17 January 2019 [see CLC (2019)]. Among those backing it are all the former Chairs of the Federal Reserve, 27 Nobel Laureate economists, 15 former Chairs of the Council of Economic Advisers and two former Secretaries of the US Department of Treasury. The statement, published in the Financial Times, The Wall Street Journal and The Washington Post, notably includes among its signatory economists both Democrats and Republicans.

As indicated, setting a price on each unit of CO_2 emitted is not a sufficient condition for effectively addressing the problem of CC; but it is undoubtedly a necessary prerequisite. At this stage, with almost 30 years having elapsed since the Rio de Janeiro Convention, 57 initiatives setting a price on CO_2 are today in place in 46 national jurisdictions. These initiatives have entailed, in some cases, setting a tax and, in others, creating markets for transferable emission permits. However, it should be stressed that, overall, they cover only 20% of global GHG emissions, according to the data provided by the World Bank's Carbon Pricing Dashboard (CPD) [see CPD (2019)]. Notable in this connection is the EU, a pioneer in setting in place markets for transferable emission permits in 2005. Currently this is the world's most outstanding initiative, as it involves more than 11,000 electric power and industrial plants, along with airline companies, in the 28 EU countries and the three associated countries: Norway, Iceland and Liechtenstein.

However, for one reason or another, not all these initiatives are yielding the expected results. For example, under its approach, currently in its third phase (2013-2020), the EU has had to introduce successive changes from the outset. Among other reasons, this has been to avoid the excessively low prices a ton of CO_2 had reached. But this is a more general situation since half of the emissions subject to the aforementioned 57 initiatives are priced at below $10 per ton of CO_2. That is far below the margins set by the World Bank's High-Level Commission on Carbon Prices, co-chaired by Joseph Stiglitz and Nicholas Stern, for intervention to be effective. These minimum values have been estimated at $40-$80 per ton of CO_2 for 2020 and at $50-$100 per ton of CO_2 for 2030 [see CPLC (2017)]. In sum, it is not a very flattering picture.

The process is encountering many difficulties along the way. True, the CC narrative appears to have changed in the past decade, and the deniers are less prominent than was the case some years back. But it is not difficult to appreciate that the discourse is one thing and specific action something quite different. The real players in the fossil fuel industry and the lobbies surrounding them continue to act by pursuing the well-publicised strategies that have been described in this article, namely to hamper the vital energy transition needed. For example, as once more signalled [see CTI (2019a)], none of the major European oil firms are in step with the Paris Agreement targets, in light of the investment projects their boards have since

approved. This is particularly worrying since these firms are precisely those that have most adhered to the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD). It is disheartening to see, once again, how incongruous this behaviour is. Corporate and social responsibility involves saying what you are doing, and doing what you say.

All told, incentives have a key role to play here too. And this is highlighted in a recent paper covering the 40 biggest US companies in upstream oil and gas activities [see CTI (2019b)]. As recently as 2017, 92% of the companies analysed included, for their managers' remuneration, metrics directly incentivising growth in the use of fossil fuels, in relation to reserves and production. The paper notes the small number of firms that have included measures directly relating to CC, but also flags up the somewhat perverse situation whereby many of them are compatible with the incentives to increase fossil fuel generation.

The obstacles fossil fuel companies are placing in the way of a genuine energy transition are, then, no surprise. We might well recall the words of the US novelist Upton Sinclair: "It's impossible to make a man understand something when his salary depends on him not understanding it".

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Building a sustainable financial system: the state of practice and future priorities

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Abstract

Efforts to align the global financial system with climate security and sustainable development are entering a new phase. Five years ago, only a handful of central banks were addressing the significance of the environmental crisis for the delivery of their mandate. Today, a growing number of central banks, along with supervisors across banking, insurance, pensions and securities, are moving from the recognition of their role in building a sustainable financial system to the implementation of a growing range of measures. This paper charts the rise of central bank and supervisor action on climate change and wider sustainability issues, analyses the key features of the "new normal" and then highlights priority themes for policy and research in the years ahead.

1 Introduction: The rise of central bank action on climate and sustainability

The full resources and expertise of the global financial system will be needed to respond to the existential threat of climate change and wider environmental crises such as the decline in biodiversity, the human and ecological impacts of air and water pollution, as well as the degradation of natural resources. In 2007, the Stern Review concluded that climate change was "the world's greatest market failure" [Stern (2007), p. VIII]. Prices not only fail to reflect the costs of carbon pollution, but many climate damaging activities (notably in the energy and agricultural sectors) continue to be incentivised with perverse government subsidies, amounting to some 5.2 per cent of global GDP in 2017 according to Coady et al. (2019). Strategically, this implies that most, if not all, financial assets are mispriced to a greater or lesser extent, posing major challenges for central banks and supervisors seeking to encourage efficient capital allocation, safe and sound financial institutions and financial stability of the system as a whole.

Until recently, the debate, as well as practical strategies to promote sustainability, have focused on correcting market and policy failures in the real economy with fiscal policy as the first best solution (e.g. through internalising externalities through pricing reform), supplemented by the provision of public finance to fill market gaps (e.g. in the development and deployment of sustainable technologies). Initially, only a limited role was assigned to central banks and financial supervisors, with a focus largely on addressing information asymmetries in the marketplace through improved disclosure. The essential complementary role of financial regulation came to the

fore following the global financial crisis and the growing recognition of the system-wide scale of the threat posed by the disruption of the natural capital foundations for long-term economic development [Robins and Zadek (2016)]. According to the United Nations Environment Programme (UNEP) Inquiry into the Design of a Sustainable Financial System, by 2008, only around 50 sustainability measures had been adopted by central banks, financial supervisors and other public authorities worldwide; by the end of 2013, this had more than doubled to 131, which doubled again to 267 by the end of 2017 [McDaniels and Robins (2018)].[1]

An early signal for central banks and financial supervisors emerged in September 2015 through a speech by Bank of England governor Carney (2015) on the "Tragedy of the Horizon", which outlined the novel threat of climate change for financial stability, transmitted through physical, transmission and liability risk. The agreement of the Sustainable Development Goals (SDGs) by the world's governments in the same month laid out a comprehensive approach to integrating economic, social and environmental factors. In December 2015, the Paris Agreement on Climate Change went further, setting the goal in Article 2.1 c) of "making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development" [UNFCCC (2016), p. 3].

From these foundations, central banks and supervisors have increasingly recognised sustainability as relevant to their core mandates and functions. Looking across 133 investigated institutions, 38 central banks and monetary unions are mandated to support their government's economic priorities, which may include the transition to low-carbon growth in the future, and 16 mandates include the explicit objective to enhance the "sustainability" [Dikau and Volz (2019a)].

Today, it is increasingly recognised that the macroeconomic implications and regulatory consequences of unabated climate change for central banks are significant, for prudential as well as monetary policies [Cœuré (2018)]. This process has been supported by the growth in international cooperation, initially through the G20's Green Finance Study Group, as well as the Task Force on Climate-related Financial Disclosures (TCFD) of the Financial Stability Board (FSB). When the possibility of consensus-based progress through the G20 became constrained following the election of the current US Administration, new coalitions were built, notably through the establishment of the Network for Greening the Financial System (NGFS) in December 2017 with eight initial members. The NGFS has since grown to 46 members and 9 observer central banks and supervisors, which represent over half of global greenhouse gas emissions [NGFS (2019a), p. 1]. The NGFS can be seen

1 There is no comparable assessment of the number of sustainable finance measures adopted since 2017. In 2019, the Principles for Responsible Investment estimates that there are now 730 measures across the world covering environmental, social and governance (ESG) factors, with a focus on the investment sector [PRI (2019)].

Table 1
RESEARCH AND CAPACITY BUILDING ON CLIMATE CHANGE IN INTERNATIONAL FINANCIAL INSTITUTIONS

BIS	The growing interest in climate-related risks at the BIS has been reinforced recently by Deputy General Manager Pereira da Silva (2019), who has stressed the importance of exploring the systemic risk implications for financial stability of climate change. Research at the BIS has focused on the pricing of environmental risk in syndicated loans [Ehlers *et al.* (2018)], green bond finance and certification [Ehlers and Packer (2017)], and the incorporation of environmental sustainability objectives into portfolios of central banks' reserve managers [Fender et al. (2019)].
IMF	The IMF, which has recently produced a comprehensive literature review of financial and monetary policy in light of climate change and enhancing green finance [Krogstrup and Oman (2019)], is also increasingly concerned with the economic implications of climate change [Lagarde and Gaspar (2019)] and ways to finance an appropriate response [Bredenkamp and Pattillo (2010) and Farid et al. (2016)].
IAIS	The Sustainable Insurance Forum, which was created as a global working group of insurance regulators, and has worked with the International Association of Insurance Supervisors to provide guidance for on the potential implications of climate change [IAIS and SIF (2018)].
IOPS	The International Organisation of Pension Supervisors (IOPS) has issued guidelines for the integration of ESG factors in the area of supervision of pension fund investment and risk management and thereby proposes to enhance disclosure of ESG factors by pension funds [IOPS (2019)].
IOSCO	The International Organization of Securities Commissions (IOSCO), which brings together the world's securities regulators, published a document outlining the importance of ESG related information for investors and the role of securities regulation [IOSCO (2019)].

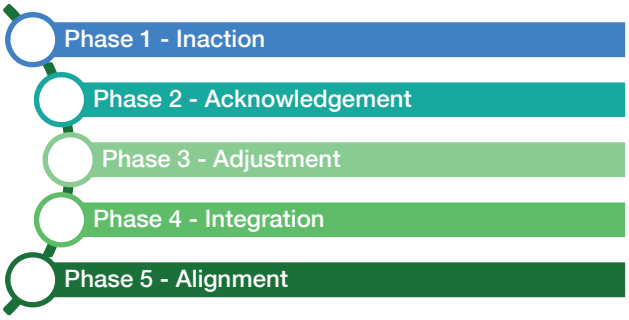
SOURCE: Compiled by authors.

as a "coalition of the willing" working to exchange experience and promote shared action on the impact of climate change and other environmental factors on their objectives and operations. International financial organisations, including the International Monetary Fund and the Bank for International Settlement, have also been increasingly active in addressing the challenges posed by climate change (see Table 1).

What is striking is how financial authorities have successfully developed a compelling narrative for their involvement, which respects their specific functions and mandates (notably around risk and stability), separate from political imperatives. US financial authorities such as the Federal Reserve are also beginning to recognise the importance of climate risk in spite of opposition in the political sphere [Powell (2019) and Rudebusch (2019)].

Traditionally, central banks believed that they had no role to play in confronting climate change and sustainability. This phase is now over. The next phase of acknowledging the challenge and the role that they can play is also coming to an end. We are moving into a more action-oriented phase focusing on adjusting existing central bank policies and activities. Beyond this lie full integration of climate change and sustainable development as key features of central bank and regulatory operations and the ultimate goal of the alignment of the financial system with the goals of Paris Agreement and the Sustainable Development Goals,

Figure 1
PHASES IN THE ENGAGEMENT OF CENTRAL BANKS AND SUPERVISORS IN CLIMATE AND SUSTAINABILITY



SOURCE: Compiled by authors.

facilitated, guided and driven by the actions of central banks and supervisors (see Figure 1).

The remainder of this chapter explores the key pillars of the emerging "new normal" for central banks and financial supervisors. The final section outlines the central challenges that exist, points to new horizons and concludes.

2 The new normal: the acknowledgment and incorporation of sustainability factors

It has been increasingly accepted by monetary and supervisory authorities that climate and sustainability-related factors are a source of financial risk and fall within the financial stability mandates of central banks and supervisors [NGFS (2018)]. The bulk of the focus has been on the threat of climate change and there is broad agreement on the two main transmission channels, namely physical and transition risk. Most of the policies and initiatives of this "new normal" can be clustered around five main areas of activity:

— Awareness raising and capacity building.

— Micro-prudential supervision.

— Macro-prudential action and financial stability.

— Monetary policy.

— Scaling up green finance.

Table 2
TIMELINE OF MAJOR SPEECHES ON CLIMATE CHANGE BY CENTRAL BANKERS, 2015-2019

Bank of England: Carney (2015)	"Tragedy of the horizon, climate change and financial stability"
De Nederlandsche Bank: Knot (2015)	"Incorporating sustainability into core business"
Banque de France: Villeroy de Galhau (2015)	"Taking account of climate related issues, public intervention necessary"
Reserve Bank of India: Gandhi (2016)	"Recognition of the challenge of financing sustainable development"
Financial Stability Board: Carney (2016)	"Launch of TCFD, introduction of disclosure framework and recommendations"
Bundesbank: Wuermeling (2017)	"Sustainable investing: the Bundesbanks' role as fiscal agent"
Bank Negara Malaysia: Lian (2017)	"Promoting green finance trough sustainable finance initiatives"
Bundesbank: Weidmann (2017)	"No preferential treatment of green bonds through monetary policy, instead greening of pension funds"
De Nederlandsche Bank: Knot (2018)	"Quantification of climate related risk for the Dutch financial system, need to incorporate into supervision"
Banque de France: Villeroy de Galhau (2018)	"Priority of developing forward-looking carbon stress tests, need for taxonomy"
Hong Kong Monetary Authority: Chan (2018)	"Promotional role for green bonds and finance, incorporation of ESG principles in own investment process"
European Central Bank: Cœuré (2018)	"'Greening' of central bank portfolios, acknowledgement of impact of climate change on the conduct of monetary policy"
Banco de España: Delgado (2019)	"Urging banks to develop risk models, developing stress tests"
Bank of England: Carney (2019a)	"Call for mandatory disclosure of climate-related risks"
Banca d'Italia: Visco (2019)	"Absence of further regulation, market forces pushing greenhouse gas concentrations to unsustainable levels"
De Nederlandsche Bank, NGFS: Elderson (2019a)	"In the process of incorporating a climate risk, financial sector cannot act fast enough without help from governments"

SOURCE: Compiled by authors.
NOTE: Out of the 4,426 central banker speeches archived by the BIS between 2015 and today (October 2019), 42 speeches address climate change or sustainability.

2.1 Awareness raising and capacity building

A first important step for central banks and financial supervisors lies in signalling the importance of sustainability factors both internally and externally to the wider market. Beyond the issuance of binding regulation and supervisory expectations, a central role for monetary and supervisory authorities lies in educating financial institutions with regard to the implications of climate change for their operations to ensure that climate change-related financial risks are understood and are disclosed and managed. The formation of in-house capacity and global cooperation with other institutions and researchers thereby plays an important role for enhancing the conceptualisation of climate-related risks with regard to financial stability implications, as well as understanding the needs and options for enhancing green finance. A clear evolution in central banks" approaches to market signalling on climate and sustainability issues can be identified in the speeches of central bank

governors since 2015, which have become progressively more activist and moved from the mere acknowledgment of climate change towards calls for mandatory rules (see Table 2).

2.2 Microprudential policy

Climate- and wider sustainability-related risks have direct implications for the goals of micro-prudential regulation to ensure the safety and soundness of individual financial institutions, cutting across the classic pillars of risk-weighted capital, supervisory review and market discipline through disclosure. The First Progress Report by the NGFS (2018) has reinforced central banks" acceptance that climate change and the transition towards a low-carbon economy are relevant sources of financial risk at the micro-prudential level. An important supervisory step lies in the calibration of micro-prudential instruments. Banco Central do Brasil (BCB) has been among the first central banks to issue regulation that addresses environmental and social risk, requiring commercial banks to incorporate environmental risk factors in their "Internal Capital Adequacy Assessment Process" (ICAAP) [Banco Central do Brasil (2011)].

Promoting market discipline through enhanced disclosure has been the main focus for central banks and supervisors, notably through the FSB's TCFD. Insurance supervisors have been at the forefront of micro-prudential action. For example, the California Department of Insurance has addressed transition risks of carbon-intensive "stranded assets" on the books of insurance companies by requiring firms to disclose their investments in fossil fuels and requesting them to divest voluntarily from thermal coal investments [Jones (2018)].

Disclosure often requires changes in legal frameworks alongside supervisory requirements for institutions to improve their reporting of climate risk management and governance. France's Energy Transition Law, for example, under Article 173, requires firms to disclose their climate-related risks or provide an adequate explanation [NGFS (2019b)]. A core aspect of the EU's Sustainable Finance Action Plan is improved disclosure by corporations and financial institutions (see Box 2).

Discussion has also focused on the effectiveness of differential capital adequacy ratios, which distinguish between low-carbon (or "green') and high-exposure (or "brown") assets. The aim of such measures would be to reflect key risks not adequately reflected in market prices. One explanation for this shortcoming can be attributed to the short-term time horizon of most banks and investors, within which the full materialisation of climate risks may not fall [Carney (2019b)]. So far, the rationale for higher capital ratios for carbon-intensive assets has found greater favour among the central bank community,

Box 1

THE TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES (TCFD)

Under the chairmanship of Mark Carney, the FSB convened the TCFD in early 2016 to develop *recommendations on climate-related financial disclosures.* Enhancing disclosure was seen as the first and best step at the time to implement the G20's directive of making sure financial markets account for climate change in their operations. Its work is being supported by Bloomberg and the Big Four accounting firms. Thus, while the TCFD was convened and endorsed by the FSB, it is a fully industry-led institution with minimal involvement by central banks and financial supervisors. The TCFD published its final recommendations on climate-related financial disclosures in summer 2017.

Closely following the risk taxonomy developed by the BoE's PRA, these recommendations provide companies with a *framework for how to think about climate change* within their organisation by separating this thinking into four distinct categories: *Strategy, Governance, Risk Management,* and *Metrics & Targets.* Following this categorisation, the recommendations lay out more specific guidance on disclosure for both financial and non-financial corporations. For the financial sector, guidance addresses the specificities of banks, insurance companies, asset managers, and asset owners. For non-financial corporations, specific guidance was issued for the energy, transportation, materials & building as well as for the agriculture, food, and forests products sector. One of the most prominent features of the TCFD's recommendations related to forward-looking disclosure aided by scenario analysis.

This element of scenario analysis can also be counted as one of the *main achievements* of the TCFD: Firmly establishing the notion of *forward-looking analysis and disclosure* in the debate around how the financial industry can and should account for climate change is a major contribution the TCFD made. This allows stakeholders as well as supervisors to get an insight not into how a company is doing under present conditions of pervasive market and policy failure but how it is planning to develop in a future characterised by a stern transition towards a low-carbon economy or by catastrophic climate-related impacts on ecosystems, societies and economies. The TCFD's second major achievement is the sourcing of industry consensus on how to think about climate change within a company. The *flexible and yet comprehensive framework* of the four categories of strategy, governance, risk management, and metrics & targets both standardise disclosure across and within markets while on a more fundamental scale instruct internal company practice around the issue of climate change. The TCFD recommendations firmly establish that *climate change is financially material* and therefore a matter of financial and not sustainability disclosure while at the same time providing a first suggestion of how exactly climate change is material and what therefore needs to be disclosed on this issue.

In some regards, however, the TCFD recommendations do *not suffice as disclosure framework,* particularly for central banks and financial supervisors. First, the recommendations *exclusively focus on climate change,* neglecting other crucial and material environmental issues. Thus, the TCFD framework is not suitable for a systemic view on financial markets as it does not fully capture a company's dual embeddedness in the wider financial system which in turn is embedded in a socio-ecological system. Second, the TCFD framework's main focus lies on *risks as opposed to opportunities.* Third, as of September 2019, *implementation is slow and disclosure practices are underdeveloped* even according to the TCFD's own Status Reports. The fact that the recommendations allow a grace period within which climate-related disclosure can be moved from the financial filings to separate climate or sustainability reports does not spur thorough reporting either. Thus, financial supervisors and regulators might learn from this experience and not resort to private self-regulation for the sake of speed as voluntary regulation might be faster in its development but slower and more limited in its implementation phase.

in other words a potential "brown penalising factor" rather than a "green supporting factor".

In addition, there is growing interest in the possible utilisation of pillar 2 mechanisms, such as capital buffers to deal with climate-related risks inadequately managed by financial institutions (such as stranding risk for coal-assets).

2.3 Macroprudential policy

Environmental and climate change-related risks also have implications for the financial stability of the system as a whole and are therefore relevant for macroprudential policy frameworks [Campiglio et al. (2018)]. While standard macroprudential approaches do not explicitly take climate risks into account, approaches "green macroprudential policy" have started to be developed [Monnin (2018); and Schoenmaker and Van Tilburg (2016)]. Apart from mitigating transition risk and the financial stability implications of a manifestation of stranded assets, green macroprudential policy also has allocative effects and can play a role in incentivising a transition to low-carbon assets. Instruments that could be adjusted to take account of systemic climate and sustainability risks include calibrated countercyclical capital buffers, capital instruments (risk weights) and caps. Countercyclical capital buffers, which are implemented to ensure that capital requirements for the banking sector take threats to overall financial stability into account, can be implemented to require banks to increase their capital buffer in order to protect the sector from periods of excessive carbon-intensive credit growth. Instruments under the structural pillar, so-called "large exposure restrictions", can be calibrated to address the exposure concentration to unsustainable investment and, if large banks are insufficiently incentivised to address climate-related risks, capital surcharges for SIFI could be adjusted accordingly.

The incorporation of climate risks into macroprudential frameworks again centrally relies on the understanding and disclosure of risk and effective disclosure requirements can play a vital facilitating role. The understanding of the exposure of individual institutions and the financial system to climate change-related risks can be enhanced through the incorporation of these risks into stress testing, which creates a foundation for the calibration of macroprudential policy instruments, such as countercyclical capital buffers [NGFS (2019b)]. Methodologies for the evaluation of climate risks through stress tests have been pioneered by Battiston et al. (2017) and Vermeulen et al. (2019). De Nederlandsche Bank (DNB) has been the first to conduct a climate risk-related stress test in 2018 for the Netherlands with the aim of quantifying the consequences of a disruptive energy transition for financial stability. A central finding has been that a disruptive transition could be associated with substantial losses for the financial sector [Elderson (2019b)]. Furthermore, the Bank of England has announced its intentions to apply stress testing of physical and transition risk to insurance companies [Bank of England (2019a)], which it also plans to extend to general financial institutions by 2021 [Bank of England (2019b)].

2.4 Monetary policy

Climate change can potentially directly affect price stability and therefore has implications for monetary policy, independently of whether policies to mitigate climate risks will be successfully implemented in the future. Climate change-related

shocks to the economy may either occur in the form of a demand shock, which is controllable for the central bank because growth and inflation move in the same direction, or as a supply shock, which is more difficult to address because inflation and output may move in different directions, thereby creating a potential trade-off for central banks between the stabilisation of inflation and output [Cœuré (2018), p. 2). Typically, climate change-related shocks are considered to manifest as supply shocks, caused for example by droughts, floods or heatwaves that can negatively affect agricultural production and create upward pressure on food prices [Parker (2018)]. In practice, different climate change mitigation scenarios also have diverse and specific implications for different monetary policy regimes [McKibbin et al. (2017)]. One factor worthy of further consideration is how monetary policy could need to adjust in light of the more capital-intensive nature of the low-carbon, climate resilient economy. The transition involves a higher rate of upfront investment – for example in energy efficiency or renewable energy technology – offset by lower energy and resource use in terms of operating costs. At the margin, this shift from an "Opex" to a "Capex" focused economy would be more sensitive to changes in the cost of capital (and thus interest rates). Historically low interest rates since the financial crisis have thus provided a strong positive tailwind behind the deployment of low-carbon solutions which could falter if rates normalise in the future.

Climate change has implications for both conventional and unconventional monetary policies. The introduction of quantitative easing (QE) following the financial crisis failed to take the environmental and the social quality of asset purchases into account. The result was an unintentional carbon bias in the corporate bond purchase programmes of the Bank of England and the European Central Bank which have been skewed towards carbon-intensive industries [Matikainen et al. (2017)]. This has prompted calls for the "greening" of QE along with central bank balance sheet and monetary policy operations. For example, the ECB's practice of buying new bonds as its existing stock comes to maturity, as well as its plans of renewed bond purchases, announced in September 2019, is seen to offer a "window of opportunities" for the central bank to replace the old bonds of its quantitative easing programme with new environmental green bonds [De Grauwe (2019)]. This experience also raises a fundamental question for central bankers on how to interpret the principle of market neutrality: should policy be neutral relative to the current market, which is subject to pervasive market failures, or relative to a sustainable market in which externalities are priced?

2.5 Scaling up green finance

Climate change is now recognised as not just generating risks to the stability of the financial system, but also requiring a substantial reallocation in financial flows to scale up investments in sustainable solutions [Elderson (2019a)]. According to HSBC, the world needs to invest $6-8 trillion per year by 2030 to keep the global temperature

rise below two degrees Celsius, while current levels only amount to $1 trillion per year at the very best [Klier (2019)].

Central banks can engage in the scaling up of green finance for two main reasons. First, the mandates of some central banks oblige them to support government priorities and/or sustainable development [Dikau and Volz (2019a)]. Second, due to the endogenous nature of climate risk, the scaling up of green finance can be seen as a long-term risk management strategy to alleviate the most severe physical climate shocks. At the same time, scaling up green finance mitigates systemic transition risk by creating capital market infrastructure capable of absorbing and allocating the capital freed by potential divestment from assets which are not aligned with climate change targets. To mobilise and scale up green finance, central banks have various policy instruments at their disposal. There are significant differences of mandates and broader policy frameworks among central banks and supervisors, as well as across advanced and emerging market and developing economies with regard to how they approach the issue of scaling up green finance. Central bank in advanced economies have started to green their own portfolios. Some central banks in emerging markets and developing economies have taken more active – and contentious – allocative approaches.

2.5.1 The greening of central bank portfolios

Increasingly the integration of environmental, social and governance (ESG) criteria in the portfolio management of central banks is recognised as an important step through which monetary institutions can "lead by example" while staying within their mandate [Cœuré (2018) and NGFS (2018)]. This brings central banks into line with the wider move towards responsible investment by leading asset owners: more than 2,000 institutions with an excess of $80 trillion in assets have now signed the Principles for Responsible Investment (PRI).

On the asset side of central bank balance sheets, there are four portfolios, which have been discussed with regard to their suitability for the incorporation of ESG criteria in order to promote green finance [Cœuré (2018)]. Traditionally, central banks manage three types of portfolios, including foreign assets (such as exchange reserves), pension funds and a portfolio of own funds, which provides the central bank with income to help cover its operating expenses. Additionally, the implementation of "unconventional" monetary policy measures has added a fourth asset portfolio to the balance sheets of some institutions, which, as discussed above, need to have sustainability factors incorporated to avoid an unintended carbon bias.

With regard to foreign assets, problems can potentially arise from the need to balance ESG objectives against liquidity, safety and return [Fender et al. (2019)]. Initial research has shown that the safety and return of green bonds support their incorporation into

reserve portfolios, however, their accessibility and lack of liquidity in markets currently pose some constraints (ibid.). Central banks" pension portfolios have been recognised as suitable for the incorporation of ESG standards, which constitutes a rather uncontroversial first step that has been taken already by several institutions, including the ECB [Cœuré (2018)].

The incorporation of ESG principles into central banks" own activities can achieve several objectives. First, it ensures that risks are appropriately accounted for in central banks" portfolios; second, it guarantees that central banks" operations are not subject to an unintended carbon bias; and third, it can also contribute to the scaling up of green finance. Again, this practice is still far from universally accepted, however it has been increasingly addressed by leading central bankers [Cœuré (2018) and Elderson (2019a)]. In practice, the DNB has been the first central bank to include ESG criteria in its investment processes, having applied ESG considerations to its own funds and foreign reserves portfolios [De Nederlandsche Bank (2019)]. DNB was also the first central bank to sign the PRI.

2.5.2 The development of green financial markets

Effective markets for green assets are of central importance under a "bottom-up" approach, which relies primarily on markets to play a central role in financing the economic transition to a low-carbon economy. An important facilitating role for central banks and supervisors lies in addressing the problem of missing markets and supporting the creation of new asset classes in listed equities and debt as well as unlisted assets such as infrastructure that are aligned with long-term system health.

Green bonds have been a particular focus and demonstrated strong growth through a combination of initial market-making by public development banks, demand from institutional investors, the development of voluntary guidelines and standards as well as measures from security regulators to ensure market integrity. One issue that has been highlighted is that the trade of green bonds is obstructed by a lack of transparency and standardization with regard to the reporting climate risks and missing markets, leading to low liquidity and turnover in these markets [Krogstrup and Oman (2019), p. 27)]. Deep, liquid and more advanced markets for green assets can, in turn, play a central role in increasing demand for and the supply of green securities, thereby contributing to reducing the cost of financing climate change mitigation efforts (ibid.). The importance of certification in the green bond market through independent third parties has been stressed as a central element that can enable firms to improve their environmental footprint [Flammer (2019)]. The development of market infrastructure, information and issuance guidelines can be centrally supported through green bond guidelines and taxonomies. Green bond guidelines and definitions of criteria define what the use of the proceeds from green bond issuances can be, and also regulate disclosure standards. Both measures can

strengthen the issuance of green bonds by preventing greenwashing and lowering transaction costs. With regard to disclosure, the introduction of disclosure requirements regarding environmental and sustainability-related information on bonds and other assets can contribute to the strengthening of the identification and acceptance of green assets. In practice, examples of support for the development of green bond markets include the EU's outline for a green bond standard as part of its Sustainable Finance Action Plan (see Box 2), as well as various efforts of the Peoples Bank of China's (PBOC).

This points to the wider efforts in China by the central bank and financial authorities to green its financial system, stretching back to the 1980s [Zadek and Chenghui (2014)]. In 2007, the PBOC, the China Banking and Insurance Regulatory Commission (formerly CBRC) and the Ministry of Environmental Protection jointly issued the Green Credit Policy in 2007. Efforts to develop definitions of green credit also trace back to 2007 to the jointly-issued Opinions on Implementing Environmental Protection Policies and Regulations to Prevent Credit Risks [NGFS (2019b)]. In 2016, alongside its inclusion of green finance into its presidency of the G20, China also issued comprehensive Guidance on Greening the Financial System in 2016.

2.5.3 Green credit allocation

The scaling up of green finance and "greening" of the economy may also be facilitated through more direct government guidance, following a "top-down" approach. The underlying justifying rationale can be seen in the existence of pervasive market failures, which may prevent markets from bringing about a low-carbon transition on their own. For example, due to a discrepancy between private returns and social or environmental returns, banks and other financial institutions may not allocate their resources to sustainable and green activities on their own, funding carbon-intensive and polluting industries instead. In this situation, as discussed by Stiglitz (1994), a market failure-alleviating and Pareto efficiency-improving role for central bank and financial supervisors can emerge. Because market failures may also lead to a lack of necessary long-term private investment, financial policies are widely seen as a necessary complement to fiscal policies [Krogstrup and Oman (2019)].

Monetary and supervisory institutions have a wide variety of allocative instruments at their disposal, in order to directly intervene into the allocation of credit and enhance the flow of resources to sustainable projects. Instruments include targeted refinancing lines, portfolio ceilings, differential interest rate ceilings, informal credit guidance and other quasi-fiscal tools, which can be implemented to intervene in the allocation of credit and direct resources to green sectors and industries [Dikau and Volz (2019b)]. The effectiveness and appropriateness of most of these instruments depends centrally on the structure and sophistication of the financial system and interventionist

Box 2

EUROPEAN UNION APPROACH TO SUSTAINABLE FINANCE

The EU Commission appointed at the end of 2016 a High-Level Expert Group (HLEG) on sustainable finance, which played a central role in mainstreaming sustainable finance as a normal policy goal for EU policymakers [Thimann (2019)]. The groups final report caused the European Commission to develop its own Action Plan [European Commission (2018)]. Building on the core recommendations and proposals of the HLEG, the Commission report focuses on two central aspects of sustainable finance, namely, first, the contribution of finance to sustainable growth and secondly, the incorporation of ESG factors into investment decision-making. The 10 actions proposed under the Action Plan include "necessary" (prudential rules, financial product standards, low-carbon benchmarks and "green" product labels), as well as "complementary" (public investment and policy, and private investment, corporate disclosure and provision of investment advice) elements.

The EU Commission Action Plan	Progress
Action 1: Establishing an EU classification system for sustainable activities. The taxonomy is a central, as well as concluding element of the Commission's Action Plan on Financing Sustainable Growth that provides the other 9 initiatives with a definition of climate change adaptation and other environmental activities	June 2019: EU taxonomy launched, which defines 67 low-carbon activities and 9 transition activities in high-emitting sectors. To classify under the taxonomy, investments have to substantially contribute to at least one of six environmental objectives, "Do no significant harm" to any objective and comply with minimum social safeguards
Action 2: Creating standards and labels for green financial products	June 2019: Voluntary and non-legislative EU Green Bond Standard (GBS) launched, which includes the publication of a green bond framework, mandatory reporting, as well as external verification through an accredited verifier
Action 3: Fostering investment in sustainable projects. It is recognised that it is necessary to mobilise private capital for sustainable projects, especially for infrastructure, to achieve a transition to a more sustainable economy and enhancing efforts are discussed	
Action 4: Incorporating sustainability when providing financial advice. Through the Markets in Financial Instruments Directive (MiFID II) and the Insurance Distribution Directive (IDD), financial institutions are required to offer and advice their customers on "suitable" products	April 2019: Publication of ESMA's technical advice to the European Commission on integrating sustainability risks and factors in MiFID II
Action 5: Developing sustainability benchmarks	June 2019: Introduction of the EU Climate Transition Benchmark (EU CTB) and the EU Paris-Aligned Benchmark (EU PAB)
Action 6: Better integrating sustainability in ratings and market research. Because it remains unclear to what extent the assessment of companies' ESG performance is considered by rating agencies, the European Securities and Markets Authority (ESMA) has been invited to explore solutions	July 2019: ESMA published its technical advice on sustainability considerations in the credit rating market and its final guidelines on disclosure requirements applicable to credit ratings
Action 7: Clarifying institutional investors' and asset managers' duties. The legislative requirement for institutional investors and asset managers to fulfil their "fiduciary duty" and to act in the best interest of their investors is discussed with regard to the necessity to include sustainability factors and risks	March 2019: EU Parliament and Council achieved political agreement on requiring ESG integration by financial market participants
Action 8: Incorporating sustainability in prudential requirements. Banks, insurance companies and pension funds are potentially exposed to climate change-related risks with implications for financial stability	June 2019: EIOPA has publishes a Consultation Paper on an opinion on sustainability within Solvency II
Action 9: Strengthening sustainability disclosure and accounting rule-making. While the EU Directive on the disclosure of Non-Financial Information (NFI) requires the disclosure of ESG aspects, efforts to strengthen disclosure requirements are discussed	April 2019: European Parliament endorses the legislation setting the building blocks of a capital markets union, including the regulation on disclosures relating to sustainable investments and sustainability risks
Action 10: Fostering sustainable corporate governance and attenuating short-termism in capital markets. Corporate governance is considered to potentially contribute to a sustainable economy, but short-term market pressures may make it difficult to lengthen the time horizon in corporate decision-making	June 2019: Publication by ESMA of a survey on undue short-term pressure on corporations from the financial sector

SOURCE: Compiled by authors.

policies, which have historically been discussed as a form of "financial repression", remain controversial and have been associated with distortive side-effects. Most of these instruments are no longer used in advanced economies today, where they fell out of favour in the 1970s. An active sustainability-enhancing role also raises questions with regard to the compatibility with current mandated objectives of central banks and financial supervisors. Generally, an interventionist allocative role of central banks and supervisors stands in contrast to the understanding of the neutrality of central banking policy towards different segments of the economy as well as to the concept of central bank independence. This raises the question of in how far an active contribution to the scaling up of green finance and the support for a transition to a low-carbon economy is compatible with current mandates. Independent of the scope of individual mandates, however, actively informing governments and the general public on the current failures and shortcomings of financial markets to account for climate change in order to facilitate the necessary interventions by the responsible institutions – whether by governments or parliaments – clearly lies within the mandate of every central bank.

In practice, some emerging market and developing economies have continuously utilised credit guidance policies to allocate credit to priority sectors, including green industries [Dikau and Ryan-Collins (2017)]. Examples include the central bank of Bangladesh, which has introduced several green credit allocation programmes, such as preferential refinancing for "green" loans, with the aim of enhancing commercial bank lending for sustainable investment [Barkawi and Monnin (2015)]. The overall approach of Chinese authorities, among them the PBOC, has been described as a "top-down" model, in which macroprudential and monetary policy play key roles and which differs from the Western "bottom-up" approach that attributes a central role to the private sector [Yao (2018)]. Among various initiatives, the PBOC has incorporated green finance into its macroprudential framework in order to incentivise the scaling up of green finance (ibid.). The Reserve Bank of India continues to maintain a Priority Sector Lending (PSL) programme introduced in the 1940s, under which commercial banks are required to allocate a percentage of their loan portfolio according to the central bank's economic priorities. Recently, the programme's targets were extended to also include renewable energy [Reserve Bank of India (2016)].

3 Challenges and new horizons

This growing body of action by financial authorities, alongside action by market participants and complemented by an increasingly incisive academic literature, is an impressive achievement in the space of only a few years. Yet these steps remain at an early stage, with limited breadth and depth. In the words of Bank of England Governor Mark Carney in October 2019: "Like virtually everything

else in the response to climate change, the development of a more sustainable financial system is not moving fast enough for the world to reach net zero" [Carney (2019c), p. 3].

The current phase of adjusting existing central bank and supervisory policies is only a few years old and it is still too early to evaluate the impact of these measures in terms of the classic three-fold policy priorities of their effectiveness, efficiency and equity (fairness). In addition, as these initiatives straddle the worlds of financial and sustainability policy, new tools will be needed to assess the achievement of two or more objectives. From a finance perspective, the focus will need to be on how these initiatives improve market efficiency and system resilience. From a sustainability perspective, the question is whether these measures lead to the enhanced delivery of social and environmental outcomes [McDaniels and Robins (2018)]. Furthermore, attention needs to be placed on identifying positive (and negative) unintended consequences of this greening process.

Many challenges lie ahead and to conclude this chapter, we would like to outline four of these, highlighting the role that academic research could play.

3.1 Clarifying core definitions, disclosures and differentials

As policy makers, supervisors and market participants have sought to build a sustainable financial system, a set of fundamental issues have come to the foreground. These include how to introduce a common language for green and sustainable finance that enables reliable classification and thus efficient market responses. This need lies behind the introduction of the EU's sustainable finance taxonomy (see Box 2), which builds on market practice (for example, in the green bond market). The strategic prize is the system-wide adoption of definitions that can be applied to national statistics and measurements, decisions by issuers, banks, investors and insurers, as well as the way in which financial supervisors oversee the system as a whole. Indeed, financial authorities need a clear way of identifying which assets and activities are "system enhancing" from a sustainability perspective and which are "system degrading". Agreeing such a taxonomy is by no means an easy process – even in terms of identifying activities that can be classified as "green" –, let alone "brown". But practical steps can be taken now within the EU and globally on priority areas. Ensuring that the definitions are dynamic is also recognised as a critical characteristic to enable this taxonomy building to be a learning process. Finally, a taxonomy of activities defined in terms of the transition to the low-carbon economy still needs to be supplemented by environmental, social and governance analysis by banks, investors and insurers as well as financial authorities.

Alongside this imperative lies the related priority of ensuring consistent, reliable and market-wide disclosure of key data points. The FSB's TCFD recommendations have

made a significant step forward, but their recommendations only relate to climate change. Further convergence is needed on common standards across the ESG and sustainability area, for example, through initiatives such as the Global Reporting Initiative (GRI). From a financial system perspective, consistent data and disclosure is also needed for sovereign bonds, one of the largest asset classes, but one that is omitted from existing reporting frameworks, such as the TCFD.

Importantly, the absence of comprehensive disclosures should not postpone efforts to assess and take action on sustainability factors until a world of "perfect information" is achieved. Serious attention therefore needs to be placed on how to take decisions under uncertainty in the context of incomplete data. This is particularly important for the critical question of evaluating the implications of sustainability factors for the risk and performance differentials of financial assets and institutions. Even in the context of profound market and policy failures, increasing evidence is available for assets on public equity and debt markets which suggests that assets with superior ESG performance offer better risk-adjusted returns [Benlemlih and Bitar (2018), Friede et al. (2015) and In et al. (2017)]. However, far less evidence is available for the performance of loans on bank balance sheets, not least because the underlying data is confidential and not disclosed. For the NGFS, the assessment of whether a financial risk differential exists between "green" and "brown" assets has also been listed as a key challenge [NGFS (2018)]. Here, there is considerable potential for joint research between central banks that have access to this data and academic institutions.

3.2 Reflecting on strategic principles to guide the greening of the financial system

Even in a world of shared definitions and perfect information, central banks would still face profound challenges over the strategic principles they should apply to the sustainability imperative. Climate change and associated environmental challenges do not easily fit within the framework of conventional regulatory wisdom for two interrelated reasons. First, time horizons are far longer and, second, impacts can be irreversible and real uncertainty is intrinsic, partially due to the longer time scales involved. The "tragedy of the horizon" that Governor Carney identified in 2015 still remains, although greater visibility over potential future shocks is emerging through the first wave of scenario analyses and stress tests. Looking ahead, specific attention needs to be focused on what long-term supervision and monetary policy could look like and how this could address continuing market imperatives for short-termism [Thomä and Chenet (2017)].

Further reflection also needs to take place on how core principles of central banking practice might need to change in the new era of the climate emergency.

The principle of market neutrality is one of these as discussed above in section 2.4. As Ignazio Visco, Governor of Banca d'Italia has noted "it may be inquired whether this principle [of market neutrality] should be fully preserved or be adjusted in a context in which, absent of further regulation, market forces are pushing greenhouse gas concentrations to levels that will soon be unsustainable" [Visco (2019), p. 5]. In addition, to account for intrinsic uncertainty and the fundamental threat of irreversible damage to vital ecosystem functions, new principles could be usefully adopted by central banks and financial authorities, such as most notably the precautionary principle, long a core feature of environmental policy. This states that the absence of information and inherent uncertainty that is intrinsic to a climate transition should not stop preventive action [Ryan-Collins (2019)].

3.3 Broadening the scope from climate change to sustainable development

To date, much of the focus of central bank initiatives has been focused on climate change. However, this is not the only environmental threat facing the financial system. In developing countries, environmental problems such as air pollution and water stress are more pressing, with climate change playing the role of a threat multiplier rather than a primary focus. In China, for example, the first environmental stress test was focused on air pollution rather than climate change. This points to the need to consider an integrated approach that looks at the intersecting issues of the ecological transition as a whole rather than just individual features such as climate change alone. Some central banks, such as DNB, have started to explore the strategic implications for their work of the full set of environmental challenges in the Sustainable Development Goals [De Nederlandsche Bank (2019)].

Beyond this, central banks will need to consider how they respond both to the social implications involved in greening the financial system, as well as the core social objectives of the SDGs such as ending poverty, reducing inequality and ensuring universal access to essential financial services.

One example of this is the imperative of ensuring a "just transition" to a zero-carbon economy, a commitment included in the Paris Agreement. Policymakers, key stakeholders (such as trade unions), as well as long-term investors increasingly recognise that the transition will need to be "fair and seen to be fair", making sure that workers, consumers and communities are not stranded or left behind in the process [CCC (2019)] and Robins et al. (2019)]. This joining up of the environmental and social dimensions of sustainability takes central banks and financial authorities back to their core system focus, where a close understanding of living standards, employment and regional prosperity is normal practice.

3.4 Building supportive international regimes for central bank action

Central bank and financial supervisory approaches to sustainability have grown up through a complex interplay of national action and international coordination. Leadership at the national level is needed to initiate the process of change and inspire efforts in other jurisdictions. But international coordination is also essential, both to ensure the rapid take-up of good practice so that individual authorities do not need to "reinvent the wheel" and also to prevent regulatory arbitrage between different approaches to sustainable finance. Here, the EU's Sustainable Financial Action Plan is the more comprehensive approach to international coordination and regulation.

To date, developing a habit of cooperation between authorities has been crucial to building momentum, with a focus, sharing experience and developing common approaches. Key initiatives have been the sector-focused coalitions such as Sustainable Insurance Forum and the Sustainable Banking Network as well as the more systemic NGFS (see Box 3) [IFC (2018), McDaniels et al. (2017) and NGFS (2019b)]. The FSB's TCFD is an interesting example of a regulatory authority initiating a market-led, voluntary process of norm setting; the FSB itself has yet to incorporate climate risks into its routine operations.

Clearly, one of the challenges for the future is when and how sustainability factors become incorporated into the core international regulatory regimes (such as the Basel framework for banking). This is both a technical question depending on the establishment of sufficient analytical foundations for action, as well as a political question relying on clear consensus from all G20 nations.

Responding to these and other challenges needs to be focus of the next phase of central bank action on sustainability. As part of this, there is a powerful agenda for academic teaching, research and policy dialogue. The Global Research Alliance for Sustainable Finance and Investment (GRASFI) is one network of academics working in this area. Another is the International Network for Sustainable Financial Policy Insights, Research, and Exchange (INSPIRE), established in 2019 [INSPIRE (2019)]. INSPIRE has been purpose-built to commission analysis and insights from best-in-class scholars and analysts in all parts of the world on key research questions linked to the NGFS work program. INSPIRE is hosted by the ClimateWorks Foundation and the Grantham Research Institute at the London School of Economics, and commissions research guided by an Advisory Committee along with inputs and exchange from the NGFS.

A sustainable financial system is not only necessary but entirely possible. Making this a reality is increasingly a shared global objective.

Box 3

NGFS RECOMMENDATIONS AND FUTURE PRIORITIES

The NGFS has published a first comprehensive report, accompanied by six practical best practice recommendations for central banks, supervisors, and financial institutions on how to enhance their role in the greening of the financial system and incorporating environment and climate-related risks into their operations [NGFS (2019b)]. The first four recommendations are aimed at central banks and supervisors, while recommendations 5 and 6 address broader issues.

1 The NGFS recommends the *integrations of climate-related risks into financial stability monitoring and microprudential supervision* through i) the assessment of climate risks, and ii) the integration of these risks into prudential supervision.

2 The *integration of sustainability factors into the management of central banks portfolios* is acknowledged as an important and potentially pathbreaking step.

3 Data gaps are recognised as a central challenge and the public *sharing of data* is considered to be an important enabling move.

4 The *creation of in-house capacity* and collaboration with other institutions is seen as a vital step that can contribute to rising awareness and establishing intellectual capacity.

5 Supporting the effort of establishing an internationally *consistent climate and environmental disclosure framework* as well as the work of the TCFD.

6 Encouraging the *development of a taxonomy* that enhances the transparency around which economic activities are "green" and which ones are most exposed to climate and environment-related risks.

In April 2019 the NGFS also outlined its next steps with regard to concrete deliverables (ibid.):

1 Publishing a *handbook on climate and environmental risk management* for supervisory authorities and financial institutions that outlines concrete steps to better understand and respond to climate and environmental risks.

2 Issuing *voluntary guidelines on scenario-based risk analysis* and the development of data-driven scenarios to assess climate-related risks.

3 Providing best practices guidance for *incorporating sustainability criteria into central banks" portfolio* management.

Through the publications of its technical supplement to the first comprehensive report, the NGFS provides an overview of the academic research that focuses on modelling the impact of climate change on the economy and the financial system, and thereby provides a range of options for central banks and supervisors to assess climate change risks [NGFS (2019c)].

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Non-bank financial intermediation

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NON-BANK FINANCIAL INTERMEDIATION[1]

Abstract

Non-bank financial intermediation (NBFI) encompasses the activity of a group of heterogeneous institutions which, under certain circumstances, engage in a business with aspects similar to those of a regular bank business. In recent years this sector has grown both in Spain and abroad in a setting characterised by the contraction of bank credit and prolonged low interest rates which encouraged the development of new investment and funding possibilities falling outside of the banking channel. Concerns about the suitability of the regulation of this sector gave it an unfavourable connotation that was even reflected in the name originally given to it ("shadow banking") and which has remained in use until recently. In many countries these entities are appropriately regulated and supervised, although their regulation differs from banking regulation and should possibly evolve to adapt to the risks posed by this new financial reality.

In Spain NBFI-related assets [estimated in accordance with the methodology proposed by the Financial Stability Board (FSB)],[2] amounted to €284 billion in 2018, accounting for 6.3% of the Spanish financial system. This figure has been on a growth trend since 2013, although it declined in 2018 owing to the expansion of investment funds. In comparison with other entities (securitisations, finance companies, broker-dealers, etc.) investment funds are by far the most important institutions in the sector in Spain (89%). The CNMV adequately monitors this sector, also from a financial stability standpoint, and for the moment the risks currently seen are limited, although they warrant constant monitoring (for example, in connection with liquidity and contagion risks). Against this backdrop, the use of tools to mitigate and, if appropriate, reduce NBFI-related risks is crucial both from a microprudential standpoint and in connection with the design of a constantly evolving holistic macroprudential policy.

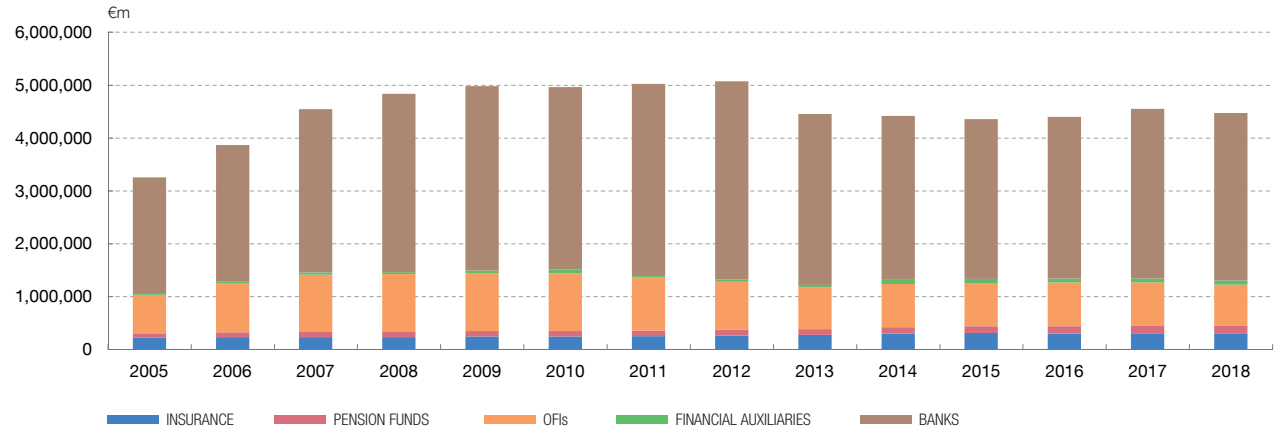
1 Introduction

The Spanish economy has traditionally been characterised by a high degree of banking intermediation in the provision of funds to the private sector. This phenomenon is also present in other benchmark European economies and is

1 This article is based on the information available up to 2018, which is subject to review.

2 See FSB document "Policy Framework for Strengthening Oversight and Regulation of Shadow Banking Entities" published in 2013.

Chart 1
THE SPANISH FINANCIAL SYSTEM



SOURCES: CNMV and Banco de España.

different from that seen in the United States or in the United Kingdom, where capital markets are more important. In fact, some estimations indicate that in these two economies business financing provided by capital markets accounts for 70% to 80% of total financing received by firms, a proportion which has remained relatively stable over time.[3] In Europe, the relative importance of the markets is lower, fluctuating between approximately 50% and 60%, but is on a rising path since the latest financial crisis and the contraction of credit in several European economies.

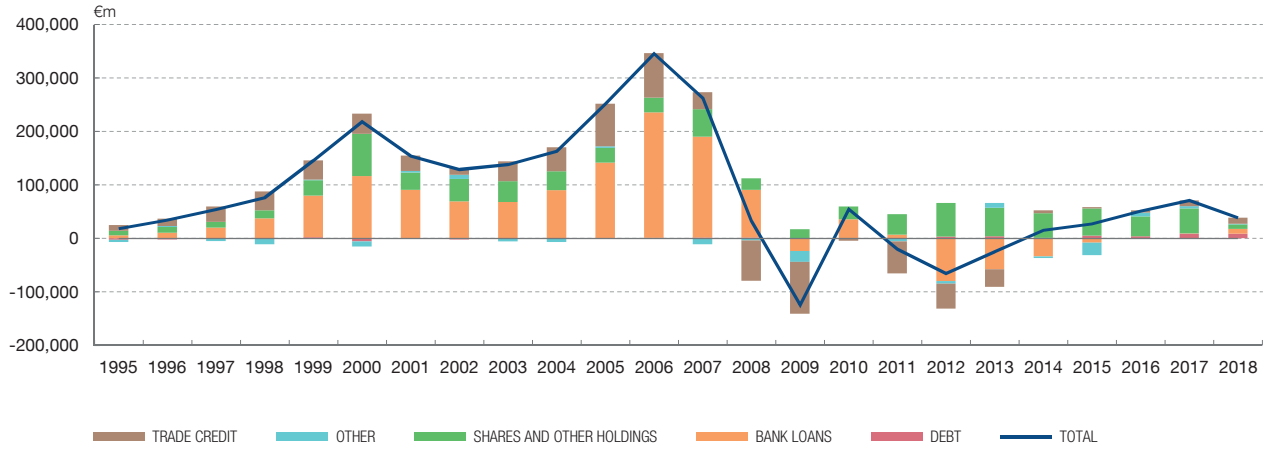
The composition of Spain's financial system reveals that banks continue to be the most significant institutions by size, with assets of €3.3 trillion in 2018, including the central bank's assets[4] (see Chart 1), and accounting for 71% of the system's total assets. However, this predominance has decreased in recent years,[5] owing to different factors. These include, on one hand, the contractionary effects on the outstanding balance of credit deriving from the intense restructuring process undergone by the financial system in 2012, in a recessionary economic setting which fed this decline. On the other, an environment of very low interest rates over an extended period encouraged the development of new investment and financing models different from the banking channel.

3 See the article "The presence of Spanish non-financial companies in capital markets" by Eudald Canadell and María Isabel Cambón published in the CNMV quarterly bulletin for the third quarter of 2018.

4 Including the central bank and public institutions e.g. the Official Credit Institute (ICO, by its Spanish acronym).

5 Between 2012 and 2018 the relative importance of the banking sector (including the central bank and public financial institutions) has declined from 73.9% to 70.9%. However, there has been a slight increase in the past three years, owing to the increase in the central bank's assets, from €449 billion in 2014 to €749 billion in 2018.

Chart 2
FINANCING OF NON-FINANCIAL CORPORATIONS



SOURCE: Financial Accounts of the Spanish Economy (Banco de España).

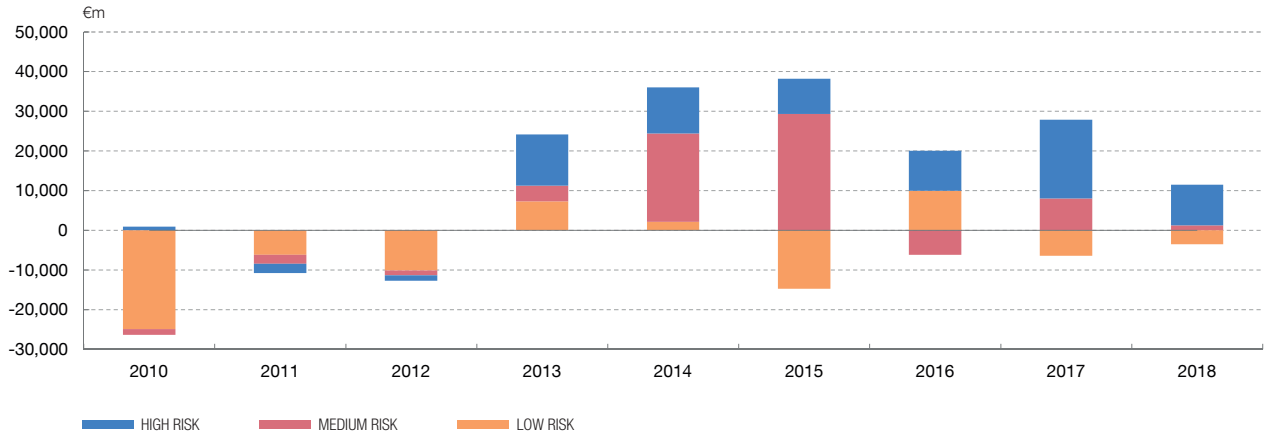
For some time there has been talk of the need in Spain for firms' sources of finance (those provided by the banking sector and those obtained via the financial markets) to be better balanced. These sources of finance should not necessarily be understood as competitors, but rather as complementary. It is reasonable to think that an economy with a more balanced funding structure between the banking sector and the capital markets can record higher growth rates in the medium and long term and also show less extreme fluctuations in its economic cycle.

The stabilising nature of funding provided by the financial markets to firms when other alternative funding sources are not available or they are substantially reduced has been seen in the last few years, particularly during the worst period of bank credit contraction in 2012, 2013 and 2014. As shown in Chart 2, financing of non-financial corporations was strongly affected during the crisis years, both in terms of volume and of composition. Thus, until 2008 financing related mainly to bank loans and, to a lesser extent, intercompany loans (commercial credit). During the crisis years the importance of bank loans in firms' total liabilities declined (from accounting for 43% to below 30%). By contrast, the item "shares and other holdings" (which also includes earnings retained by banks), showed much strength and stability during the crisis years, being almost the only recurring source of corporate finance and rising in relative importance to figures close to 60% of total liabilities.

From a more general viewpoint, financing of firms through the markets is beneficial for several reasons, namely firms' transparency levels rise, their financing possibilities improve, companies note that they have reached a degree of professional management of their business and there are also improvements in terms of prestige and reputation. However, participating in the markets may entail high costs (not only in economic terms). Hence, this form of financing is in many cases only used by

Chart 3

NET SUBSCRIPTIONS OF INVESTMENT FUNDS BASED ON FUND RISK (a)



SOURCE: Financial Accounts of the Spanish Economy (Banco de España).

a Low-risk funds include fixed-income and collateralised funds; medium-risk funds include mixed funds; and high-risk funds include equity funds, absolute return funds, global funds and passive management funds.

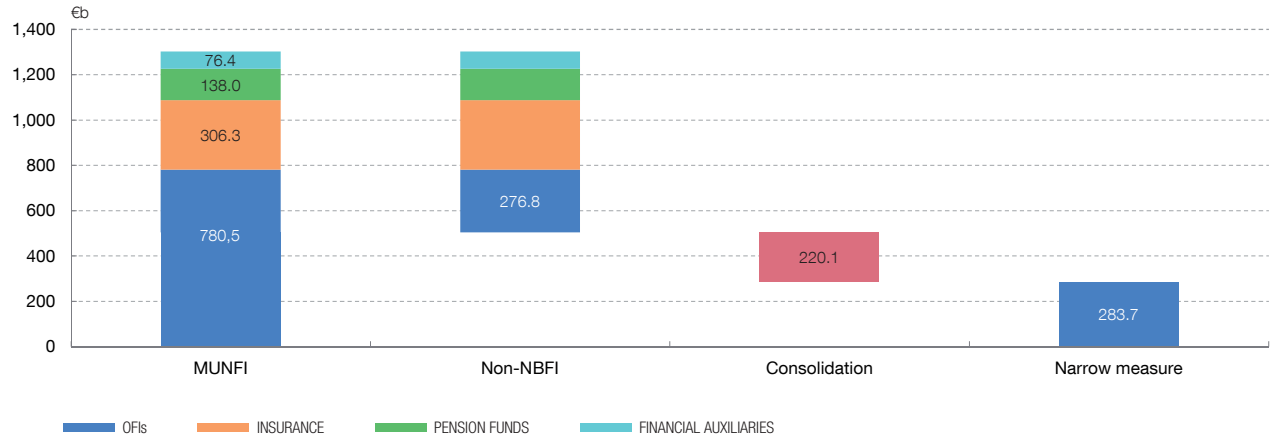
larger firms. Smaller firms (of which there are many in Spain) may access other sources of finance aside from the traditional bank loans, including most notably alternative markets, venture capital financing and crowdfunding.

From the standpoint of investment, the rising significance of the non-bank financial sector in recent years has taken place in a setting of very low interest rates that has fostered search-for-yield strategies in a considerable number of investors. These strategies may lead to purchases of riskier and less liquid assets and, consequently, to greater vulnerability for some investors. As an example, Chart 3 shows how the pattern of investment in investment funds in Spain has shifted from more conservative fund categories to riskier ones. The latter changed from recording net redemptions in the period 2010-2012 to annual net subscriptions in excess of €12 billion, on average, from 2013 to 2018.

In parallel to the growth of the non-bank financial sector, some concern arose about the nature of the risks relating to these activities and the suitability of their regulation. Indeed, for several years and until recently, this sector was called "shadow banking" owing to the (often mistaken) perception that these entities carried out activities relatively similar to those carried out by banks and were not regulated. It is true that there are very different types of entities in the non-bank financial sector which, depending on their jurisdiction, may be subject to scantly homogeneous regulations. However, in many countries they are adequately regulated and monitored, although such regulation might be different from banking regulation and should possibly evolve to respond to the challenges of a new financial reality.[6]

6 See also the report "Macroprudential policy beyond banking: an ESRB strategy paper", published in 2016.

Chart 4
FROM MUNFI TO NBFI IN SPAIN



SOURCES: CNMV and Banco de España. 2018 data.

This article tries to describe and determine the main activities and entities related to NBFI in Spain (Section 2) and the most significant risks they can entail in terms of financial stability (Section 3). It also describes the most important tools available to the authorities for the purpose of mitigating such risks against a backdrop of a holistic design of macroprudential policy (Section 4). The conclusions drawn are set out in Section 5.

2 Non-bank financial intermediation[7]

MUNFI[8] entities are the starting point for specifying NBFI activities. They include all non-bank institutions engaging in financial intermediation (excluding central banks).[9] The asset volume of these activities in Spain is approximately €1.3 trillion (see Chart 4). Most of these assets relate to other financial institutions (OFIs), followed by insurance companies, pension funds and financial auxiliaries. OFIs include highly diverse entities, as explained later on in this article. Their regulation is not homogeneous among jurisdictions and, in general, it is perceived as being less defined than banking regulation. For this reason, the size of this sector has sometimes been used as a broad and approximate measure of what can be called NBFI.[10]

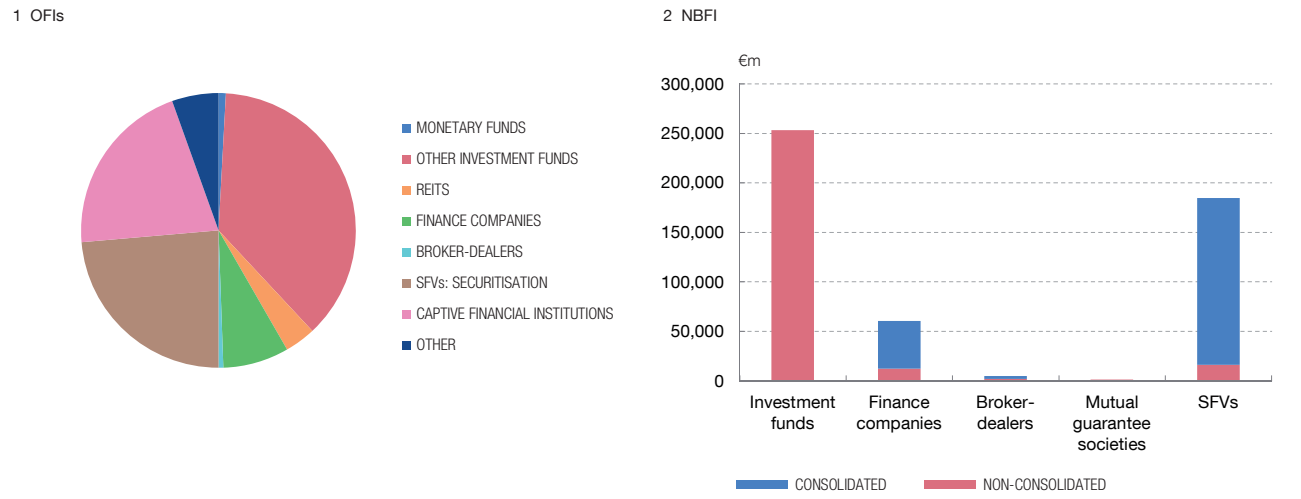
7 Most of the information included under this heading is based on the article "Non-bank financial intermediation in Spain" by Anna Ispierto, published in the CNMV's quarterly bulletin for the first quarter of 2019.

8 Monitoring Universe of Non-bank Financial Intermediation.

9 Including public institutions.

10 This approximation is more in line with that carried out by the European Systemic Risk Board (ESRB). See, for example, the latest ESRB report on the non-bank financial sector "EU Non-Bank Financial Intermediation Risk Monitor".

Chart 5
FROM OFIs TO NBFI



SOURCES: CNMV and Banco de España. 2018 data.

In Spain, OFIs hold assets amounting to €780 billion as a whole, although they peaked at more than €1 trillion between 2007 and 2010. Between 2002 and 2009 OFI assets recorded cumulative growth of 241%, but after the crisis they contracted to levels close to €800 billion in 2013, remaining stable since then. In recent years the sector has expanded somewhat less in Spain than in other European economies. This is because although investment funds have posted significant growth, it has been partially offset by the decline in the outstanding balance of securitisations.

OFIs include different types of entities depending on the activity they engage in. Under the conceptual framework established within the scope of the FSB, to be detailed later on, OFIs include entities that are part of NBFI, such as certain types of investment funds, special purpose vehicles for securitisation, broker-dealers and finance companies.[11] Entities that are OFIs but are not part of NBFI include captive financial institutions and money lenders, equity investment funds, Sareb (the Spanish asset management company for assets arising from bank restructuring), REITs,[12] and other smaller entities. In terms of asset volume, the latter group includes most notably captive financial institutions and money lenders which provide investment services and whose assets or liabilities are not, in general, exchanged in open financial markets. These entities concentrated 20.9% of the total assets held by OFIs in 2018 (see Chart 5.1).

11 Some entities that are not OFIs are also part of NBFI, although, in general, these are smaller in size. In Spain, this would be the case of mutual guarantee companies, which are financial auxiliaries.

12 Real Estate Investment Trust.

The FSB developed a conceptual framework in 2013 based on five economic functions to identify and classify entities engaging in "shadow banking",[13] as this activity was called practically up until 2018 and 2019, when, after much debate on the negative connotation of that name, the NBFI term was adopted. The idea was for the different competent authorities to use this framework to classify the entities in this sector, not so much in relation to their legal form, but rather to the characteristics of their activity. International consistency was thus sought in quantifying the sector and identifying associated risks.

Considering the five economic functions mentioned above (see subsequent Charts) and that mainly a part of OFIs are considered[14] (see Chart 4), assets involved in NBFI in Spain at end-2018 amounted to €504 billion, 5.3% less than in 2017. This figure, which relates to the broad NBFI measure,[15] can be fine-tuned somewhat more if the proportion of assets consolidated in banks is eliminated. After discounting these assets, NBFI activity in Spain can be quantified at €284 billion, of which 6.3% relates to Spain's financial system and 36.4% to the OFI sub-sector (see Chart 5.2).

NBFI in Spain posted high growth between 2002 and 2007, in terms of both the broad measure and the narrow measure. From 2007, at the start of the crisis, assets managed by NBFI entities began to decrease, especially in 2008, and did not begin to recover until 2013. Although NBFI assets grew significantly in absolute terms before the crisis, there was a decline relative to the financial system (from 11.8% in 2002 to 8.4% in 2007), because their expansion was more subdued than that of bank assets. However, the expansion recorded since 2013 was in absolute and relative terms, although the pre-crisis figures have not yet been reached (see Chart 6).

By type of entities comprising NBFI, those classified under economic function 1 (certain types of investment funds) are the most significant ones, followed at a distance by those classified under economic function 5 (securitisations) (see Chart 5.2 and Chart 6.2).

The preliminary analysis of interconnectedness among entities in the financial system (particularly significant in times of market turbulence) reveals that direct exposure between the banking sector and OFIs has decreased slightly in recent years down to around 10% of the banking sector balance sheet.[16] These percentages are in line with the figures for the jurisdictions which submit data to the FSB when

13 Policy Framework for Strengthening Oversight and Regulation of Shadow Banking Entities.

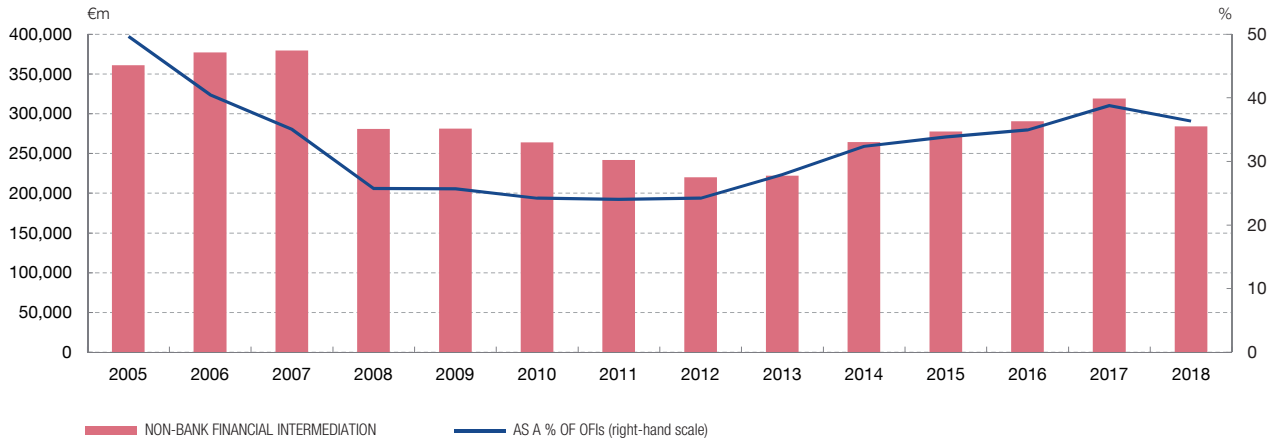
14 Mutual guarantee companies are the only institutions which are part of NBFI without belonging to OFIs (they are financial auxiliaries).

15 This broad measure of NBFI should not be confused with that used by the FSB, which refers to MUNFI institutions.

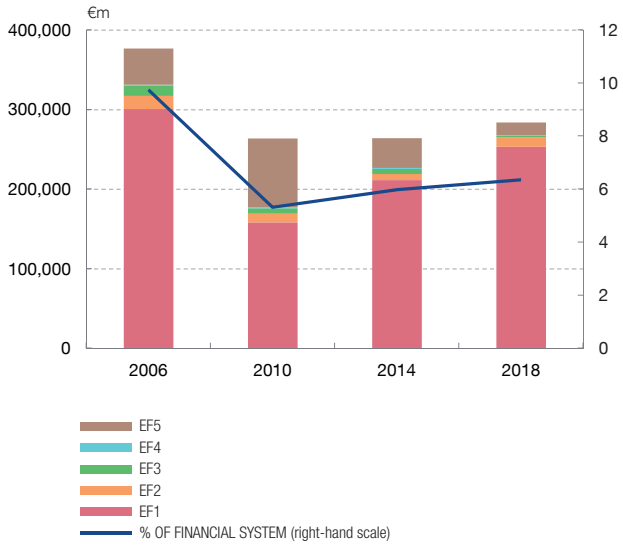
16 Both the exposure of banks to OFIs and bank financing through OFIs would be slightly above 10% of total banking assets, although much higher peaks were posted.

Chart 6
NBFI ASSETS IN SPAIN

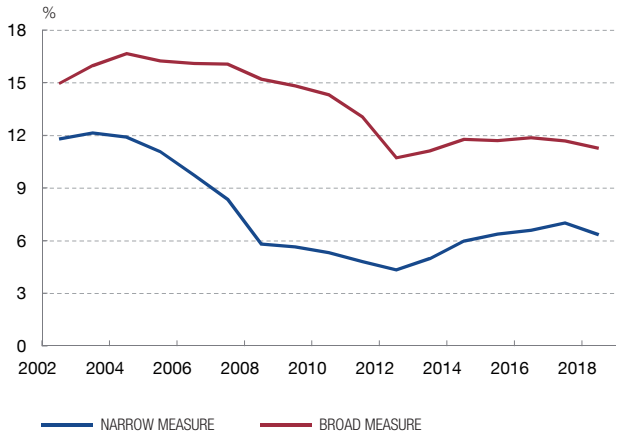
1 TOTAL ASSETS AND RELATIVE PERCENTAGE



2 BY ECONOMIC FUNCTION



3 AS A PERCENTAGE OF THE FINANCIAL SYSTEM



SOURCES: CNMV and Banco de España.

calculated on the basis of the size of the banking balance sheet.[17] As regards the size of OFI assets, the percentages for Spain (over 15% for both rights and obligations) are among the highest, particularly owing to the smaller size of OFIs in Spain.

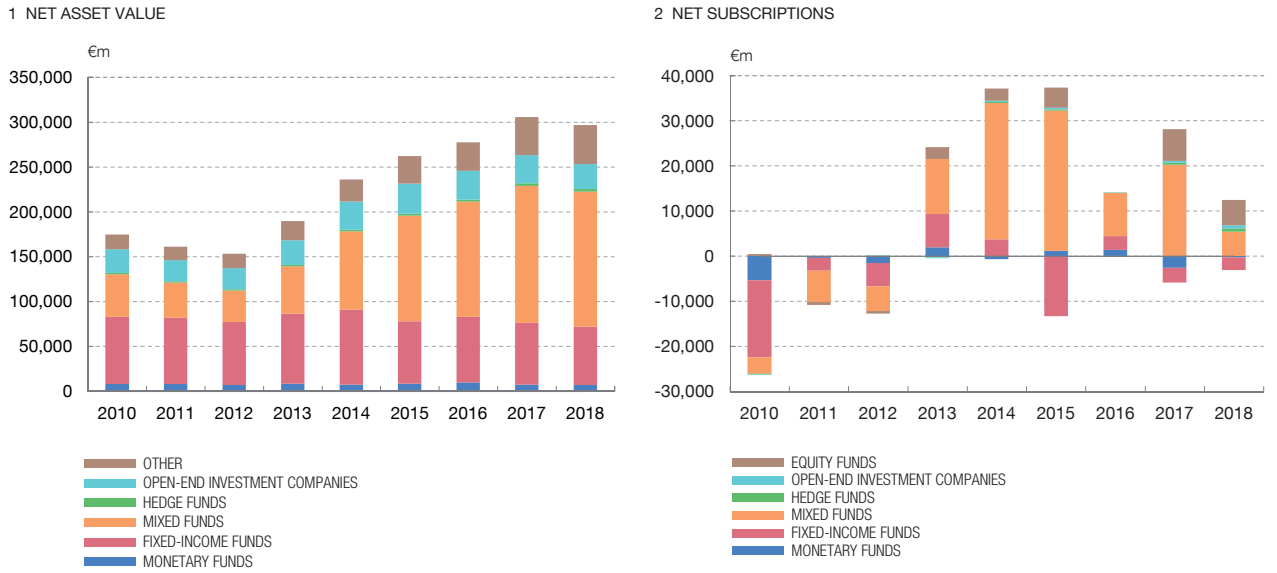
2.1 Economic function 1

Economic function 1 is defined as the management of collective investment vehicles (CIVs) with features that make them susceptible to runs. In certain circumstances collective investment schemes may be subject to significant runs by unit-holders in

17 See the FSB report "Global monitoring report on non-bank financial intermediation 2018".

Chart 7

NET ASSET VALUE AND NET SUBSCRIPTIONS AT EF1 INSTITUTIONS



SOURCE: CNMV.

a short period of time, particularly in times of market turbulence. Against this background, CIS management companies must address investors' requests for assets that offer the possibility of daily redemption in most cases. The obligation to sell in a short period of time a considerable portion of the portfolio may ultimately affect less liquid assets, with the risk of forcing asset sales that will push prices downwards (fire sales) and end up having adverse effects on other entities and on markets. The impact on unit-holders and on markets may depend on diverse matters, including most notably the strategy followed by the manager when selling the assets, unit-holders' loss-absorption tolerance, fund portfolio liquidity, leverage, concentration of investments in assets affected by turbulence, etc.

There are two distinct strategies: the waterfall strategy, under which the fund's most liquid assets are sold first, and the slicing strategy, under which assets are sold in a manner proportional to the CIS portfolio. In the first case, the estimated impact on the markets would be lower (more liquid assets are sold primarily) albeit to the detriment of an equal treatment for the unit-holders, since those remaining in the CIS would be exposed to a less liquid asset portfolio. Under the second approach, an equal treatment to unit-holders is preserved, but the consequences on the financial markets would be immediately more adverse (less liquid assets are sold from the start). To mitigate these risks there are several tools which are normally available to securities supervisors (to be discussed in a subsequent section). These tools are mainly related to the management of redemptions (possibility of suspending or creating special purpose compartments, i.e. side pockets), management of liquidity (possibility of requiring entities to increase additional liquidity buffers) and leverage

limits. Some of these measures, such as the imposition of reaching certain liquidity ratios, have been created recently.[18]

Against this backdrop, the types of investment vehicles considered in Spain to be part of economic function 1[19] are monetary funds, fixed-income funds, mixed funds,[20] hedge funds[21] and open-end investment companies. These vehicles represent the most important part of NBFI in most of the economies belonging to the FSB sample countries. In Spain they accounted for 89.2% in 2018 (amounting to €253 billion, see Chart 5), as compared with 71.7% for the FSB sample countries in 2017. This proportion has increased over the last few years in line with the expansion of the collective investment sector since 2013.

It should be noted that the composition of CIS on the basis of the different types of funds is not homogeneous among jurisdictions. In Spain, mixed funds account for a majority (60%) of CIS included in NBFI, of which more than one quarter relate to mixed fixed income. Additionally, their importance has grown over time almost uninterruptedly since 2013, with large inputs of funds mainly responsive to unit-holders' search for yield in view of the setting of very low interest rates. This has given rise to a substantial change in the composition of the investment funds industry in Spain, which has traditionally been dominated by conservative or low-risk products such as collateralised, fixed-income or monetary funds, towards products with a greater proportion of equity investments. Consequently, the significance of fixed-income funds has been declining, from 50% in 2011, to close to 25% in 2018. The net asset value of open-end investment companies represented 11% of the total, while that of monetary funds and hedge funds represented 2.7% and 1.1%, respectively.

2.2 Economic function 2

Economic function 2 is defined as loan provision that is dependent on short-term funding. This category encompasses a large variety of entities which may be subject to very different legal systems depending on their jurisdiction. In Spain, the largest entities belonging to this function are finance companies. There are, however, smaller and more recent types of funds (direct lending funds),[22] which also provide funds to

18 See royal Decree-Law 22/2018 of 14 December 2018 establishing macroprudential tools.

19 Closed-end institutions are not considered part of economic function 1 because their features do not make them susceptible to runs.

20 The definition of mixed funds used by NBFI encompasses all funds that cannot be categorised as fixed-income or equity funds. Accordingly, these include mixed equity funds, mixed fixed-income funds, passive management funds, global funds, absolute return funds and guaranteed equity funds.

21 These institutions are susceptible to runs in their liquidity windows, if they have them.

22 These funds, which grant loans or credit to generally medium or small firms, are usually either large international funds or structures created by Spanish managers which are normally located in other jurisdictions, such as Luxembourg. These entities are not registered in Spain but Spanish legislation (Law 22/2014, of 12 November 2014, regulating venture capital undertakings and other closed-end collective

firms, either competing with banks or offering services in niche markets where banks are not active players. The assignment of some of these entities to economic function 1 or 2 is currently being debated, owing to their CIS nature.

Several kinds of measures can be adopted to mitigate the risks associated with these activities. According to the work performed in the FSB, some of these measures might be related to the imposition of prudential regimes equivalent to banking, capital requirement and liquidity buffer regimes.

The quantification of assets relating to this function represents a share lower than the real one since lending is an activity not requiring license and, consequently, information is not available about all the entities that might engage in it. Also, in the case of recently created entities, some are not registered with the CNMV (information is not available) and the information that is available for the rest is incipient.[23] The calculations (only considering data on finance companies) reveal that in Spain assets relating to this economic function account for approximately 12% of total NBFI (using a broad definition), amounting to somewhat more than €60 billion. Net of the amount consolidated into banking groups (around 80%), the assets of these entities would decline to €12 billion, i.e. 4.2% of NBFI according to the narrow measure (see Chart 5).

2.3 Economic function 3

Economic function 3 is defined as intermediation of market activities that is dependent on short-term or secured funding. In Spain this function would involve broker-dealers, which can be exposed to significant liquidity risk based on their funding model. In the case of entities using customer assets to obtain funds (generally through repos), a significant withdrawal of funds may give rise to a mismatch between the maturity of assets and liabilities. Some of the instruments available to the authorities to mitigate the risks associated with this activity are related to the imposition of prudential regimes equivalent to banking regimes, liquidity requirements or restrictions to the use of customer assets.

In Spain, 39 broker-dealers were registered at end-2018, with assets amounting to €4.56 billion. This sector is small in comparison with other European

investment institutions) addresses a type of vehicle (closed-end collective investment vehicles) which can also engage in this activity, as can open-end mutual funds, which are regulated by Art. 73 of the collective investment institutions regulations.

23 Some estimates reveal that direct lending funds operating in Spain may have assets of nearly €1.5 billion. The activity of closed-end collective investment vehicles (which are required to register with the CNMV), of which there is limited information, is estimated to amount to €550 million. Crowdfunding platforms account for approximately €60 million and according to the data available, debt investing hedge funds amount to €30 million.

jurisdictions, since investment services in Spain are primarily provided by banks, many of which took over their broker-dealers over the last few years, thereby increasing their significance in this business niche. Broker-dealers are subject to the Basel III Accord requirements, as they must comply with European legislation[24] on prudential requirements for credit institutions and investment firms.

2.4 Economic function 4

Economic function 4 encompasses entities that facilitate the creation of credit. In Spain, they relate to mutual guarantee companies. The main aim of these entities is to facilitate the access of credit to SMEs and to improve, overall, their financing conditions by providing guarantees to banking institutions, public administrations, customers and providers. The provision of credit improvements contributes to the creation of credit and, consequently, to the build-up of agent leverage and the appearance of risks that might be a threat to financial stability.

There are also tools for mitigating certain risks that might derive from the activity of these entities (capital requirements, business restrictions, liquidity buffers, etc.), although their small size in comparison with the activities encompassed by NBFI as a whole should be taken into consideration. At end-2018 their assets hardly accounted for 0.2% of the total activities.

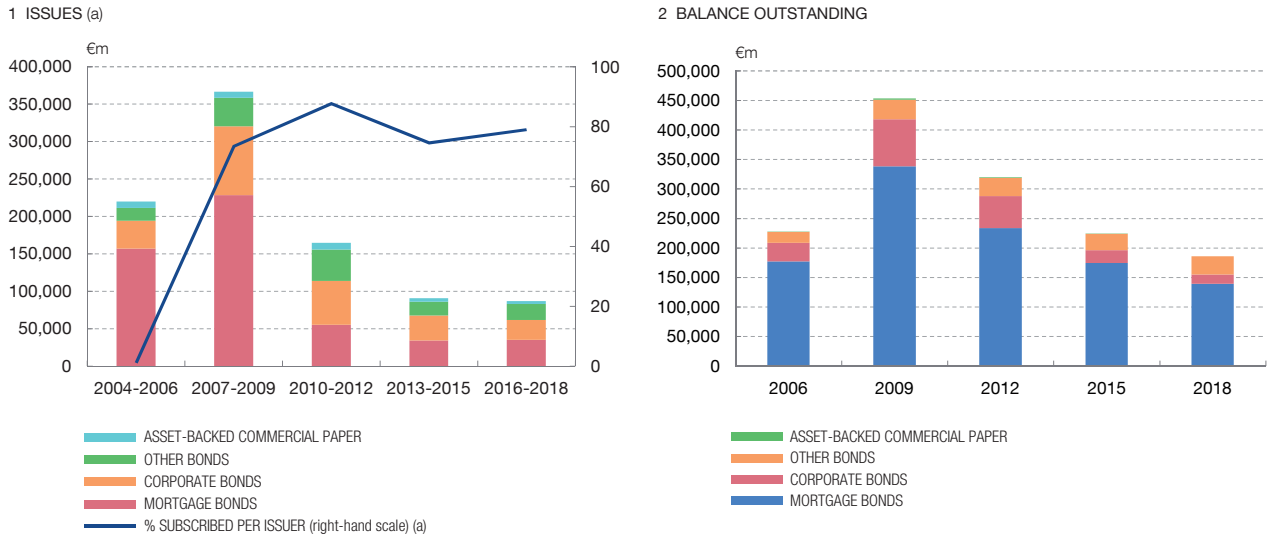
2.5 Economic function 5

Economic function 5 is defined as securitisation-based credit intermediation for funding financial institutions. It encompasses special purpose vehicles whose purpose is asset securitisation. The provision of funding to financial institutions (with real transfers of assets or risks) may be part of the credit intermediation process and may, consequently, be significant in terms of maturity transformation and excessive leverage. In Spain securitisation issuance is generally structured so that payments are made based on groups of assets that are amortised over time. Therefore, the risk relating to maturity transformation is much lower. Notably, securitisation in Spain has largely been used as a source of funding and not as a risk transfer mechanism (as occurred in other jurisdictions, giving rise to one of the most significant problems in the latest financial crisis). The tools that aim to minimise the risks relating to these activities include most notably restrictions on the transformation of maturities, the possibility of obliging the originator to withhold part of the securitised asset, restrictions on eligible collateral and restrictions on exposures to banks or other financial institutions.

24 Regulation (EU) No 575/2013 of the European Parliament and of the Council of 26 June 2013 on prudential requirements for credit institutions and investment firms.

Chart 8

SECURITISATION FUND ISSUANCE AND BALANCE OUTSTANDING



SOURCE: CNMV.

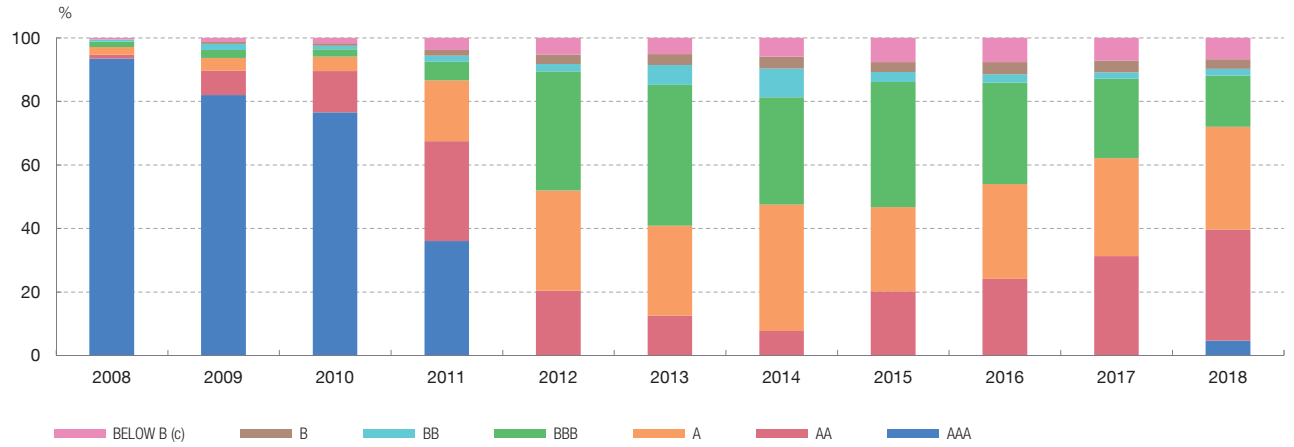
a Amounts accumulated in the period.

In Spain, securitisation is the second most important economic function in NBFI as a whole. The assets of these vehicles amounted to €185 billion in 2018, accounting for approximately 37% of NBFI (under the broad definition). This sector was much larger a few years ago (nearly €500 billion in 2010), but it decreased against the backdrop of the financial crisis. That said, the decrease recorded in issuance (see Chart 8.1) was more moderate than could have been expected, since financial institutions decided to continue issuing securitisations and to subscribe them themselves in order to use these assets as collateral in the Eurosystem's lending operations. The outstanding balance of securitisations declined from 450 billion in 2009 to 186 billion in 2018 (see Chart 8.2). In the Spanish market most of the asset-backed bonds and commercial paper related to mortgage bonds, which accounted for three quarters of the total. In addition to the decrease in the outstanding balance of securitisations, the deterioration of the credit quality of these assets, which arose in 2011 and 2012 and which was due both to the increase in country-risk in those years and to the increase in the intrinsic risk for these products, was notable. Thus, AAA-rated assets, which concentrated more than 90% of the total in 2008, were non-existent between 2012 and 2017, while the percentage of assets rated BBB or lower rose from 3% to 37% in 2018.

Spanish legislation does not envisage specific restrictions relating to eligible collateral or to maximum volumes of loans that can be securitised. However, the CNMV promotes the transparency of entities engaging in securitisation to mitigate the risks deriving from the complexity of these products. This

Chart 9

OUTSTANDING BALANCE OF ASSET-BACKED BONDS AND COMMERCIAL PAPER BY CREDIT RATING (a) (b)



SOURCE: CNMV.

a Does not include the alternative fixed-income market (MARF, by its Spanish abbreviation).
b Based on Standard and Poor's ratings.
c Includes unrated issues.

transparency is reflected in the obligation of asset management companies to send, on a half-yearly basis, standardised and detailed information on the amount and situation of the securitised assets and the bonds issued.[25] Additionally, although there is no national legislation, Regulation (EU) No. 201/2402 of the European Parliament and of the Council of 12 December 2017, setting out a general framework for securitisation and a specific framework for simple, transparent and standardised (STS) securitisation, entered into force in 2019. One of the most significant developments introduced by this regulation is the distinction between STS and other securitisation, since the former has a favourable treatment in terms of capital requirements and the withholding requirement for the originator.

Lastly, it is important to note that in Spain most securitisations are consolidated into banking groups and, consequently, they are excluded from the narrow measure of NBFI. The reason for this is that the assigning entity retains control in compliance with the existing regulations and is exposed to the variable yields of the funds and of the securitised assets, either because the entity has made a credit improvement or because there has been a swap where it collects the returns on the securitised portfolio and pays the bond coupons.

25 This information is published on the CNMV website.

3 Risks associated with NBFI

In addition to identifying the entities involved in financial intermediation and quantifying their assets, it is necessary to analyse the risks to financial stability that they can generate as a result of their activity, size or linkage with other entities. In this connection, identifying and monitoring potential risks is particularly important. This section briefly analyses the major risks of the largest entities engaging in NBFI in Spain, i.e. investment funds (monetary, fixed-income and mixed investment funds are analysed independently), finance companies, broker-dealers and structured finance vehicles (SFVs).

Table 1 illustrates the intensity of the risks analysed, which is the result of calculating an indicator[26] by type of entity representing some kind of vulnerability and of the position of such indicator relative to a previously established threshold. These thresholds have been defined by taking into account the debate that is being held about them in international fora and they have been adapted to the characteristics of each type of entity. However, they have been set through purely qualitative criteria which may be revised in the future if it is considered necessary.[27] The intensity of credit intermediation, liquidity and maturity transformation, and leverage should be assessed in a setting that takes into account the size of the sector analysed and the degree of interconnectedness among entities. As regards sector size, the importance for certain entities of asset consolidation in banking groups should be noted. For example, the weight of securitisation, which is high (37%) in the broad measure of NBFI, drops to 5.6% once the vehicles consolidated in the banking group are excluded, while the relative importance of investment funds, which are highly affected by consolidation, increases from 50% to nearly 90% of NBFI. In connection with the degree of interconnectedness among entities, a preliminary analysis of exposures across sectors[28] reveals that the most significant interconnectedness relates to that between securitisation funds and the banking sector, although such significance has declined in recent years.[29]

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26 The indicators presented were calculated for all the entities, including those consolidated into banking groups.

27 In the case of liquidity risk reference thresholds for investment funds, it has been determined that they are lower than for the rest of entities owing to their specific features. Specifically, the possibility of runs by unit-holders generates an additional need for liquidity, which has been considered to be 20%. This figure is consistent with the percentage drop in equity driven by the publication of a significant event by a management company and, from an empirical viewpoint, with the redemptions carried out in Spanish investment funds during the stress period between May and July 2012. In the latter case, the studies performed determine that the fund which related to percentile 90 in connection with redemptions in that period experienced fund outflows representing 22% of total net assets in fixed-income funds and 13% of those in equity funds.

28 Exposure through loans and fixed-income and equity securities.

29 This preliminary analysis does not exclude the part of interconnectedness generated by vehicles consolidated into banking groups.

Table 1
RISKS ASSOCIATED WITH NBFI (a)

	Investment funds			Specialized lending institutions	Broker-dealers	SFVs: securitisation
	Monetary	Fixed-income	Mixed			
Credit intermediation	●	●	○	●	●	●
Maturity transformation	○	○	○	○	○	○
Liquidity transformation	●	●	●	●	○	●
Leverage	○	○	○	●	○	●
Interconnnectedness with the banking system	○	○	○	○	○	●
Relative importance (b) (c) (%)	1.3	13.0	28.7	10.8	0.7	38.9

SOURCE: CNMV. 2017 data.

a Absence of colour denotes low risk, while light, medium and dark purple denote moderate, medium and high risk, respectively.
b The weights of each of the entities in the table do not add up to 100%, since neither mutual guarantee companies nor some other types of funds also belonging to NBFI are represented.
c These percentages are calculated based on the sector's total size, without discounting entities consolidated into banking groups.

As Table 1 shows, the highest risk currently identified for investment funds, which is the group with the highest weight in NBFI, relates to credit intermediation, particularly in monetary and fixed-income funds. This is the most obvious risk (stable in the last few years) and it illustrates the nature of the activity of this group of entities, which is primarily investing in credit assets.[30] Next is the risk relating to liquidity transformation (at a medium level for the three types addressed), which has increased slightly in recent years. This source of risk is one of the most significant ones in the field of investment funds and as such it has been analysed and addressed in the most important international fora over the last few years. The underlying concern is that managers may have difficulty finding debt assets with attractive yields and may be including assets with higher expected yields (and also riskier and less liquid) in the portfolios. In our analysis the measure relating to liquidity risk considers any assets readily convertible into cash as liquid assets. Therefore, the ratio that measures liquidity risk (calculated as a proportion of the total portfolio, as are all assets not considered liquid) could be including assets which a priori appear to be scantly liquid but are liquid in practice. In any event, liquidity risk for investment funds is not considered excessive, but it is advisable to monitor its performance over time to see if it continues on an upward trend[31] and, above all, its distribution at fund level.[32]

30 Against this background, investment in credit assets would be comprised of cash, deposits and domestic and foreign fixed-income securities.

31 In the three types of funds analysed (mixed, fixed-income and monetary) the estimated proportion of liquid assets to total assets was between 50% and 60% in 2018, having followed a rising trend since 2015.

32 In this connection, the CNMV periodically evaluates the liquidity conditions of investment funds' fixed-income portfolio and has not detected at individual level any significant problems in terms of liquidity. Nonetheless, it should be noted that these analyses are conducted in times of absence of market stress. During times of shocks debt security liquidity conditions may change significantly in a short period time.

As regards the other two most important groups of entities in NBFI (although far behind investment funds), i.e. securitisations and finance companies, most of the indicators calculated point to the existence of medium or high risk, especially for securitisations. In most cases, the high level of indicators is responsive to the nature of the activity carried out by these entities. In securitisations, for example, where the asset side of the balance sheet is almost entirely comprised of credit assets (the basis for securitisation) and liabilities almost exclusively reflect the different kinds of asset-backed commercial paper and bonds issued, it is natural for conventional indicators relating to credit intermediation, liquidity transformation and leverage to be valued highly. Therefore, although analysing these traditional indicators is relevant and a good starting point for comparing entities using homogeneous criteria, it should be complemented by developing other additional analyses adapted to both the business models and heterogeneity within each sector.

4 Non-bank financial intermediation and macroprudential policy[33]

Macroprudential policy, which aims to preserve the stability of the financial system as a whole and has traditionally had a banking focus, has been adopting for several years a more global view of the financial system, with emphasis on work relating to the non-bank area. This change arose from the latest global financial crisis, which revealed how other actors and activities outside the banking sphere can be sources of systemic risk under certain circumstances. The new macroprudential policy stance takes into account other matters aside from size (related to the "too big to fail" theory), such as interconnectedness between agents and their behaviour, lack of transparency, and issues related to asymmetrical information and moral hazard.

Designing an appropriate macroprudential policy requires setting intermediate objectives linked to the policy's ultimate aim (financial stability) and having adequate tools for achieving such objectives. These intermediate objectives are assessed by means of multiple and diverse indicators. This framework is clearer in the banking area, where the intermediate objectives include most notably credit growth and indebtedness or the transformation of maturities and illiquidity.[34] Other important tools within the European Union are countercyclical capital buffers, capital conservation buffers and those aimed at systemically important institutions.

Macroprudential policy design is currently in progress in the non-bank sphere, particularly as regards tools which in many cases are given a macroprudential use

33 See "The participation of the CNMV in macro-prudential policy" published by the CNMV in July 2019.

34 For further details see the article "Macroprudential policy: objectives, instruments and indicators" by Javier Mencía and Jesús Saurina.

despite having a microprudential origin. As regards the definition of intermediate objectives, many of those taken into account for banks are also important in the non-bank area. This would be the case for objectives relating to increased leverage, maturity transformation and, above all, illiquidity. There has been much progress over the last few years in analysing and designing indicators relating to risk identification, but there is still room for improvement, especially as regards the tools available.[35]

This caption describes the most significant macroprudential tools relating to CIS (the most important entities in quantitative terms from an NBFI standpoint). There are other noteworthy macroprudential measures in the non-bank sphere affecting other sectors or entities, which are not detailed in this article. These include, for example, restrictions to short sales in the market infrastructure area. The tools available to the CNMV have increased recently,[36] in parallel with the creation of a new macroprudential authority in Spain (AMCESFI, by its Spanish acronym),[37] which has commenced to function this year. AMCESFI aims to improve the coordination of macroprudential supervision at national level and to help prevent or mitigate systemic risks. It is comprised of members of the Ministry of the Economy and Business Affairs, the Banco de España, CNMV and the Directorate General for Insurance and Pension Funds. In addition to monitoring and analysing the factors which may affect systemic risk, it may issue opinions, alerts and recommendations as it may deem appropriate. Supervisors should also inform AMCESFI in advance when they decide to activate, recalibrate or deactivate any of their macroprudential tools.

Table 2 contains a list (non-exhaustive) of the main macroprudential tools in the CIS area, with a detail of those available under Spanish legislation, those which may be adopted by the institutions supervised and those which may be initiated or require authorisation by the CNMV. Most of the instruments address problems relating to maturity mismatch and illiquidity, notably including redemption restrictions and suspensions, redemption fees, in-kind redemptions, side-pockets (special purpose vehicles) and liquidity ratios. Some of these measures must be authorised by the CNMV before they are initiated by CIS management companies. In recent years, the CNMV has authorised the temporary suspension of redemptions in certain funds (several of them real estate funds) at the request of their management company. As regards liquidity management, the table addresses both compliance with specific ratios (which derive from existing regulation and have a microprudential origin) and reinforcement of liquidity. This latter aspect is one of the newest tools

35 One of the first documents which addressed the tasks of securities supervisors in connection with systemic risk was published by IOSCO in 2011 (Mitigating systemic risk: a role for securities regulators).

36 See Footnote 18.

37 Royal Decree 102/2019 of 1 March 2019 creating the Macroprudential Authority Financial Stability Board, establishing its legal regime and implementing certain aspects on macroprudential tools.

Table 2
MACROPRUDENTIAL TOOLS IN THE CIS SECTOR

		Availability under current legislation			
Instrument	Intermediate objective	Available under Spanish legislation	CNMV authorisation required	Possibility of adoption by the CNMV (a)	Remarks
Redemption fee	Maturity and liquidity mismatches	Yes	No	No	Its implementation gives unit-holders the right to leave
Redemption gate	Maturity and liquidity mismatches	Yes	No	No	For alternative and real estate funds
In-kind redemption	Maturity and liquidity mismatches	Yes	Yes	No	Cannot be used under normal circumstances
Side pockets	Maturity and liquidity mismatches	Yes	Yes	Yes	Cannot be used under normal circumstances. Not available for real estate funds
Suspension of redemptions	Maturity and liquidity mismatches	Yes	Yes	Yes	Cannot be used under normal circumstances. Real estate funds may suspend funds up to two years. There are no limits for the rest
Anti-dilution levy	Maturity and liquidity mismatches	No			
Swing pricing	Maturity and liquidity mismatches	No	Yes	No	Not expressly included in the regulations but the CNMV allows management companies to adopt this tool if it is so established in their procedures
Restrictions to redemptions	Maturity and liquidity mismatches	Yes	No	No	
Limits to asset concentration	Excessive concentration of risks in certain assets or sectors	Yes			Regulatory requirement
Limits to the use of derivatives	Excessive leverage	Yes			Regulatory requirement
Limits to leverage	Excessive leverage	Yes		Partial	Regulatory requirement for UCITS. The CNMV may establish specific limits for alternative funds (hedge funds and venture capital funds)
Liquidity ratio	Maturity and liquidity mismatches	Yes			Regulatory requirement
Reinforcement of liquidity	Maturity and liquidity mismatches	Yes		Yes	For reasons of financial stability and on a temporary basis, the CNMV may require one entity or a group of entities to increase the percentage of investment in especially liquid assets (this tool may be applied to open- and closed-end CIS and to venture capital entities)
Limits to and conditions on these entities' activities to avoid excessive indebtedness in the private sector	Excessive leverage	Yes		Yes	This measure is applicable to all CNMV-supervised institutions

SOURCE: CNMV.

a Where there are measures that the CNMV cannot adopt, management companies are generally responsible for making such decisions.

provided by legislation. The CNMV may use it, for reasons of financial stability and on a temporary basis, to require one entity or a set of entities to increase their percentage of investment in particularly liquid assets. Finally, it is important to note the existence of measures which try to limit the exposure of funds to derivatives,

and to contain their leverage and degree of concentration in the exposure to certain assets or sectors.

5 Conclusions

Conceptually, NBFI encompasses a group of activities performed by very diverse entities, such as investment funds, finance companies or securitisation vehicles, which share some features with those of the traditional banking activity. These entities provide, therefore, a type of financing that may in some cases involve similar risks to those of credit institutions (maturity mismatch, liquidity risk, excessive leverage, etc.). In general, non-bank financing should not be considered as a source of competition as regards bank lending, but as a possibility for firms to diversify their sources of finance and to achieve a stable base for obtaining funds. In fact, one of the most significant advantages offered by non-bank finance and, in particular, by that provided by capital markets, is that it acts as a buffer, stabilising the financing flows of entities in times of bank credit contraction. Some years ago, coinciding with bank credit contraction, financing through the markets was, together with firms' retained earnings, the most stable and recurrent source of funding. From a macroeconomic standpoint, it also seems clear that economies with more diversified sources of funding end up recording higher growth rates at medium and long term.

NBFI-related activity has grown in recent years[38] against a backdrop of credit contraction in many economies in the wake of the global financial crisis and as a result of a prolonged environment of very low interest rates. These factors, together with others, such as the impact of regulatory changes on certain banking activities, led to the emergence of a group of entities which operated outside the banking channel. In some cases these entities entered market niches which banks avoided because they considered them too risky.

The growth of these activities in recent years has generated some concern because it was considered, sometimes erroneously, that these entities remained outside the scope of regulation and supervision. These concerns were even reflected in the term used for this sector, which until recently was "shadow banking". The truth is that regulation and supervision are very heterogeneous among jurisdictions but, overall, it can be said that these entities are indeed subject to a regulatory and supervisory regime, albeit different from that applicable to banks. Therefore, the question to be posed is whether this regime is appropriate from the standpoint of financial stability and containment of systemic risk or whether it should change in any way.

38 In Spain this expansion commenced in 2013 and was interrupted in 2018.

NBFI-related assets in Spain amounted to €284 billion at end-2018, which accounts for 6.3% of the Spanish financial system. Nearly 90% of this amount relates to the net assets of some investment fund categories, a proportion that is higher than that seen in other European economies. The next entities in terms of importance (securitisation vehicles and finance companies) are at a much greater distance and are affected, especially in the case of securitisation vehicles, by the large proportion of their assets which are consolidated in banks' balance sheets (and are therefore excluded from the final NBFI figure). In addition to being relatively small in size, perceived risks in connection with these entities are low, although some of them, such as liquidity risk, have grown somewhat and this evidences the need to analyse these studies in greater depth. It is also necessary to persevere in identifying risks relating to interconnectedness among entities.

Insofar as the activities developed by entities engaging in NBFI may entail a risk to financial stability, the question arises of whether the authorities have the tools required to deal with this. In this connection, the CNMV has a broad set of tools, many of which are microprudential in origin but, if necessary, may be applied for macroprudential purposes. In the investment funds area, one of the best known tools, which has been used on some occasions in the last few years, is the suspension of redemptions. Also very important are those related to adequate portfolio liquidity risk management at these institutions. Of note is the recent approval of a new measure which allows the CNMV to temporarily require a group of entities to strengthen their liquidity in the proportion considered necessary. The implementation of any of the tools available should be reported in advance to the new macropudential authority (AMCESFI), to the Banco de España and to the Directorate General for Insurance and Pension Funds.

As a challenge for the future, the CNMV will continue to prioritise work relating to NBFI, focusing in particular on the need to evaluate on an ongoing basis the actors which may form part of these activities (lending funds are a recent example of the numerous cases which may arise), to quantify NBFI activity and to correctly assess the risks deriving from it. Ultimately, it will be possible to determine if the availability of macroprudential tools is adequate or needs to be revised. Also noteworthy is the effort in transparency made by the institution of which I am Vice-Chairperson and which has started publishing this year a half-yearly monitoring report including the most significant and updated information on NBFI in Spain.

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The shadow banking system and regulatory arbitrage: the eternal return?

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THE SHADOW BANKING SYSTEM AND REGULATORY ARBITRAGE: THE ETERNAL RETURN?

Abstract

Shadow banking is defined as financial intermediation carried out by non-bank institutions which has the following features: credit risk, leverage (scant own funds and predominance of external funding), and maturity mismatch (long-term assets funded by short-term liabilities). The shadow financial system played a predominant, and perhaps even a determining, role in the gestation of the 2007/2008 global financial crisis. This article takes a critical look at the efforts made to control the risk emanating from the shadow financial system. It concludes that, despite the efforts made, there is no guarantee that this risk is under control. The reason for this failure lies in the architecture of financial regulation, in the asymmetric measures taken (the current stringent regulation of the banking sector does not extend to shadow banking) and in the transformation produced by the fourth industrial revolution.

1 Introduction

If we were to ask about the causes of the global financial crisis, addressing not the general public but rather informed readers, the practically unanimous response would be that the banking crisis or banks are responsible for this deplorable episode of our recent history. Careful analysis of the inception of the crisis, between summer 2007 and autumn 2008, shows, however, that things were more complex.

In the author's mind the crisis began with the announcement by BNP Paribas of the suspension of a real estate investment fund, since it was not possible to calculate redemption values (the uncertainty caused by the subprime mortgage crisis in the USA prevented the market price of assets from being calculated). As a former executive board member of the CNMV, I recognised that the proper decision had been made: if redemption prices cannot be calculated accurately, there is a risk that the investors leaving the fund will be treated better than those who stay. Subsequently, although there were some resounding bank failures, the peak of the crisis was marked by the collapse of SIVs, structured investment vehicles (special purpose vehicles – SPVs – with a marked mismatch between the maturities of assets and liabilities) and of monolines (insurance companies specialised in the underwriting of credit risk), the government bail-out of AIG (a US insurance company which was the leading actor in the credit risk insurance market), the difficulties of money market funds running the risk of breaking the buck (realisable value below the nominal value) and, above all, the disorderly bankruptcy of Lehman Brothers, preceded by the fall of Bearn Sterns (ultimately bailed out by JP Morgan for $10). Although

Lehman was often referred to as an "investment bank", it had few of the characteristics of banks: it did not take deposits, it was not supervised by the Federal Reserve (FED) and it did not have access to central bank liquidity. It was what in Europe is called a securities dealer. The term "investment bank" in the USA has the same meaning as "securities dealer" in Europe.

In sum, at the peak of the crisis the leading players were investment vehicles, insurance companies (with non-traditional business models), securities dealers and a single bank. Evidently, the liquidity interconnectedness of banks with many of these players (SIVs and investment funds) finally triggered huge contagion and the crisis became an eminently banking crisis. But the presence of players that are not strictly banks should lead us to reflect on the role they played in the outbreak of the global financial crisis.

How did these non-bank financial institutions come to operate in the credit risk market? Owing to a combination of two factors prevalent in financial markets: innovation and regulatory arbitrage. Innovation creates completely new financial instruments which may generate added value (if they complete the markets á la Arrow-Debreu), but which may also have spurious purposes. And regulatory arbitrage exploits the weaknesses in all regulations which often allow them to be circumvented by financial agents operating outside the regulated sector and using innovative ways to obtain extraordinary returns, at least in the short term.

The question posed by this article is: what is the point of rigorous, prolific and stringent regulation of the banking sector when more than half of financial activity is in areas with considerably less supervisory oversight and regulatory requirements?[1] That is to say, in areas of financial activity in which the authorities acknowledge they do not know what happens,[2] what fragilities are being generated and what new linkages between risks and institutions are being formed in that new post-crisis financial ecosystem?

2 The role of the shadow financial system in the gestation of the crisis

To understand the role of the shadow banking system, first we have to step back and examine the "originate-to-distribute" banking model which predominated in the years before the crisis. Under this model, some universal banks packaged credit risk (assets) generated by them (and specifically conceived to be packaged) in a SPV.

1 See Table 1. The weight of the financial activity of banks is less than 50% of the total.

2 See Jenkins (2018).

This SPV proceeded to sell liabilities – divided in different combinations of seniority, yield and risk – to non-bank operators in financial supermarkets in the form of securities. This model, still existing, albeit less prevalent than before the crisis, combines banks' traditional risk management with modern forms of asset and risk transfer.

This originate-to-distribute banking model attracted a cluster of new agents and innovative financial instruments along with old actors which took on different roles. The new agents include, inter alia, the so-called *monoline* insurance companies (specialised in the underwriting of credit risk, a risk not traditionally handled by the insurance sector). The innovations included CDOs, CDO2s and CLOs, i.e. payment obligations backed by the debt of third parties (initially corporate debt, and later mortgages and consumer debt) in the form of bonds and loans, divided into different yield and risk tranches based on their seniority. SIVs were similar, except that they were sponsored by a bank (which provided lines of liquidity) and they focused on maturity transformation (the assets had longer maturities than the liabilities), not being consolidated on the sponsoring bank's balance sheet until the crisis.[3] Notable among the traditional agents which took on new roles in the vigorous credit risk market were certain insurance companies (AIG), which began to offer credit risk insurance in the derivatives markets, and credit rating agencies, which expanded their activity not only to assign ratings to these new instruments, but also to help in their design.

In short, the global financial crisis is often wrongly described as a basically banking crisis because of the need to bail out a large number of large, highly complex banks (Spain was an exception, as the problems were mainly in medium-sized savings banks, while the large international banks were actually an anchor of stability). But the truth is that the shadow financial system not only played a fundamental role in the genesis of the problems, but also triggered the crisis.

3 The taxonomy of the shadow financial system

Shadow financial system, shadow banking system or, according to the latest terminology of the Financial Stability Board (FSB), non-bank financial intermediation,[4] generally refer to all financial activity performed by non-bank agents – insurance companies, hedge funds, real estate funds, money market funds and investment

3 In Spain they were not developed because the Banco de España clarified that SIVs had to be consolidated on the sponsoring banks' balance sheets and SPVs' assets were therefore subject to capital and provisioning requirements. Under these conditions, SIVs were not profitable and Spanish banks did not develop them.

4 With the 2018 Report, the FSB moves away from the term "shadow banking" and adopts "non-bank financial intermediation" (hereafter NBFI), to emphasise the forward-looking aspect of the FSB's work.

Table 1
MACRO REPRESENTATION OF THE FINANCIAL SYSTEM
December 2017 data

					MUNFI (a)			
	Total global financial assets	Central banks	Banks	Public financial institutions	Insurance corporations	Pension funds	Other financial institutions	Financial auxiliaries
Size (USD trillions)	382.3	30.1	150.8	17.0	32.8	33.7	116.6	1.2
Share of total global financial assets (%)	100.0	7.9	39.4	4.5	8.6	8.8	30.5	0.3
Growth in 2017 (year-over-year, %)	5.3	8.8	2.8	4.9	4.8	6.8	7.6	22.6
Growth 2011-2016 (annualised, %)	5.9	8.9	3.6	4.2	6.0	6.1	8.9	7.0

SOURCE: FSB (2019a), p. 13.

a Monitoring Universe of Non-bank Financial Intermediation.

vehicles, and the like – which engage in banking operations (entailing leverage, credit risk assumption and maturity transformation, i.e. funded by short-term liabilities) that thus bypass or fall outside of banking regulation. It is not in itself harmful, since it meets the objective of complementing the banking sector's financing of the productive economy. However, when it becomes overly developed as a result of regulatory arbitrage and is unable to be properly controlled, it may pose a threat to global financial stability.

Non-bank financial intermediation is identified by a process of elimination, so its composition and size are not easy to calculate. Since 2010 the FSB has persevered in its definition and monitoring effort, publishing each year a report on this sector[5] and on the interconnectedness of financial segments. Evidently, the quality of the monitoring has improved much since it began, as refinements are made to the methodology and more countries contribute to the exercise. It would not serve any purpose to repeat here the FSB's exercise, but it is of interest to take a look at some aspects of the analysis made in it (see Tables 1 and 2).

First, banks, although individually they are the largest institutions in the global financial system, only represent 40% of it. Moreover, since 2011 they are the institutional group which has grown least, so that 40% share shows a clear downward trend. Second, examination of what the FSB calls "the narrow measure of non-bank financial intermediation" (that representing the greatest risk of instability because it

5 See FSB (2019a).

Table 2
NON-BANK FINANCIAL INTERMEDIATION (NBFI)
December 2017 data

1 NARROWING DOWN

2 COMPOSITION OF THE NARROW MEASURE

Economic functions	Size ($ trillion)	Share (%)	Change in 2017 (%)
EF1			
Collective investment vehicles features that make them susceptible to runs	36.7	71.2	9.1
EF2			
Lending dependent on short-term funding	3.5	6.7	5.8
EF3			
Market intermediation dependent on short-term funding	4.2	8.2	5.2
EF4			
Credit facilitators	0.2	0.3	4.4
EF5			
Credit intermediation based on securitisation	5.0	9.6	9.1
Unallocated	2.0	4.0	9.7
TOTAL	51.6	100.0	8.5

SOURCE: FSB (2019a), p. 7.

is susceptible to large-scale withdrawals in the form of runs, owing to leverage and maturity mismatch) shows that it accounts for somewhat less than 14% of the global financial system. Although 14% may seem little, the fact is that, since it is an activity carried on by quasi-banks outside the perimeter of banking regulation, it is a not insignificant source of vulnerability. What's more, between 2011 and 2017 it grew from representing 61% of GDP of the countries participating in the FSB's exercise to 75%. In some jurisdictions, such as China, the aggregate growth in that period exceeded 40%. In 2017 its growth of nearly 9% doubled that of banks.

On closer examination of that non-bank financial intermediation (see Table 2), specifically, when it is defined more narrowly and disaggregated by economic function, there seems to be more reason for alarm. First, the most delicate component of non-bank financial intermediation, i.e. that susceptible to runs, represents more than 70% of the total of the narrower definition. Moreover, its growth of 9% in 2017

tripled that of banks. When we add other segments dependent on short-term funding (and thus liable to suffer supply restrictions and bottlenecks when they roll over funding at times of market tension), it takes us up to nearly 90% of the total of that narrow measure.

In short, there is increasing non-bank financial intermediation activity, which moreover is concentrated in highly problematic segments because of its need to roll over short-term funding. Far from being a problem under control, regulatory arbitrage continues to fuel the growth of this truly unregulated parallel banking system.

As an additional thought, the interconnectedness of these sectors is of key importance because it is responsible for contagion between one area and another. Given the intrinsic fragility of banks, any difficulty in a segment of the shadow banking system will end up becoming a problem for the regulated banking system, as it did in 2007/2008. And, as occurred then, the word "bank" will prevail in the press headlines without distinguishing whether the entities which caused the disaster lived in the shadows or under the spotlight of stringent regulation.

It is enormously difficult to measure that interconnectedness. There have been no more than a few attempts of a static nature to describe it,[6] and the conclusion is that, even with a purely static definition, the inter-relationships between the actors of the shadow banking system and of the other sectors are incredibly complex. As an anecdote, one of the diagrams setting out those ties is so intricate that it would have to be printed on a sheet of paper the size of a meeting room table in order for the text describing them be able to be read.[7] In sum, we are far from understanding, measuring and controlling the inter-relationships generated by the shadow banking system.

Finally, the digital revolution and the emergence of a buoyant fintech industry, which will foreseeably help to do away with the boundaries between countries and sectors, can only aggravate this problem in the future. Regulatory arbitrage already existed in the years before the 2007 crisis, but the emergence of the digital world will boost it.

4 The flawed architecture of financial regulation

Financial regulation has historically been based on the type of institution rather than on the activities they engage in. This means that, even when financial activities are actually very similar, they are regulated differently depending on whether they are carried out by a bank, an insurance company or a money market fund. Of course, this description of the problem is overly stylised. For example,

6 See Pozsar (2014) and Pozsar et al. (2012).

7 https://www.newyorkfed.org/medialibrary/media/research/economists/adrian/1306adri_map.pdf.

the taking of deposits is an activity reserved to banks, i.e. to institutions subject to banking regulation. But the increasing haziness of the distinction between deposits and other short-term liabilities has substantially reduced the value of this protection of deposit-taking. Or, in other words, as that distinction disappears, there will be more and more financial institutions which are near-banks (not regulated as banks) and thus subject to suffer bank runs.

The source of that regulatory distinction by type of institution is obvious. Not only are the activities of banks, insurance companies and other collective investment instruments genuinely different, but moreover they were being supervised and regulated by different authorities. Spain is a good example of this, since the Banco de España, the Directorate General of Insurance and the National Securities Market Commission regulate and supervise banks, insurance companies and investment funds, respectively.

In the international arena, a similar specialisation exists: the Basel Committee on Banking Supervision (BCBS) focuses on banks, the International Association of Insurance Supervisors (IAIS) on insurance companies, and the International Organization of Securities Commissions (IOSCO) on investment services. However, the emergence of the FSB has improved the coordination between these three bodies (essential for the consistency of post-crisis regulation).

However, the flaw in this architecture is clear. Since post-crisis regulatory reform raised banks' capital requirements (threefold for banks as a whole, although up to tenfold for certain portfolios), it also increased the incentive for regulatory arbitrage. In fact, the potential gain from operating outside the regulatory perimeter has been multiplied by the same factor as capital has. The tougher the rules, the more attractive it is to avoid them: that is precisely the nature of regulatory arbitrage. We have made banks safer. They are more solvent, more liquid, better managed from the standpoint of risk, endowed with better corporate governance and more tightly supervised. But we are shifting risk to a part of the financial system where that improvement has not occurred. The problem of a shift in activity from banks to the shadow financial system is not just one of competition (given the unequal comparative treatment of banks by the regulator). It is fundamental to know whether shadow banking is raising the risk of financial instability, and even the likelihood of another systemic crisis due to quasi-banks operating outside the regulatory perimeter.

Another clear example of those flaws in regulatory architecture can be seen in the area of the systemically important financial institutions (SIFIs).

One of the lessons of the global financial crisis is that when a financial institution is too big, complex or interconnected with other parts of the financial system, winding it up in the event of difficulties is not an option, and it may have to be bailed out with public money to preserve financial stability. This is not only an aberration, contrary

to the required market discipline (where poorly managed companies are replaced by better managed ones), but also an intolerable use of taxpayers' money in bad times.[8] Examples of cases in point abound, the most notable being the US federal mortgage agencies (such as Fannie Mae and Freddie Mac), AIG and numerous international banks.

In Spain this was what happened with many savings banks. What stands out is the wide range of institutions bailed out: not only securities dealers, banks and insurance companies, but also entities with peculiar ownership structures and corporate governance, such as the US mortgage agencies or the Spanish savings banks.

Sensibly, the FSB, in cooperation with the BCBS, IOSCO and IAIS,[9] decided to address the problem of SIFIs by developing a new methodology to correct the externality posed by the too-big-to-fail (TBTF) status. The methodology development work was finished, but only the banking sector has a list of global systemically important banks and a set of clear and complete measures which assign additional capital ratios on the basis of systemic importance. The other sectors, except for market infrastructures[10] (including Clearing and Settlement Systems, or CCPs), have not been subjected to the same degree of surveillance and currently there is no clear methodology to identify the main actors, no specific countermeasures and not even a list of potentially affected institutions.[11] Banks are clearly subject to corrective measures, but the systemic risk of insurance companies, asset managers or hedge funds is unknown. For example, after four years of putting off its decision, the FSB concluded that asset managers, which account for the majority of the non-bank institutions included in this concept of shadow banking, were not systemic. They thus dodged specific, more stringent regulation, even though some of them currently have $6.5 trillion of assets under management, nearly five times their volume in 2008.

Some may argue that this decision is reasonable, since the funds they manage do not have maturity mismatch and invest in liquid assets and are therefore not prone to runs by investors. The counter-arguments are twofold: first, as we have seen, the FSB itself acknowledges that the more unstable non-bank financial intermediation (vulnerable to runs) represents 14% of total global financial intermediation; second, given the size of these asset managers, we need to understand the consequences, in times of turmoil, of the decisions taken by a small number of managers on how to

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8 This is the reason why one of the major new developments of post-crisis regulation is the resolution of complex financial institutions, i.e. setting up legal and institutional schemes to combat the crisis without extensive recourse to public money.

9 See FSB (2019b).

10 For example, in the USA the following market infrastructures are considered to be SIFIs: The Clearing House Payments Company, CLS Bank International, Chicago Mercantile Exchange, The Depository Trust Company, Fixed Income Clearing Corporation, ICE Clear Credit LLC, National Securities Clearing Corporation and The Options Clearing Corporation.

11 See FSB (2018).

mobilise the huge amounts of funds managed by them. In any event, this is a controversial issue on which the author has a clear position which others may not share.

If we look at the developments in the main financial centers, the situation is definitely no better. Thus, the attempts of the US macroprudential authority, the Financial Stability Oversight Council (FSOC), to designate an insurance company as systemically important, were contested by the insurer, and it managed to have the decision overturned by the courts.[12]

When the new US Administration came into power, it placed on hold the application of too-big-to-fail rules to areas beyond the banking sector.[13] For its part, the EU does not seem to have a clear interest in this matter. It is thus obvious that the incentive for regulatory arbitrage is stronger than ever and that we run the risk of controlling the banking TBTF problem at the cost of shifting the risk to more loosely regulated sectors.

5 The digital revolution: is a new shadow banking system emerging?

The world of technology represents another challenge for which traditional regulation may not be prepared: technology erases boundaries between sectors and between countries, so firms can find ways to sidestep the control systems in place in the financial system. Fintechs now form part of the financial sector but are not subject to the stringent regulation applied to banks. And bigtechs are starting to show interest in also forming part of this shadow financial world. Although fintechs represent for banks both a threat and an opportunity (to improve the provision of financial services), in the new digital era bigtechs, i.e. the large international technology firms well known to everyone, may become the main competitors of banks, thanks not only to the advantages derived from their business model, but also because they are subject to less stringent regulation and thus have a clear competitive advantage.

True, there has been some progress, and banks' complaints on this score are gradually making some impression on regulators, who are now taking steps to level the playing ground. Thus, for example, in Spain the draft bill on Measures for Digital

12 Metlife was designated by the FSOC as a SIFI in December 2014 but the designation was overturned by a federal court. In January 2018, the FSOC and Metlife decided not to continue litigation and Metlife's designation as a SIFI was eliminated.

13 See FSOC, U.S. Department of the Treasury (2019). The process of "de-designation" was as follows: June 2016 GE Capital Global Holdings, September 2017 AIG, and October 2018 Prudential Financial. In March 2019 a consultation stage was opened for changes in the FSOC's SIFI designation methodology to make it more restrictive (less interventionist).

Transformation of the Financial System included the application of a sandbox (a controlled testing environment) for banks and other interested firms to experiment with new digital financial services in a more flexible regulatory framework. Also, greater awareness is also perceived on the issue of unequal treatment in the application of the new payments directive, known as PSD2, which opens the payment services of banks to third-party firms – the so-called third-party payment service providers (TPPs) – through the platforms which banks must create for such payments. The new entrants will thus have access to the bank data of customers that so authorise.

For their part, banks are pushing to be allowed access the data of the customers of other types of services and sectors so as to offer them all the advantages which go with a data-based economy.

But these hesitant steps forward do not offset the serious problems created by a global financial regulation based on institutional type rather than on the specific activities that supervisors should actually be regulating. And although earlier we have mentioned, above all, the risk to financial stability posed by regulatory arbitrage (regulatory capital arbitrage), other risks do also exist. Specifically, they are the risks associated with arbitrage to side-step regulations on conduct (or investor protection), risks of a fiscal or tax nature, and the risk of arbitrage to get around data protection regulations. Let us look briefly at these three areas.

Starting with regulations on conduct, or on protecting financial customers, it should be noted that these are defined on a sectoral basis, although recent years have seen a clear effort towards convergence of the banking, securities and insurance sectors. In this area, no clear sectoral differences are apparent either for or against any sector nor has there been any visible shift in activity for this reason. In the regulated financial sectors, the level playing field issue is not a significant problem.

However, in the unregulated sectors, the situation changes radically. Here the applicable consumer protection rules are relatively undefined and, to put it plainly, much less strictly supervised than in the financial sector. And the golden rule is that regulation is only as good as the supervision of its proper application. That is to say, it is of no use to have perfect consumer protection rules if they are not policed.

At present, fintechs and bigtechs providing financial services are in a limbo regarding the rules of conduct that affect them. In general, none of the sectoral regulations apply to them because they lie outside the sectoral regulatory perimeter. This anomaly is not unknown to the public authorities, be they national or supranational (European Commission or International Monetary Fund), but the perception that the emergence of these new players may fuel competition in certain segments (such as

payments), and thus lower costs for consumers, outweighs the problems of consumer protection architecture.

The problem for the regulated sectors, i.e. for the *incumbents,* is that such competition, if based on laxer consumer protection rules, may be unfair. This is because, since all regulation has a cost, if that price advantage is not based on lower costs derived from the use of technology, but rather on lower compliance costs, it is not only unequal, but also potentially damaging, because when the digital *challengers* drive out the traditional operators and dominate those markets, consumer protection will have been degraded forever.

The situation regarding the large digital operators, i.e. bigtechs, is much more complex, since the distance between their operating practices, which are not just supranational, but universal, and that general consumer protection regime, usually in the hands of local authorities (municipalities), is enormous. In practice these firms circumvent national and sectoral boundaries and exploit the shortcomings of all the old consumer protection architecture. It may be considered that this is an inevitable and undesirable result of the digital revolution. But it is unacceptable that existing operators, which have to adapt to this new digital world, are being burdened with heavier regulatory saddlebags that hamper that adaptation.

As regards possible tax dumping by new digital operators, a look at the tax burden on the regulated financial sector, compared with that of these emerging sectors, suffices to appreciate the problem. If the price transfer mechanisms of multinationals have always been a headache for tax authorities, the challenges represented by this emergence of the new digital world are formidable. A paradox in this respect is the lively debate on the tax contribution of the regulated financial sectors, which can be readily calculated and checked and is equal to that of other sectors, and the lack of debate over the new digital operators. It seems as if there is a wish to raise the tax pressure on the regulated sectors simply because it is feasible, and because the issue of taxation of digital firms poses such a challenge that authorities that have to decide on it end up in a logjam.

Another matter is the emergence of criptoassets or private cryptocurrencies, whether decentralised (like bitcoin) or supported by bigtechs (such as that recently launched by Facebook, called *libra).* The challenges posed by these proposals go well beyond the territory of shadow banking and regulatory arbitrage, and directly affect the current monetary architecture. It is not the purpose of this article, nor, frankly, is it easy, to analyse the implications of developments of this type. Certain similarities with issues analysed here should, however, be mentioned, i.e. how the digital revolution and innovation are posing challenges which we can label unreservedly as vital, not only for the current regulatory framework, but also for monetary policy.

6 The shadow banking system and the financial cycle: possible effects on procyclicality

When the economic performance of the USA is compared with that of Europe from 2007/2008 onwards, it is customary to point out the greater capacity of the former to withstand the crisis, and the slower response of Europe. The main factor explaining this differing behaviour is the greater weight of market financing in the USA. Indeed, although market discipline acts rapidly and brutally, the adjustment is sharp but short. In the case of a systemic banking crisis such as that in Europe, the process is inevitably more gradual, since it is necessary to assess which banks have damage that can be repaired, separate them from those failing or likely to fail and, within the latter, identify those which are systemically important (too big to fail) and those which can be resolved more expeditiously.

For this reason, the EU is setting in train the Capital Markets Union initiative to supply the private sector with financing less dependent on the banking sector, which would not only diversify the funding sources of the productive economy, but would allow more rapid adjustment in crises and a faster return to normal.

But evidently this benevolent view has a darker side. Specifically, the pre-crisis build-up of the US shadow banking system was a key factor in the global financial crisis. Or, as recently noted by the ECB vice president, Luis de Guindos, only when market financing "remains resilient in the face of shocks", can it improve the European economy's current dependence on the banking sector.[14]

This is thus another dark spot in the shadow financial system: as mentioned earlier, while risks in the banking sector are assessed and reassessed by stress tests, in that part of the financial system which we do not see, a storm may be brewing like that in the run-up to the 2007 crisis. The mere fact that we do not know it, because the macroprudential monitoring mechanism for this segment is still in its infancy,[15] should be cause for deep concern by the authorities.

In sum, an uncontrolled shadow banking sector may increase the procyclicality of the financial system, not reduce it. Arguably, the evidence from the years leading up to the 2007 crisis points to this, at least in the past financial cycle.

14 See De Guindos (2019).

15 See De Guindos (2019).

7 Conclusion

It seems obvious that controlling risks in the banking sector is not enough to control all the risks stemming from the financial system. Thus, rather than continuing to talk about (more or better) regulation, it is necessary to address immediately the problem of shadow banking, i.e. include in the regulatory perimeter all the financial agents that generate systemic risks. Regulation should treat all agents according to the risk represented by their activity, regardless of whether they are banks, asset managers or another type of fund. If the activity and the risk are the same, the rules should be the same. And this also goes for the new financial actors from the digital world, particularly the bigtechs, i.e. those large IT operators which, because of their size, may give rise to systemic risk or even to problems of collusion which limit competition and hamper consumer protection.

Another corollary points to the need to avoid the proliferation of inappropriate developments stemming from the "originate-to-distribute" model. This has been one of the objectives of the regulation set in place after the crisis. However, paradoxically the new regulation is introducing incentives for regulatory arbitrage, i.e. for activity to shift from banks to the shadow financial system, since the new regulations are aimed at institutions (banks, insurers, etc.) and not at types of transactions (use of short-term liabilities to fund long-term credit risk). The key issue is whether the emergence of quasi-banks outside the regulatory perimeter is raising the risk for financial instability, or whether these new intermediaries may cause customer protection problems (since they engage both in capital arbitrage and in arbitrage of financial customer protection regulations).

The regulatory reform is recent and still being implemented, so it is too early to give an answer, but it is a contradiction that we are making banks much safer at the cost of shifting risk to parts of the financial system that we neither see nor control.

Additionally, bigtechs represent an even greater challenge because of their universal (non-national) nature, their enormous innovative ability (which nobody questions) and their talent for circumventing the restrictions under which other sectors operate (e.g. in the area of data protection).

In short, the issue of regulatory and supervisory treatment of the shadow banking system is far from having been resolved. Considering the role which it played in the incubation of the 2007/2008 global financial crisis, this vulnerability should be foremost in the thoughts of those responsible for global and local financial stability.

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Capturing macroprudential regulation effectiveness: a DSGE approach with shadow intermediaries

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CAPTURING MACROPRUDENTIAL REGULATION EFFECTIVENESS: A DSGE APPROACH WITH SHADOW INTERMEDIARIES

Abstract

We develop a New Keynesian DSGE model with heterogeneous agents to investigate how the shadow financial system affects macroeconomic activity and financial stability. In the adopted framework, regulated commercial banks finance small firms through traditional business loans and exert costly effort to screen the projects they finance. Shadow financial intermediaries finance large firms, provide short-term lending to commercial banks, and are engaged in the secondary market for loans. In this market, commercial banks originate asset-backed securities under moral hazard to exploit regulatory arbitrage. Shadow intermediaries purchase these loans from commercial banks under adverse selection. In general equilibrium, this set of externalities is not internalized by the financial system. We show that a macroprudential authority may successfully mitigate the externalities by activating caps to both the leverage ratio and the securitization ratio in the traditional banking sector. Such policy actions are effective in safeguarding financial stability, dampening aggregate volatility and improving welfare.

1 Introduction

The financial turmoil triggered by the recent sub-prime crisis has revealed the flaws of the pre-crisis regulation framework designed for traditional financial intermediaries. Moreover, it has put under the spotlight the functioning of the universe of non-bank financial institutions operating within an unregulated or only lightly regulated environment – thereby known as "shadow banking or shadow financial intermediation system".[1,2]

The growing concerns pertaining to the vulnerability of the financial system in the aftermath of the 2007-2008 crisis have led authorities worldwide to devise a regulatory response aimed at mitigating undesirable consequences of under-capitalization and liquidity shortages in the banking system. Such response, known as Basel III, introduced more stringent (counter-cyclical) capital requirements and liquidity

1 In this paper, we intend the concepts of "shadow banking system" and "shadow financial intermediation system" interchangeably.

2 Shadow financial intermediation can be defined as the set of activities consisting of the origination and acquisition of loans by non-bank financial intermediaries, the assembly of these loans into diversified pools, and the financing of these pools with external debt, much of which is short term and supposedly riskless [Gennaioli et al. (2013)].

requirements for credit institutions, and other provisions to be applied to insurers.[3] The additional costs induced by the burden of the financial compliance has raised new concerns for regulatory authorities, as it may create further incentives for banks to shift part of their activities outside the regulated environment, thereby increasing the size of the shadow sector even further.[4]

This paper contributes to the theoretical understanding of the implications of the shadow financial intermediation system interacting with both the financial system as a whole and with the real economy.

The role of the shadow financial system and its connected securitization activity has long been recognized as controversial. While securitization certainly adds economic value by allowing risk-tranching, it may also undermine the correct mechanism of incentive compatibilities and can create other information problems [Ashcraft and Schuermann (2008)]. Recently, it gained a renewed interest due to a surge in securitization transactions registered in the post-crisis period.

After a major contraction in the wake of the financial crisis, in fact, there has been a resurgence of risk-pooling transactions in Europe through both traditional and synthetic securitization, driven by banks' need to lower capital ratio requirements by exploiting regulatory arbitrage opportunities.[5]

To visually inspect the connection between regulatory arbitrage and securitization activity, the left panel of Chart 1 shows the developments of securitization during the

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3 Basel III represents the third wave of the new international regulation framework. Basel I introduced capital adequacy ratios for credit institution. Basel II allowed banks to use internal risk-based measure to weight the different types of of assets held in their portfolio.

4 This type of behavior follows the so-called "regulatory arbitrage hypothesis". As described by Farhi and Tirole (2017), the regulatory arbitrage view includes two possible sub-views. In the first sub-view, retail banks evade capital requirements by providing liquidity support off-balance sheet to shadow intermediaries. The second sub-view involves capital requirement "evasion" by shadow intermediaries, which face no capital adequacy requirement and yet receive public assistance.

5 This behavior is also boosted by the regulatory actions aimed at relaunching sound securitization practices and free up capital for economic growth through simple, transparent and standardized securitization. In particular, following the slow recovery of the securitization market in Europe, as part of the Capital Markets Union (CMU) action plan to increase investment in the EU, the European Commission proposed in 2015 a regulatory framework consisting of two components: i) a regulation on securitization that would require due diligence, risk retention and transparency with a set of criteria to identify simple, transparent and standardized (STS) securitizations, and ii) an amendment to the rules relating to the capital treatment of securitizations for banks and investment firms. Under the proposal, a securitization receiving an STS designation would be eligible for certain lower capital requirements. As initially proposed, however, the STS designation would apply only to traditional (i.e., true-sale) securitizations, and not to synthetic securitizations, although institutions retaining senior positions in certain synthetic securitizations backed by an underlying pool of loans to small and medium-size enterprises that meet certain strict criteria would be permitted to apply the lower capital requirements. See Regulation (EU) 2017/2401 of the European Parliament and the Council, 7 December 2017.

implementation of the regulatory framework "Basel III". The dark line represents the stock of loans that have been securitized or otherwise transferred and derecognized from the balance sheet of the euro area Monetary and Financial Institutions (MFIs), while the light line represents the stock of securitized loans reported in the asset side of Financial Vehicle Corporations (FVC) engaged in traditional securitization (see Chart 1).

The risks related with a rapidly growing shadow financial sector as a consequence of regulatory arbitrage have been emphasized, notably, by the President of the European Central Bank, Mario Draghi, in the following statement:

> "The crisis demonstrated that the shadow banking system can itself be a source of systemic risk, both directly and through its interconnectedness with the regular banking system, leading to a build-up of additional leverage and risks. Therefore, enhancing supervision and regulation of the shadow banking system in areas where systemic risk and regulatory arbitrage concerns are inadequately addressed is important."[6]

In this paper, we further contribute to the debate on the role of securitization through the lens of a New Keynesian dynamic, stochastic, general equilibrium (NK-DSGE) model with shadow financial intermediaries, which includes macroprudential regulation as a tool for macroeconomic stabilization in the presence of such intermediaries.

In the model, financial intermediaries operating in the traditional banking sector – which we refer to as commercial banks – can originate risky loans and can finance such loans both with own resources and with interbank credit obtained from the shadow financial system. These loans are granted solely to small firms. This assumption is made to replicate structural granular characteristics of the euro area economy. As shown in the right panel of Chart 1, in fact, small firms find it more difficult relative to large firms to access the capital market, thus relying on traditional business loans as the prevalent source of external finance.[7]

Within our framework, loans are subject both to idiosyncratic risk and to aggregate risk. This entails that loan default may occur in equilibrium. Crucially, commercial banks may exert costly screening effort to reduce, although without eliminating, the failure probability of the projects they finance.

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6 Statement by Mario Draghi, Chairman of the Financial Stability Board to the International Monetary and Financial Committee, Washington, DC, 24 September 2011.

7 The data are elaborated from the ECB SAFE 2017 (Survey on the Access to Finance of Enterprises in the euro area).

Commercial banks are the originators of asset-backed securities which are purchased by the shadow intermediaries. This is an empirically important feature in the euro area as securitized loans represent about two-thirds of total FVCs' assets.[8,9] The decision to securitize a pool of loans made by the commercial bank is the result of the interplay of two key factors present in the model, both exerting upwards pressures on the incentives to securitization, i.e. moral hazard and regulatory arbitrage. Moral hazard arises as a consequence of the possibility for commercial banks to sell off their loans to shadow intermediaries and invest the proceeds towards an alternative investment opportunity. Regulatory arbitrage provides an additional motive to securitize loans due to both the direct and indirect costs associated with holding capital idling unproductively. These two factors lie at the root of the commercial bank's incentives to resort to securitization.[10]

The impact of securitization is twofold. On the one hand, it allows banking capital to accumulate faster and provides an efficient market-based channel to unchain the traditional banking sector from risky and potentially non-performing loans. On the other hand, securitization generates an externality that is not internalized by shadow intermediaries: the acquisition of securitized loans occurs under adverse selection, due to the asymmetric information problem stemming from the uncertainty of the payoff incorporated in the securitized loans when the transaction on the secondary market is cleared. Were shadow intermediaries isolated entities from the rest of the economy, the pass-through of risk entailed by securitization would indeed result in an effective conduit of risk immunization of the traditional banking sector. Instead, in our model and close to reality, shadow intermediaries are interconnected both with the banking sector and with the productive sector, as they sell credit contracts both to commercial banks and to large firms. As a consequence, any transfer of risk from the traditional banking to shadow intermediaries may feed back into the former sector through the interbank market and into the productive sector through corporate lending. The

8 See the report "EU Shadow Banking Monitor", No. 2, May 2017, by the European Systemic Risk Board (ESRB).

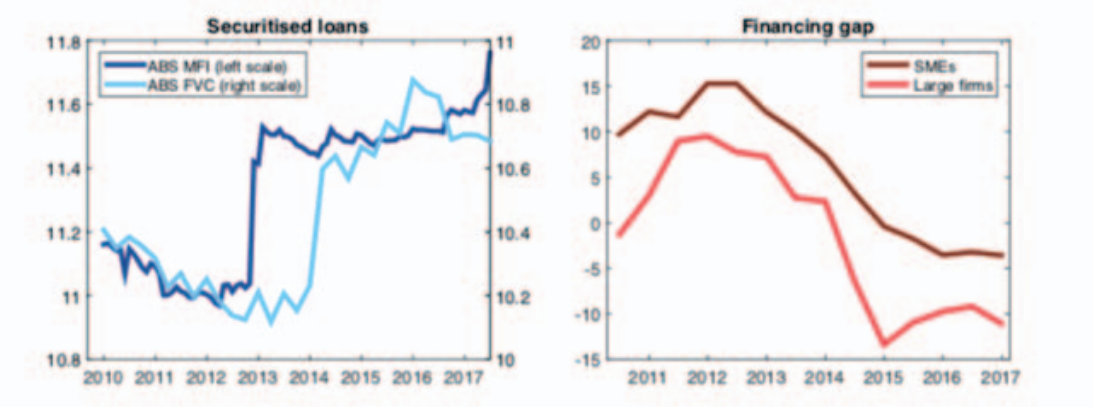
9 A more detailed analysis about the size of the shadow banking system in the euro area, with comparisons to the United States, can be found in Malatesta et al. (2016).

10 To be more precise, the model features several chained financial frictions that contribute to shock amplification. These frictions lie at the root of the commercial bank's incentives to resort to securitization. The first is a regulatory friction implying the inability for the regulatory framework to map each individual asset to the appropriate risk weight. This entails that there exist two investment opportunities whose differences in their risk/return profile do not require a different treatment within the regulatory framework. Banks exploit this "inefficiency" by arbitraging between the two investment opportunities (namely, selling business loans and taking on the outside investment option) to benefit of the higher return while keeping unchanged the regulatory burden. One way to rationalize this behavior could be the strategic use of internal models by banks to generate more favorable risk weights. Further, there is an asymmetric information problem underlying business loans: banks finance risky projects whose return is subject to ex-ante uncertainty and exert costly screening to limit the probability of incurring in non-performing loans. The interaction of these frictions plays an important role in driving our results.

Chart 1

SECURITIZATION ACTIVITY IN THE EURO AREA AND FIRM FINANCING GAP

In the left panel, the evolution of securitization measured as the outstanding amount of securitized assets reported in the asset side of euro area FVCs (logs). In the right panel, the perceived external financial gap for SMEs and large firms as measured by the safe composite indicator.



SOURCES: In the left panel, the time series (in logs) are obtained from the ECB SAFE 2017 (Survey on Access to Finance of Enterprises). "ABS MFI" Series key: BSI.M.U2.N.A.A20D.A.1.U2.2240.Z01.E) and "ABS FVC" Series key: FVC.Q.U2.N.T.A40.A.1.A1.0000.00.Z01.E). The right panel displays the perceived financing gap indicator, which combines financing needs and availability of bank loans, bank overdrafts, trade credit, debt securities and equity at the firm level. A positive value of the indicator suggests an increasing financing gap.

interconnectedness plays a role in creating a tension between the two productive sectors, making the relative availability of credit in each of these sectors dependent on shadow intermediaries and on the propagating effects of securitization.

We consider a possible macroprudential policy regulation that aims at safeguarding financial stability and mitigating the undesirable effects of securitization while preserving its potential benefits. Therefore, commercial banks are compelled to conform to a double layer of regulation: the leverage ratio, which imposes the maximum level of exposure towards small firms for a given level of internal capital, and the securitization ratio, which limits the maximum fraction of loans that can be securitized and passed on the secondary market. We find that the activation of these macroprudential policy instruments is effective in smoothing business cycle volatility following the realization of a variety of shocks.

The paper is organized as follows. Section 2 reviews the related literature. Section 3 lays down the structure of the model and describes the optimizing behavior of the economic agents. Section 4 studies the quantitative implications and reports the impulse response functions to different type of shocks. Section 4.3.5 studies the role of heterogeneous firms in the transmission mechanism of shocks. Section 5 presents macroprudential policy as macroeconomic stabilization tool. Section 6 concludes.

2 Relation to existing literature

At a higher level, our model is linked to several papers which develop general equilibrium models with a shadow financial sector. For example, Verona et al. (2013), develops a DSGE model and find that central banks ignoring the shadow sector may wrongly anticipate the effects of monetary policy. Our model differs from the above in the fact that we focus on macroprudential policy rather than monetary policy transmission. Plantin (2014) develops a banking model to show that tightening capital requirements may spur a surge in shadow banking activity that leads to overall larger risk of the formal and shadow banking institutions. With this model, we have in common the underlying result that regulating shadow banking activities may be desirable from a welfare perspective, although we differ in the modeling approach as we develop a fully-fledged New Keynesian DSGE model. Other worthwhile examples are Ordóñez (2017) and Begenau and Landvoigt (2017). These two papers have in common the result that shadow banking may potentially be welfare improving making the aggregate banking system safer. In common to these papers, our paper also entails a positive effect of the shadow banking system through securitization that allows increasing aggregate efficiency, but differs in the overall result, since the presence of regulatory arbitrage in our model reduces bank screening and ultimately leads to a lower overall welfare.[11]

In spirit, the closest to our paper is Goodhart et al. (2012), who construct a two-period model to show that given many complex interactions between the various agents, no single regulatory tool is sufficient to offset the many distortions arising from defaults. Our result is in line with this conclusion in the fact that financial regulation in the form of two regulatory tools – such as caps to the leverage ratio and the securitization ratio – in the traditional banking sector is welfare improving when such tools are activated simultaneously. As for the modeling approach of the financial sector, our paper closely follows Meh and Moran (2015), who study how leverage regulation effects may depend on the existence of shadow intermediaries. However, our model departs from their work in at least two dimensions: first, we include the securitization ratio to the set of financial regulatory tools; second, to closely represent structural characteristics of the European economy, our model features two types of firms: firms that get access only to bank loans (which we refer to as SMEs) and firms with access to the capital market to issue debt to the shadow sector (which we refer to as large firms). Unlike their model, our model presents a vertically integrated production sector with small firms producing the intermediate good, which is entirely used by large firms as input to produce the wholesale good. Moreover, we include and endogenous monetary policy rule and nominal rigidities in retailer's sector in the form of price stickiness.[12]

11 More recently, Farhi and Tirole (2017) show how prudential regulation must adjust to the possibility of migration toward less regulated spheres.

12 Some recent work shows that bank lending to SMEs firms is an important channel for the euro area monetary policy transmission especially for the impact of Quantitative Easing [Funk (2019)]. The distinction

A key feature of our model is the inclusion of regulatory arbitrage considerations. The regulatory arbitrage hypothesis has been investigated from several point of views. For example, Houston et al. (2012) study regulatory arbitrage empirically in a cross-country setting, although without a specific reference to the shadow financial system, finding strong evidence that banks do transfer funds to markets with fewer regulations. In addition, Acharya et al. (2013) analyze asset-backed commercial paper conduits, which experienced a shadow-banking run and played a central role in the early phase of the financial crisis of 2007–2009. They show that regulatory arbitrage was an important motive behind setting up conduits. Le Leslé and Sofiya (2012) have undertaken a comprehensive review of risk weights, pointing to possible explanatory factors for the differences across jurisdictions. Similarly, Mariathasan and Merrouche (2014) found evidence of a strategic use of internal models by banks to generate desired risk weights. Our model lends support to the above literature. However, we differ from them as to the best of our knowledge, we are the first ones to focus on the macroeconomic and financial stability implications of regulatory arbitrage through the lens of a New Keynesian dynamic, stochastic, general equilibrium (NK-DSGE) model with several layers of financial frictions, heterogeneous firms, and macroprudential regulation as a tool for curbing the effects of financial and regulatory inefficiencies.

3 The model

The economy consists of households, large firms (LF), small and medium enterprises (SME), commercial banks and shadow intermediaries, capital producers, retailers and an authority conducting monetary and macroprudential policy.

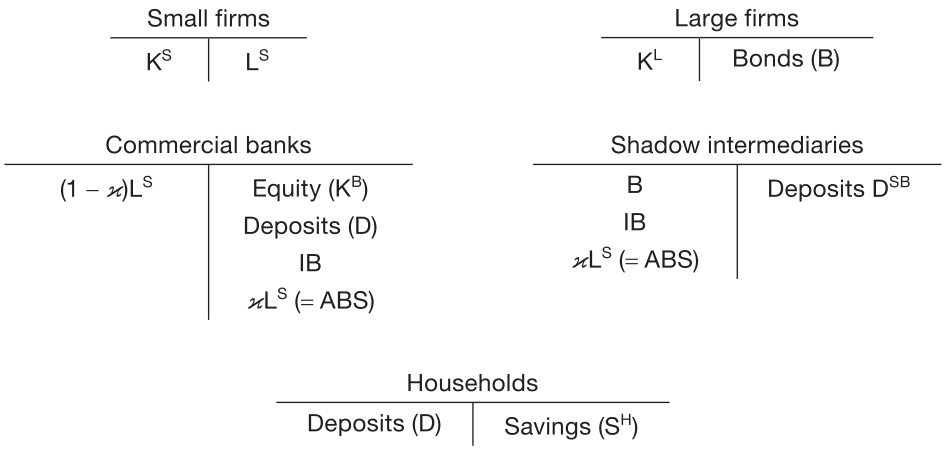
Households provide labor in a competitive labor market and use their labor income to finance consumption and to save. As they cannot directly invest in capital, households deposit their savings either with traditional banks at the gross nominal interest rate RD or with shadow intermediaries at the gross nominal interest rate RSB. Small firms produce an intermediate good, which is entirely used in the production process of large firms as input for producing a wholesale good. To introduce price inertia in a tractable manner, we introduce retailers that transform the wholesale good at no cost into a final consumption good.

Firms obtain funding through a financial sector made of commercial banks and shadow intermediaries. Both types of banks are connected through the interbank

between small and large firms also finds support in other related research showing that small firms are severely credit constrained. Other contributions are those of Beck and Demirguc-Kunt (2006), Ferrando and Griesshaber (2011), and Artola and Genre (2011) and those studies pointing to the importance of the contribution of small and medium enterprises to aggregate fluctuations, such as Moscarini and Postel-Vinay (2012), Gabaix (2011), and Acemoglu et al. (2012), inter alia.

Scheme 1

AGGREGATE BALANCE SHEET POSITIONS OF FIRMS, BANKS AND HOUSEHOLDS



market in which shadow intermediaries lend to commercial banks. Commercial banks use interbank credit, IB_t, together with own bank capital, K_t^B, to finance risky projects originated by small-medium enterprises (SMEs). On the contrary, shadow intermediaries solely finance large corporate firms (LF). There are two sources of information frictions in the financial sector. On the one hand, moral hazard of commercial banks may arise when an exogenous alternative investment opportunity materializes; in this case, the commercial bank may find it optimal to pool its loans into asset-backed securities (ABS) and sell them on the secondary market to shadow intermediaries, regardless of whether or not such loans are ultimately going to be successful. On the other hand, shadow intermediaries, which are involved in credit transformation, buy pooled loans on the secondary market under adverse selection as the payoff of the loans incorporated into the ABSs is unknown in advance. Beyond ABS, shadow intermediaries lend funds to large firms by purchasing their issued debt, B_t. Therefore, we distinguish the financing channels of both large and small firms, while connecting them indirectly through the interbank market. Finally, shadow intermediaries finance their activity by issuing liabilities. Scheme 1 summarizes the financial relationships of our agents through their balance sheet positions.

3.1 Households

Households are risk-averse and infinitely lived. They derive utility from a consumption good and disutility from labor. The consumption good acts as a numeraire. Their income is derived from renting labor to producers at the competitive real wage WH. The available income is used to finance consumption, hold deposits with financial intermediaries and pay the tax bill. Their preferences are described using an internal habit formulation common in recent DSGE literature as in Smets and Wouters (2002),

Christiano et al. (1997). In particular, households maximize the expected present discounted value of their utility:

$$\mathbb{U}_t\left(C_t, N_t\right) = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta_H^t \left[\log\left(C_t^H - hC_{t-1}^H\right) - \overline{\psi} \frac{\left(N_t\right)^{1+\eta}}{1+\eta} \right], \qquad [1]$$

where C_t^H is non-durable consumption at time t, N_t is labor supply, $h>0$ is the coefficient governing the intensity of habit in consumption, $\overline{\psi}>0$ is a scaling parameter for hours worked and $\eta>0$ is the inverse of the Frisch elasticity of labor. When choosing the allocation of their savings, households can decide to direct their savings either towards a commercial bank in a deposit account or a shadow intermediary in a custody account. The former can be seen as a traditional current account that offers an interest rate on deposits redeemable at any time. We abstract from deposit insurance. We later characterize the financial contract ensuring that households have an incentive to engage with commercial banks. In contrast, the funds deposited at the shadow intermediary can be seen as a financial investment, for example in money-market funds or assimilated financial products offered by non-bank financial institutions.[13] To model the household investment decisions, we follow Dotsey and Ireland (1996) and Meh and Moran (2015) and assume that households are distributed along a unit interval, with position $i \in [0,1]$ identifying a typical household. Commercial banks are located at point 0 and shadow intermediaries at point 1. If savings are deposited with a commercial bank, the return is taxed by the government, so that the after-tax return is $R_t^D\left(1-t^b\right)$, with t^b the tax rate and R_t^D being the gross nominal interest rate on deposits. If savings are allocated to a shadow intermediary, households incur an ex-ante quadratic cost equal to:

$$\phi(i) = \chi_1 \left[\frac{1-i}{i} \right]^2, \ \phi(0) = +\infty \text{ and } \phi(1) = 0, \qquad [2]$$

and earn a gross nominal interest rate R_t^{SB}.

When maximizing their utility function, households are subject to a sequence of budget constraints:

$$C_t^H + D_t(i)\left[1+\phi(i)\right] = \left[\left(1-t^b\right)R_t^D \Phi_t(i) + R_t^{SB}\left(1-\Phi_t(i)\right)\right] D_{t-1}(i) + W_t^H N_t + T_t, \qquad [3]$$

where D_t is the amount of deposits, Φ is a binary function that equals 1 when savings are allocated to commercial banks and 0 when savings are allocated to shadow intermediaries; $W_t^H N_t$ is labor income and T_t is lump-sum transfers, which includes profits from the retail sector, capital good producers and the banking sector.

13 As argued by Ferrante (2018), we can think of the shadow intermediaries deposits as the set of instruments that over the past years allowed investors to channel funds into this parallel (shadow) sector, such as money market mutual funds (MMMFS), which in normal times were perceived basically as risk-free assets.

The first order-condition with respect to consumption reads as:

$$\lambda_t^H = \frac{1}{C_t^H - hC_{t-1}^H} - h\beta_H \mathbb{E}_t \left[\frac{1}{C_{t+1}^H - hC_t^H} \right] \quad [4]$$

The first-order condition with respect to labor yields the labor supply:

$$\lambda_t^H W_t = \overline{\psi} \left(N_t \right)^{\eta} \quad [5]$$

The first-order condition with respect to deposits, if allocated to a commercial bank is:

$$\lambda_t^H = \beta_H \mathbb{E}_t \lambda_{t+1}^H \left(1 - t^b \right) R_t^D, \quad [6]$$

while if allocated to a shadow intermediary is:

$$\lambda_t^H \left(1 + \phi \left(i \right) \right) = \beta_H \mathbb{E}_t \lambda_{t+1}^H R_t^{SB}, \quad [7]$$

where $\mathbb{E}_t \{\cdot\}$ is the rational expectation operator conditional on information available in t, $0 < \beta_H < 1$ is the household's subjective discount factor and λ_t^H is the Lagrange multiplier associated with the household's budget constraint. By equating both first-order conditions with respect to deposits we obtain the indifference condition of the household located at position i*:

$$\lambda_t^H \phi \left(i^* \right) = \beta_H \mathbb{E}_t \lambda_{t+1}^H \left[R_t^{SB} - \left(1 - t^b \right) R_t^D \right] \quad [8]$$

Aggregating across households, the supply of funding for banks and shadow intermediaries is respectively:

$$D_t^B = \int_0^{i^*} D_t \quad [9]$$

$$D_t^{SB} = \int_{i^*}^1 D_t \quad [10]$$

3.2 The financial sector

The financial sector is made of a continuum of risk neutral commercial banks and shadow intermediaries.

Commercial banks carry out a traditional financial intermediation activity, which consists of pooling together resources collected from depositors and the interbank market (from shadow intermediaries) to finance risky projects of SMEs.

Commercial banks can increase the likelihood of a project to be successful by exerting costly effort in monitoring SMEs' projects. However, when an exogenous investment opportunity materializes, they may decide to sell a portion of their loans to shadow intermediaries in the form of ABS. The activity of commercial bank is subject to a twofold macroprudential regulation: on one hand, the maximum leverage ratio governing the bank's financial exposure towards SMEs; on the other hand, a cap to the securitization ratio. Shadow intermediaries, on the contrary, are non-bank financial institutions whose main activity consists in attracting resources from households and use such resources to operate on the secondary market for loans, provide short term finance to commercial banks and finance large firms. The next subsection provides further details on the financial sector and lays down its modeling approach.

3.2.1 Commercial banks

Commercial banks are financial intermediaries whose role is to attract deposits from households and to finance SMEs' projects.

The balance sheet of the commercial bank is given by:

$$L_t^S = K_t^B + D_t^B + IB_t, \qquad [11]$$

where L_t^S is the amount of loans extended to the SME, K_t^B is commercial bank capital, D_t^B are deposits received from households, and IB_t is interbank credit.[14]

The project carried out by the entrepreneur of the small firm is subject to an idiosyncratic shock $\omega^S \in \{0,R\}$, which determines the amount of raw capital of time t that turns into effective capital in time $t+1$. We assume that a project is successful with probability p_t, otherwise it reveals to be a non-performing loan.

The financial contract between the commercial bank, depositors and the shadow intermediary

We now lay out the financial contract between lenders (households and shadow intermediaries) and the borrowers (commercial banks). Following the set-up of Meh and Moran (2015), we assume that commercial banks have the ability to screen the

14 The credit relationship between the two financial intermediaries has not to be intended as loans from the shadow financial intermediary to the commercial bank such as "repos" contracts, or any other form of collateralized debt issued by the commercial bank. Rather, they are simply money-like deposits from the shadow intermediary to the commercial bank, for which collateral is not required. In Section 3.2 we set up the financial contract for deposits between the lenders (households and the shadow intermediary) and the borrower (the commercial bank), which ensures that the shadow bank has incentives to engage in the deposit contract without neither requiring collateral nor deposit insurance.

projects they finance. Screening at intensity γ_t allows the bank to identify and eliminate projects with low probability of success.[15]

Moreover, exerting effort γ_t allows the bank to acquire private information about the idiosyncratic shock ω^S. However, screening entails a cost, which is proportional to the value of the loan: $\mu_t = c\gamma_t L_t^S$, with $c > 0$.

The project carried out by the small-medium firm is assumed to be successful with probability p_t and subject to an aggregate return, V_{t+1}. In this case, the loan in which the commercial bank invested in generates revenues:

$$L_{t+1}^S = V_{t+1} R_t^L L_t^S, \qquad [12]$$

where R_t^L is the share of return accruing to the bank, and:

$$V_{t+1} = R_{t+1}^k + (1-\delta) Q_{t+1} \qquad [13]$$

is the aggregate return of capital.[16] In contrast, with probability $(1-p_t)$ the project is unsuccessful, and the loan turns out to be a non-performing loan, $L_{t+1}^S = 0$.

The commercial bank might occasionally receive an outside investment opportunity that brings an excess positive return. In this case moral hazard may arise. We denote the probability of the outside investment opportunity occurring by I and the excess return attached to it by $\lambda > 1$. A bank affected by this positive shock will want to sell its loan commitment before it comes to fruition and divert the freed capital resources towards the more profitable alternative investment, $\tau\lambda$. If the expected return of the outside opportunity is higher than the expected return on loans, the bank decides to liquidate a fraction of loan commitments to shadow intermediaries through securitization on a secondary market for loans. The timing of the events is such that, first, loan arrangements with SMEs take place, then the commercial bank decides on the screening intensity and learns about the quality of the project. Conditional on both that quality and on the outside opportunity received, it decides whether to keep the loan commitment until it comes to fruition or sell it on the secondary market to shadow intermediaries.[17] In doing so, however, commercial banks must comply with a regulation constraint of the type:

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15 Note that p_t is to be intended as the average probability across small firms' projects. However, in this representative firm setup this distinction can be disregarded.

16 The term R_{t+1}^k is the return on capital, δ is the rate of capital depreciation and Q_{t+1} is the price of capital, which is pinned down in the capital producers' problem in Subsection 3.3.5.

17 In our model, the commercial bank resorts to securitization to move off-balance sheet a fraction of loans that is already in the portfolio and acquired on the primary market. In this sense, the timing is such that securitization comes after loan origination. In principle, it could also be possible the bank selling a loan on the secondary market before its acquisition on the primary market. However, we abstract from short selling in this model.

$$\frac{ABS_{t+1}}{L_t^S} \leq \varkappa \qquad [14]$$

Trivially, upon the arrival of a better investment opportunity the bank would like to securitize as much as possible given the higher expected return attached to the outside option. This entails that the above constraint always holds with equality and allows us to rule out this constraint occasionally binding when solving the model.

As described in Meh and Moran (2015), due to the private nature of the bank's screening effort, an agency problem between the bank and other stakeholders arise. The bank might choose to screen less intensively than agreed; this action would result in a lower probability of success of the projects and reduces the likelihood that depositors obtain the return pledged by banks. In addition, the private nature of the two types of shocks introduces adverse selection in the secondary market for loans. As a consequence of these information rigidities, the profit maximizing behavior of the bank is subject to the financial contract ensuring that all the agents have appropriate incentives to engage in the borrowing-lending relationship. The contract is such that by the end of period the commercial bank pays a fraction R_t^H to households and a fraction R_t^{IB} to the shadow intermediary. Therefore, total return equals the sum of each agent's returns $R_t = R_t^H + R_t^{IB} + R_t^L$.

We assume that commercial banks are owned by households and managed by risk-neutral bankers, whose objective is to maximize the expected return on lending:

$$\max_{L_t^S, R_t^H, R_t^L, D_t^B, p_t, E_t} \quad p_t V_{t+1}^e R_t^L L_t^S, \qquad [15]$$

subject to the incentive compatible, technology and resource constraints detailed below:

$$R_t^L V_{t+1}^e p_t (1-l)\left(L_t^S \mathcal{P}_t^{ABS} - ABS_t\right) \geq c\Upsilon_t Q_t L_t^S \qquad [16]$$

$$p_t V_{t+1}^e L_t^S R_t^H \geq D_t^B R_t^D \qquad [17]$$

$$p_t V_{t+1}^e L_t^S R_t^{HB} \geq IB_t R_t^{IB} \qquad [18]$$

$$K_t^B + D_t^B + IB_t - c\Upsilon_t L_t^S \geq L_t^S \qquad [19]$$

$$R_t = R^L + R_t^H + R_t^{HB} \qquad [20]$$

$$R_t^L,\ R_t^D,\ R_t^{IB} \geq 0 \qquad [21]$$

$$p_t = f(\Upsilon_t) \qquad [22]$$

$$\frac{ABS_t}{L_t^S} \leq \varkappa \qquad [23]$$

Condition [16] ensures that the bank has an incentive to screen at the agreed intensity. Condition [17] is the depositor's incentive to engage in the financial contract with the commercial bank, which states that the share of expected return accruing to the depositor for a project that is successful with probability p_t must be at least equal to the bank's cost for households deposits. Similarly, condition [18] is the participation constraint of the shadow intermediary on the interbank market with the commercial bank, so that the shadow intermediary is willing to participate in the financial contract as long as the expected return of the project covers the commercial bank's cost of interbank funding. Condition [19] is the bank's resource constraint indicating its ability to bear the project's total cost. Equation [20] states that the returns on the projects accruing to the household, the shadow intermediary and the commercial bank must sum up to total return.

To solve the financial contract [15] – [23], we first start by assuming that the regulation constraint binds and plug it into [16] holding with equality. This returns the incentive compatibility constraints of the commercial banks that depends on the securitization ratio parameter.

Solving for the lending rate delivers:

$$R_t^L = \frac{c\Upsilon_t Q_t}{p_t(1-l)\left(\mathcal{P}_t^{ABS} - \varkappa\right)V_{t+1}^e} \qquad [24]$$

By using [20], the household's share of total return is given by:

$$R_t^H = R - R_t^{HB} - \frac{c\Upsilon_t Q_t}{p_t(1-l)\left(\mathcal{P}_t^{ABS} - \varkappa\right)V_{t+1}^e} \qquad [25]$$

Further, plugging [25] into the participation constraint of depositors [17] holding with equality delivers:

$$\frac{p_t V_{t+1}^e}{R_t^D}\left(R - R_t^{HB} - \frac{c\Upsilon_t Q_t}{p_t(1-l)\left(R_t^{ABS} - \varkappa\right)V_{t+1}^e}\right)L_t^S = D_t^B, \qquad [26]$$

which reveals the willingness of households to deposit their savings with the commercial banks.

Finally, introducing [26] into the resource constraint [19] and rearranging, the following bank capital to-asset ratio can be obtained:

$$\frac{K_t^B}{Q_t L_t^S} = 1 + c\Upsilon_t - \frac{p_t V_{t+1}^e}{Q_t R_t^D}\left(R - R_t^{HB} - \frac{c\Upsilon_t Q_t}{p_t (1-l)\left(\mathcal{P}_t^{ABS} - \varkappa\right) V_{t+1}^e} \right), \quad [27]$$

which can be rewritten as the leverage ratio:[18]

$$\kappa_t^B = \frac{Q_t L_t^S}{K_t^B} = \frac{1}{1 + c\Upsilon_t - \frac{p_t V_{t+1}^e}{Q_t R_t^D}\left(R - R_t^{HB} - \frac{c\Upsilon_t Q_t}{p_t (1-l)\left(\mathcal{P}_t^{ABS} - \varkappa\right) V_{t+1}^e} \right)} \quad [28]$$

For probability of success, we assume a functional form of the type:

$$p_t(\Upsilon_t) = \bar{p} + \frac{\chi_p}{\bar{p}}(\Upsilon_t - \bar{\Upsilon}), \quad [29]$$

where $\bar{p}$ is the steady state probability of success of the project, Υ_t is the screening effort and $\bar{\Upsilon}$ its steady-state value, and $\chi_p > 0$ is the elasticity of the screening intensity.

The evolution of commercial bank capital

To derive an expression for the evolution of the aggregate banking net worth available in the economy, it is necessary to account for the four possible scenarios that have been realized, which depend on the profitability of the loan commitments as well as the arrival of the alternative investment opportunity. The four scenarios and their respective outcomes in period $t-1$ are:

1 The bank had a successful project with probability p_t but did not get the outside opportunity occurring with probability l and did not issue any ABS. The joint probability of such an event is $p_{t-1}(1-l)$. Accounting for this probability, the bank's net worth in this scenario is:

$$K_{1,t}^B = p_{t-1}(1-l) V_t R_t^L L_t^S \quad [30]$$

2 With probability $p_{t-1}l$ the bank received a profitable outside opportunity and securitized the loan (regardless of whether it is successful or not) to invest the proceeds at the rate λ. The net worth in this case is:

$$K_{2,t}^B = p_{t-1} l \lambda \mathcal{P}_t^{ABS} V_t R_t^L ABS_t \quad [31]$$

18 The leverage ratio of commercial banks arises endogenously in the model. We impose this constraint to bind on a regulation-level when we conduct the policy experiment by forcing a cap on endogenous leverage.

3 With probability $(1-p_{t-1})(1-l)$ the bank did not received a profitable alternative investment opportunity but sold nevertheless the loan (because of the knowledge that it was ultimately going to be a failure). In this case the net worth is:

$$K^{B}_{3,t} = (1-p_{t-1})(1-l)\mathcal{P}^{ABS}_{t} V_t R^{L}_{t} ABS_t \quad [32]$$

4 With probability $(1-p_{t-1})l$ the bank received a profitable alternative investment opportunity and sold the loan (which was going to fail in any case) to invest the proceeds at the more convenient rate of return λ. In this scenario, the rate of return is given by:

$$K^{B}_{4,t} = (1-p_{t-1})l\lambda\mathcal{P}^{ABS}_{t} V_t R^{L}_{t} ABS_t \quad [33]$$

Taking into account these four possible scenarios, the aggregate level of banking net worth available in the economy reads as:

$$K^{B}_{t} = \tau_B\left[K^{B}_{1t} + K^{B}_{2t} + K^{B}_{3t} + K^{B}_{4t}\right], \quad [34]$$

where τ_B is the fraction of surviving banks at the end of each period. The above expression can be expanded with the regulation constraint binding in equilibrium and the aggregate evolution of bank capital reads as:

$$K^{B}_{t} = \tau_B\left[\left((1-p_{t-1})(1-l) + l\lambda\varkappa\mathcal{P}^{ABS}_{t-1} + p_{t-1}(1-l)\right)V_t R^{L}_{t-1} L^{S}_{t} + W^{B}_{t}\right] \quad [35]$$

The above relation implies that securitization through $\varkappa$ exerts a positive effect on the accumulation of banking capital.

3.2.2 Shadow intermediaries

Shadow intermediaries are financial institutions that operate outside the traditional banking system. The shadow sector is assumed to be competitive.

Shadow intermediaries are not burdened with regulatory costs, thus their activities are not covered by a safety net. Their activity consists in a classic intermediation function, carried out by collecting deposits from households to extend both financial and non-financial corporate lending, and a function of credit transformation participating in the secondary market for loans. While interbank lending can be seen as a short-term funding through which shadow intermediaries optimize their liquidity management, corporate bonds are relatively more illiquid assets but more profitable in the long run. We assume that there are quadratic management costs involved with investing either in the interbank market and in corporate loans, so that:

$$P_t^B = \frac{\chi^{SB}}{2}(B_t)^2 \text{ and } P_t^{IB} = \frac{\chi^{IB}}{2}(IB_t)^2 .^{19} \quad [36]$$

This choice is in line with studies in the macro-finance literature, such as Andrés et al. (2004) or Chen et al. (2012), and the micro-banking literature, such as Freixas and Rochet (2013). Given that shadow intermediaries face a trade-off between liquidity and return when making the portfolio decision, we capture this imperfect substitution by assuming that $\chi^{SB} > \chi^{IB}$. Unlike commercial banks, shadow intermediaries finance their activity by issuing liabilities to households on which they offer a variable gross return, R^{SB}.

The timing of the events is such that the funds obtained by the shadow intermediary from household at time t are employed to extend credit to commercial banks and large firms, and to pay the respective portfolio adjustment costs. The resource constraint at time t is thus:

$$D_t^{SB} = R_t^L V_{t+1} ABS_t \mathcal{P}_t^{ABS} + B_t + IB_t + \frac{\chi^{SB}}{2}(B_t)^2 + \frac{\chi^{IB}}{2}(IB_t)^2 \quad [37]$$

Condition [37] states that the household's deposits – which are the only source of funding for shadow intermediaries – are used to purchase asset-backed securities on the secondary market, to provide corporate and interbank lending, and to pay the respective portfolio adjustment costs. At time t + 1, the shadow intermediary receives the revenues both from corporate bond investment, interbank lending and the payoff incorporated into the ABSs, and pays back household's funds plus interest.

Thus, the flow-of-funds is given by:

$$B_t R_{t+1}^B + IB_t R_{t+1}^{IB} + \varpi R_t^L V_{t+1} ABS_t = D_t^{SB} R_t^{SB}, \quad [38]$$

with $\varpi_t = (p_t l)/(p_t l + 1 - p_t)$.

Both [37] and [38] can be combined to obtain the profit function, which is maximized by the shadow bank by choosing B_t, IB_t and ABS_t. Therefore:

$$\max_{B_t, IB_t, ABS_t} \quad B_t R_t^B + IB_t R_t^{IB} + \varpi R_t^L V_{t+1} ABS_t = \quad [39]$$

$$\left(R_t^L V_{t+1} ABS_t \mathcal{P}_t^{ABS} + B_t + IB_t + \frac{\chi^B}{2}(B_t)^2 + \frac{\chi^{IB}}{2}(IB_t)^2 \right) R_t^{SB} \quad [40]$$

19 We rule out corner solutions such as the interbank market investment set to zero by the shadow bank as it would require interbank credit and corporate loans to be perfect substitutes. However, the two portfolio adjustment costs entail imperfect sustainability between corporate bonds and "interbank investment" (deposits), ensuring an interior solution.

The first order-conditions to maximize profits are:

$$R_t^B = \left(1+\chi^B B_t\right) R_t^{SB} \quad [41]$$

$$R_t^{IB} = \left(1+\chi^{IB} IB_t\right) R_t^{SB} \quad [42]$$

$$P_t^{ABS} = \frac{\varpi_t}{R_t^{SB}} \quad [43]$$

It is worthwhile noting that the price of asset-backed securities depends positively on both the probability of success and the probability of the alternative opportunity, and negatively on the interest rate on shadow intermediaries' deposits. The price of asset-backed securities, in turn, affects both the interbank rate and the interest rate on corporate loans through R_t^{SB}.

3.3 The production sector

The production side is characterized by two types of representative firms owned by entrepreneurs. In line with empirical patterns observed in the euro area, we assume that production is strongly characterized by the presence of small and medium enterprises, which typically resort to traditional business loans to finance their activity. In our model, these firms produce the intermediate good, which is used by large corporate firms as input to produce the wholesale good. Retailers are in charge of transforming the wholesale good into the final consumption good. In contrast to small and medium enterprises, large firms benefit of a greater variety of external funding. Most importantly, they can have full access to the capital market financing. Our vertically integrated economy linking small and large firms in a production chain is a key feature of the model and plays an important role in the transmission mechanism of shocks originating both in the real and the financial sectors, and it represents a tractable way to study the real effects of macroprudential regulation.

3.3.1 Large firms entrepreneurs

Entrepreneurs manage large firms and operate in a perfectly competitive environment to produce output that is sold to monopolistically competitive retailers.

The technology of the large firm is described by a Cobb-Douglas production function that employs capital, labor and the intermediate good produced by SMEs as inputs:

$$Y_t^L = A_t \left(K_t^L\right)^{\alpha_L} \left(Y_t^S\right)^{\gamma_S} \left(N_t^L\right)^{1-\gamma_S-\alpha_L}, \quad [44]$$

where A_t is the aggregate technologic shifter, Y_t^S is the intermediate good input, N_t^L is labor input, α_L and γ_S are the elasticity of output to capital and to the intermediate good, respectively. At the end of each period, large firms purchase capital K_t^L to be used in the production process in the subsequent period at the real price Q_t. Capital acquisition is financed by a combination of internal and external finance, so that the demand of external finance is defined by:

$$B_t = Q_t K_t^L - NW_t^L, \qquad [45]$$

where NW_t^L denotes large firm's net worth. The interest rate charged by shadow intermediaries to large firms on funding B_t is denoted with R_t^B.

3.3.2 Debt contract

The debt contract signed between the large entrepreneur and the shadow intermediary follows Bernanke et al. (1999) and Christiano et al. (2007), which is based on the costly state verification framework (CSV) of Townsend (1979). In particular, the entrepreneurial activity involves risk. The entrepreneur of the large firm is thus exposed to a private idiosyncratic shock, denoted with ω^L, which affects the intertemporal transformation of capital, such that $K_t^L = \omega K_{t-1}^L$. The shock is assumed to be $\omega^L \sim \text{InN}(\mu_\omega, \sigma_\omega)$, whose parameters are chosen in order to obtain an expected value of one and to match the desired steady state default rate on loans. As customary, we assume that a fraction $(1-\nu_L)$ of large entrepreneurs exits at the end of each period. Thus, the probability that an entrepreneur will survive is ν_L. This assumption ensures that large firms' net worth is never sufficient to self-finance new capital acquisition. Each period they issue debt, B_t to finance their desired investment expenditure in excess of net worth.

As Bernanke et al. (1999) have shown, due to a demand-side friction, an external finance premium results from the financial contract signed between the entrepreneur and the financial intermediary that maximizes the payoff to the entrepreneur subject to the required rate of return of the lender. It is shown that given parameter values associated with the cost of monitoring the borrower, characteristics of the distribution of the entrepreneurial returns, and the expected life span of firms, the implied external finance premium depends on the entrepreneur's leverage ratio. Dib (2010) implemented a likewise financial contract in a framework with a banking sector wherein the marginal external financing cost is equal to an external finance premium plus the gross prime lending rate. The size of this markup depends on the ratio of the market value over firm's net worth. Hilberg and Hollymayar (2011) also incorporate a similar framework, allowing for the possibility of bubbles in the price of capital. We rule out the possibility of bubbles in the price of capital; the expected gross return to holding a unit of capital from t to t + 1 is given by:

$$R_t^Q = \frac{R_t^{K^L} + (1-\delta)Q_t}{Q_{t-1}}, \qquad [46]$$

and the markup is:

$$\frac{R_{t+1}^Q}{R_t^B} = \left(\frac{Q_t K_t^L}{NW_t^L}\right)^{\psi_L} \qquad [47]$$

This means that the expected marginal external financing costs equal the expected marginal return on capital. The external finance premium $\left(Q_t K_t^L / NW_t^L\right)^{\psi_L}$ depends on the firm's leverage ratio, a relation that embeds financial acceleration as put forward by and the size of which is governed by the parameter $\psi_L > 0$.

Moreover, the demand for entrepreneurial labor is found by equating the marginal product with the wage:

$$(1-\alpha_L)\frac{Y_t^L}{N_t^L} = W_t^L \qquad [48]$$

Combining [44] with [48] yields a difference equation for the aggregate net worth position of large firm:

$$\begin{aligned} NW_t^L = \nu_L \left[R_t^Q Q_t K_t^L - \left(\mathcal{R}_t^M + \frac{\mu \int \omega dF(\omega) R_t^Q Q_{t-1} K_t^L}{Q_{t-1} K_{t-1}^L - NW_t} \right) \left(Q_{t-1} K_t^L - NW_{t-1}^L \right) \right] \\ + (1-\alpha_L) A_t \left(K_t^L\right)^{\alpha_L} \left(Y_t^S\right)^{\gamma_S} \left(N_t^L\right)^{(1-\alpha_L-\gamma_S)} \end{aligned} \qquad [49]$$

Note that the policy rate, $\mathcal{R}_t^M$, is considered as the risk-free interest rate in the economy, under the assumption that firms may always invest into exogenously given safe assets that pay a risk-less rate that equals the policy rate.[20]

3.3.3 Small firms entrepreneurs

A continuum of firms produces the intermediate good in a perfect competitive environment according Cobb-Douglas production function:

$$Y_t^S = A_t \left(K_{t-1}^S\right)^{\alpha_S} \left(N_t^S\right)^{1-\alpha_S}, \qquad [50]$$

20 Furthermore, the model is closed by assuming also that the interbank rate, R_t^{IB} equals the policy rate, R_t^M, in equilibrium as commercial banks can also borrow at the central bank's discount window.

where A_t is an aggregate technology shifter common to both large and small firms, N_t^S is labor input, $\alpha_S < \alpha_L$ denotes the share of the capital input with respect to the intermediate good.

Entrepreneurs managing small firms have no net worth available to start production. As such, they apply for loans to commercial banks to finance their risky projects. The amount of loan equals the market value of capital:

$$L_t^S = Q_t K_t^S \quad [51]$$

Capital transformation is subject to idiosyncratic risk and to aggregate risk. The idiosyncratic shock $\omega^S \in \{0,R\}$ implies that the project generates $K_{t+1}^S = RK_t^S$ if succesful, while if unsuccessful $K_{t+1}^S = 0$.

Profit maximization delivers the following demand for inputs:[21]

$$W_t = (1-\alpha_S)\frac{Y_t^S}{N_t^S}, \quad [52]$$

$$r_t^{K^S} = (\alpha_S)\frac{Y_t^S}{K_{t-1}^S} \quad [53]$$

3.3.4 Retailers

We assume that retailers of mass one have some monopoly power and set prices in a staggered manner as in Calvo (1983). Scattered price adjustment implies that prices of some goods differ for firms that periodically adjust their prices, which implies differences in demands for these goods and consequently in labor demand across firms. We assume a continuum of retailers of mass 1, indexed by z, who purchase the wholesale goods from large firms at price P_t^w, differentiate them at no cost into $Y_t(z)$, and sell $Y_t(z)$ at the price $P_t(z)$. Final goods are:

$$Y_t^f = \left(\int_0^1 Y_t(z)^{1-\epsilon}\,dz\right)^{\epsilon/\epsilon-1}, \text{ where } \epsilon > 1. \quad [54]$$

Given this aggregate output index, the price index is:

$$P_t = \left(\int_0^1 P_t(z)^{1-\epsilon}\,dz\right)^{1/1-\epsilon}, \quad [55]$$

21 We assume that the wage rate is equalized across the two sectors, thus $W_t^S = W_t^L$.

so that each retailer faces an individual demand curve of $Y_t(z) = \left(P_t(z)/P_t\right)^{-\epsilon} Y_t^f$.

Each retailer chooses a sale price $P_t(z)$ taking P_t^w and the demand curve as given. Using the standard Calvo (1983) pricing mechanism pricing mechanism, a randomly selected fraction of retailers $(1-\theta_P)$ can adjust their prices while the remaining fraction θ_P does not adjust. Denote with $P^*(z)$ the "reset" price and with $Y_{t+k}^*(z) = \left(P_t^*(z)/P_{t+k}\right)^{-\epsilon} Y_{t+k}$ the corresponding demand. The optimal $P_t^*(z)$ solves:

$$\sum_{k=0}^{\infty} \theta_P^k \mathbb{E}_t \left\{ \Lambda_{t,k} \left(\frac{P_t^*(z)}{P_{t+k}} - \frac{X}{X_{t+k}} \right) Y_{t+k}^*(z) \right\} = 0, \qquad [56]$$

where $\Lambda_{t,k}$ is the household's discount factor and X_t is the markup of final over wholesale goods, which in steady state equals $\epsilon/(\epsilon-1)$. Profits $F_t = (1-1/X_t)Y_t$ are finally rebated to households.

Due to the nominal rigidity, the aggregate price level evolves according to:

$$P_t = \left(\theta_P P_{t-1}^{1-\epsilon} + (1-\theta_p)\left(P_t^*\right)^{1-\epsilon} \right)^{\frac{1}{1-\epsilon}} \qquad [57]$$

3.3.5 Capital producers

Capital good firms are owned by households. They operate in a perfectly competitive environment and use a linear technology to produce new capital both from old capital and with investment goods. While old capital can be transformed at no cost into new capital, the conversion of investment goods into new capital is subject to a convex adjustment cost.

Capital producers maximize the following objective function:

$$\max_{I_t} \quad Q_t I_t - \left[1 + \frac{\kappa_i}{2} \left(\frac{I_t}{I_{t-1}} - 1 \right)^2 \right] I_t \qquad [58]$$

The aggregate capital stock evolves according to:

$$K_t = (1-\delta)K_{t-1} + \left(1 - \frac{\kappa_i}{2} \left(\frac{I_t}{I_{t-1}} - 1 \right)^2 \right) I_t, \qquad [59]$$

where δ is the depreciation rate and investment is subject to a quadratic adjustment cost with κ_i denoting the parameters of such costs.

Maximization of this problem delivers the following capital supply:

$$Q_t = 1 + \frac{\kappa_i}{2}\left(\frac{I_t}{I_{t-1}} - 1\right)^2 + \frac{I_t}{I_{t-1}}\kappa_i\left(\frac{I_t}{I_{t-1}} - 1\right) - \mathbb{E}_t\left[\beta\Lambda_{t+1}\left(\frac{I_{t+1}}{I_t}\right)^2 \kappa_i\left(\frac{I_{t+1}}{I_t} - 1\right)\right], \quad [60]$$

which is the standard Tobin's Q equation relating the price of capital to marginal adjustment costs, with $\kappa_i > 0$ governing the size of the investment-adjustment cost.

3.4 Monetary policy

We set an endogenous monetary policy rule in which the central bank controls the risk-free interest rate according to a Taylor (1993) rule with interest-rate smoothing:

$$R_t^M = \left(R_{t-1}^M\right)^{\phi_r}\left(R^M\left(\frac{\Pi_t}{\Pi}\right)^{\phi_\pi}\left(\frac{Y_t}{Y}\right)^{\phi_y}\right)^{(1-\phi_r)}_{\zeta_{\iota,t}}, \quad [61]$$

with $\zeta_{\iota,t}$ being the monetary policy shock.

3.5 Aggregation and market clearing

First, we turn to the aggregation in investment projects. As discussed in Section 2.3, there are three cases in which the bank securitizes loans. In these cases, the bank redeploys the capital freed up by this transaction towards a technology that produces final goods in the current period. Thus, aggregating all the cases, there is an extra portion of consumption goods created by the redeployment of capital, which sums up to:

$$\Gamma_t = \left[l\lambda + \left(1 - p_{t-1}\right)\left(1 - l\right)\right]P_{t-1}^{ABS}V_t R_{t-1}^L \not{\iota} L_{t-1}^S \quad [62]$$

As for the other aggregate variables, these are simply given by the weighted average of the corresponding variables for each type of firm. Thus:

$$K_t = \omega K_t^S + \left(1 - \omega\right)K_t^L \quad [63]$$

$$N_t = \omega N_t^S + \left(1 - \omega\right)N_t^L \quad [64]$$

$$R_t^K = \omega R_t^{K^S} + (1-\omega) R_t^{K^L} \quad [65]$$

Moreover, market clearing for goods requires that:

$$Y_t + \Gamma_t = C_t^H + I_t \left(1 - \frac{\kappa_i}{2} \left(\frac{I_t}{I_{t-1}} - 1 \right)^2 \right) + c\Upsilon_t Q_t L_t^S \quad [66]$$

3.6 Exogenous perturbations

The exogenous shocks follow an AR(1) process:

$$\begin{aligned} \log(A_t) &= \rho_A \log(A_{,t-1}) + \epsilon_{A,t}, \\ \log(\kappa_t^B) &= \rho_\kappa \log(\kappa_{t-1}^B) + \epsilon_{\kappa,t}, \\ \log(\varkappa_t) &= \rho_\varkappa \log(\varkappa_{t-1}) + \epsilon_{\varkappa,t}, \\ \log(\iota_t) &= \rho_\iota \log(\iota_{t-1}) + \epsilon_{\iota,t}, \end{aligned} \quad [67]$$

with $\rho_j \in (0,1)$ and $\epsilon_{j,t}$ is i.i.d. with mean 0 and standard deviation σ_j and with $j = [A, \kappa^B, \varkappa, \iota]$ identifying the shock to technology, leverage ratio, securitization ratio and to monetary policy, respectively.

3.7 Equilibrium

The equilibrium is characterized by a sequence of endogenous variables: $\{C_t^H, \lambda_t^H, N_t^S, N_t^L, N_t, D_t, Y_t^S, K_t^S, L_t^S, Y_t^L, NW_t, I_t, K_t, \Gamma_t, K_t^B, ABS_t, IB_t, p_t, \Upsilon_t, W_t, R_t^D, R_t^{SB}, R_t^L, R_t^{IB}, R_t^{K^S}, R_t^{K^L}, R_t^M, R_t^B, \Pi_t, Q_t, V_t\}_{t=0}^{\infty}$, and exogenous processes for shocks satisfying the optimality conditions as well as technology and resource constraints.

4 Quantitative analysis

4.1 Parameterization

The model parameters are set to match key quarterly features of the Euro area. We set $\delta = 0.025$ to match an annual rate of depreciation of 10% of capital with respect

to output. We set $\alpha_L = 0.43$ for large firms and $\alpha_S = 0.25$ for SMEs implying an elasticity of labor $(1 - \alpha_L) = 0.55$ and $(1 - \alpha_S) = 0.75$, respectively. The weighted average elasticity of capital with respect to total output is therefore $\alpha = 0.33$ implying an aggregate weighted elasticity of labor with respect to output of $(1 - \alpha) = 0.66$. These differences capture the idea that small firms are characterized by a higher labor-to-capital ratio than large firms. Euro area data suggest a fraction of SMEs over total firms in the range (0.95 – 0.99) depending on definitions; thus we set it to $\omega = 0.95$ implying a share of large corporate firms $(1 - \omega) = 0.04$. The share of SME's output used in large firms production reflects the average share of intermediate good employed across sector based on EU data. In particular, Eurostat states that the EU-27's wholesaling of intermediate goods sector (NACE Group 51.5) consists of approximately one in seven of all wholesaling (NACE Division 51) enterprises; thus, we set $\gamma_S = 0.15$. The size of the elasticity parameter $\psi_L = 0.05$ and the survival rate of entrepreneurs, $\nu_L = 0.05$, follows from Bernanke et al. (1999).

In line with Gerali et al. (2010), the discount factor of the households is set $\beta_H = 0.9943$ in order to obtain the average of the steady-state interest rate on deposits (average of both commercial and shadow intermediaries) slightly above 2 per cent on an annual basis, in line with the average monthly rate on M2 deposits in the euro area from the years 1998-2009. The weight on leisure ψ is chosen to match a steady-state work effort of households of 0.3; the labor supply elasticity, $\eta = 1$, follows from Christiano et al. (2005).

The monetary policy rule is calibrated with conventional values adopted in the literature. In particular, $\phi_r = 0.69$ and $\phi_\pi = 1.35$ and $\phi_y = 0.26$. As for the exogenous perturbations, we assume that each type of shock follows the same AR(1) stochastic process $\zeta_{j,t} = \rho_j \zeta_{j,t-1} + e_{j,t}$, with $j \in A, \kappa^B, \iota$ and where A identifies the technology shock, κ^B the shock to the bank's leverage ratio, κ the shock to the securitization ratio, ι identifies the monetary policy shock. We set $\rho_j = 0.95$ and $\sigma_{ej} = 1$. As for the banking sector, the survival rate of bankers $\tau_B = 0.95$ adopts the value set by Gertler and Karadi (2011). Following Meh and Moran (2015), the parameter λ is set to 1.01, which indicates that capital redeployed generates just enough excess return to be valuable. The probability of the outside investment opportunity to occur is kept to $l = 0.25$ in the analysis. The leverage ratio κ^B is set to 5.0 in the baseline exercises, but we also explore the interval $\kappa^B \in [3,6]$. As for the securitization ratio, we set to $\kappa = 0.5$ in most scenarios, but we also experiment for values in the interval $\kappa \in [0.4, 0.6]$ to examine the effects of loosening this regulatory tool. The range of values chosen for the leverage ratio and the securitization ratio is the state-space in which equilibrium determinacy is ensured in all the scenarios we examine.

Table 1 summarizes the parameterization.

Table 1
PARAMETERS VALUE

Parameter	Description	Value
α_L	Output elasticity of capital for large firms	0.450
α_S	Output elasticity of capital for small firms	0.250
α	Average output elasticity of capital	0.330
α_B	Elasticity of deposit in loans production function	0.010
β_H	Subjective discount factor of households	0.990
h	Habit in household consumption	0.600
δ	Depreciation rate of capital	0.025
γ_S	Elasticity of intermediate input to large firm output	0.220
κ	Securitization ratio	[0.5,1]
κ^B	Leverage ratio	[5.7,0]
ν_L	Large firms survival probability	0.970
μ	Shadow intermediaries monitoring cost	0.120
ρ_r	Persistence term of the Taylor rule	0.690
ϕ_π	Response of interest rate to inflation	1.350
ϕ_y	Response of nominal interest rate to output growth	0.260
σ_j	Standard deviation of the *j – th* type of shock	1.000
θ_P	Price stickiness	0.750
η	Labor supply elasticity	1.000
ψ_L	Parameter governing financial accelerator for large firms	0.050
ε	Elasticity of substitution	10.000
κ_i	Investment-adjustment cost parameter	1.500
ω	Share of SMEs	0.950
λ	Return outside investment opportunity	1.010
l	Probability of outside investment opportunity	0.250
τ_B	Survival probability of commercial bankers	0.950

4.2 Steady state

We present the steady state obtained numerically for key macroeconomic variables under standard parameterization.

4.3 Impulse responses to shocks and business cycle amplification

In this section, we provide the results of the model under different types of shocks. We illustrate how business cycle amplification is affected by the heterogeneity of firms and by regulation in the financial sector. We take the technology shock as a benchmark, as it represents one of the main drivers identified by the DSGE literature on the business cycle.

Table 2
STEADY STATE OF SELECTED MACROECONOMIC VARIABLES ECONOMY

Variable	Description	Value
Y	GDP	0.690
C	Consumption	0.320
γ	Screening intensity	2.420
R^D	Deposit rate commercial banks	0.012
R^{SB}	Deposit rate shadow intermediaries	0.070
R^B	Interest rate on corporate loans	0.200
R^L	Return on project commercial banks	0.190
P^{ABS}	Price of ABS	0.360
p	Probability of success	0.960

4.3.1 Technology shock

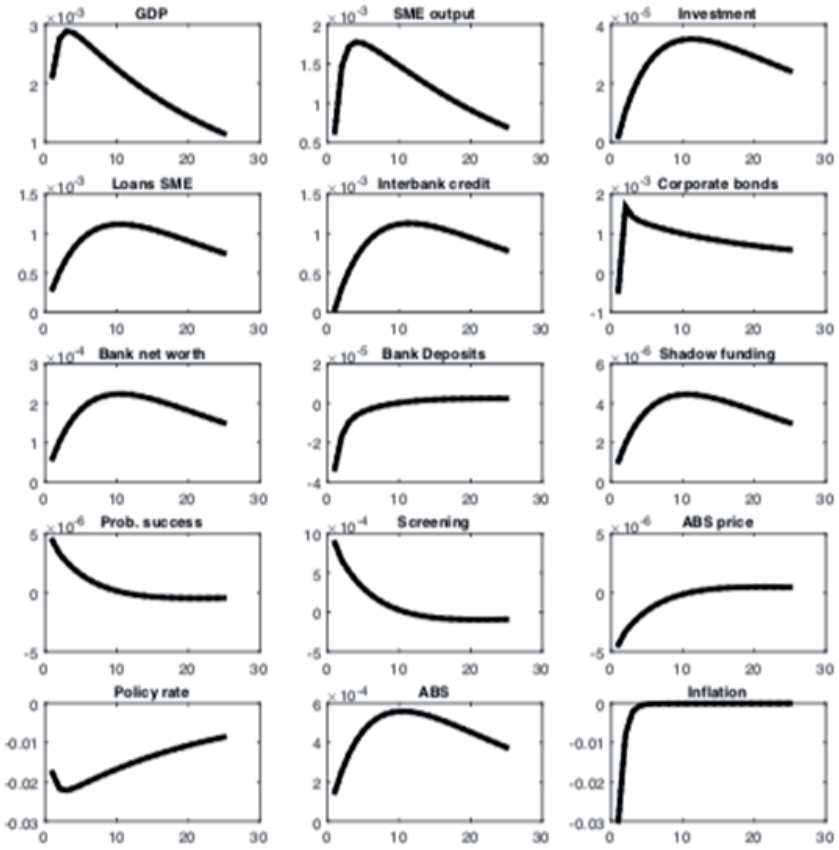
We consider a technology shock as the benchmark to describe the main transmission mechanism at work in the model. In response to a positive technology shock, both small and large firms would like to produce more and increase their demand for loans. In absence of regulation constraints on the leverage ratio, commercial banks would accommodate this higher demand and increase their exposure towards small firms. The obligation to comply with leverage regulation, instead, forces banks to raise own capital in order to increase loan supply, setting the stage for regulatory arbitrage. To allow faster capital accumulation after the shock, banks increase the intensity at which they screen projects so as to limit capital disruption stemming from risky and likely non-performing loans.

This raises the success probability of the projects, which has a direct, positive, effect on the price of asset-backed securities. The latter depends, in contrast, negatively on the gross interest rate on shadow intermediaries' deposits, which increases after the technology shock. Since the increase of the interest rate on shadow intermediaries deposit is stronger than the increase of ω, the price of asset-backed securities falls. It is important to stress that the fall of the price of securitized loans on the secondary market reflects the higher opportunity cost that banks incur when liquidating loans after having increased the intensity of costly screening effort.

The possibility opened by the presence of a secondary market for loans, thus, allows banks to redeploy capital, to accumulate net worth, and to increase loans. It is worthwhile noting that this channel, although active, exerts a limited force due to the securitization cap. The cap limits the ability of commercial banks to securitize loans on the secondary market and thus the severity of the regulatory arbitrage externality.

Chart 2

TECHNOLOGY SHOCK. BASELINE IMPULSE RESPONSES OF SELECTED KEY MACROECONOMIC VARIABLES



NOTE: The leverage ratio is set to $\kappa B = 5$, and the securitization ratio to $\kappa = 0.5$.

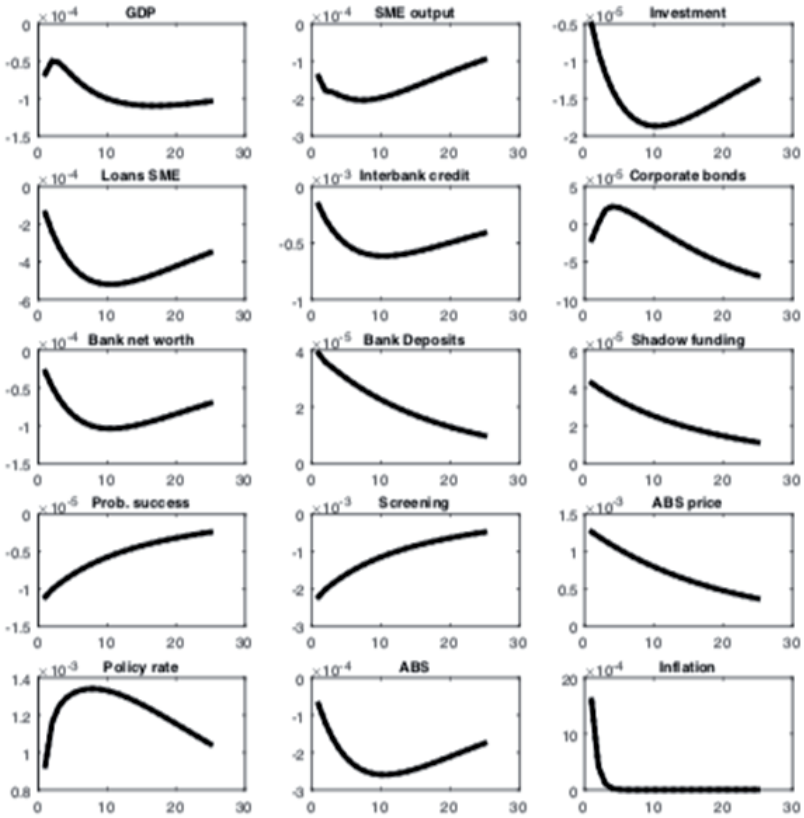
4.3.2 Financial shock

The financial shock consists of a one per cent decrease to the probability of receiving the alternative investment opportunity for the commercial bank. Chart 3 shows the impulse response functions.

Most of the transmission mechanism holds as in the technologic shock. The key mechanism at work still goes through the incentives for commercial banks to screen and thus to influence the probability of the projects to be successful, through banking capital accumulation and the consequent credit availability for small firms. Intuitively, a negative shock to the probability of obtaining an alternative investment opportunity reduces capital redeployment opportunities for commercial banks. This has a direct, negative effect on banking capital accumulation. Because of the leverage regulation ratio, the fall in banking capital needs to be accommodated by a reduction in the amount of projects financed (to keep complying with regulation), which translated in a fall of projects screened and consequently of their probability of success. This has

Chart 3

FINANCIAL SHOCK. IMPULSE RESPONSE OF SELECTED KEY MACROECONOMIC VARIABLES CONDITIONAL ON THE REALIZATION OF THE ADVERSE SHOCK TO THE PROBABILITY OF THE ALTERNATIVE INVESTMENT OPPORTUNITY



NOTE: The leverage ratio is set to $\kappa B = 5$, and the securitization cap at $\kappa = 0.5$.

a direct effect on the price of ABSs (as prescribed by condition [43]), which increases to reflect the lower opportunity cost faced by commercial banks when securitization on the secondary market for loans takes place.

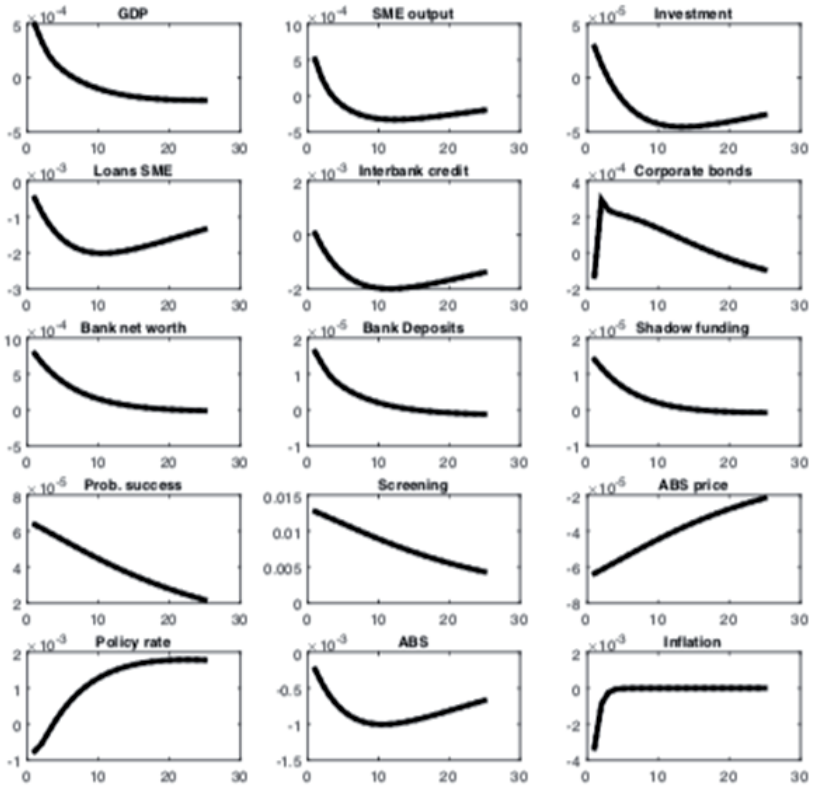
4.3.3 Regulation shock

We consider two types of regulation shocks. This first one is a one percent tightening in the leverage regulation κ^B, while the second shock is a one percent tightening of the securitization ratio κ.

A tightening of regulation, put in practice by lowering leverage in the traditional banking sector, exerts a positive effect on the screening effort by commercial banks. The severity of the moral hazard behavior is dampened and the probability of incurring into non-performing loans decreases. In fact, a tighter leverage ratio regulation implies that banks need to increase own capital to keep loans supply

Chart 4

REGULATION SHOCK. IMPULSE RESPONSE OF SELECTED KEY MACROECONOMIC VARIABLES CONDITIONAL ON THE REALIZATION OF A 1% TIGHTENING OF THE LEVERAGE RATIO FOR COMMERCIAL BANKS



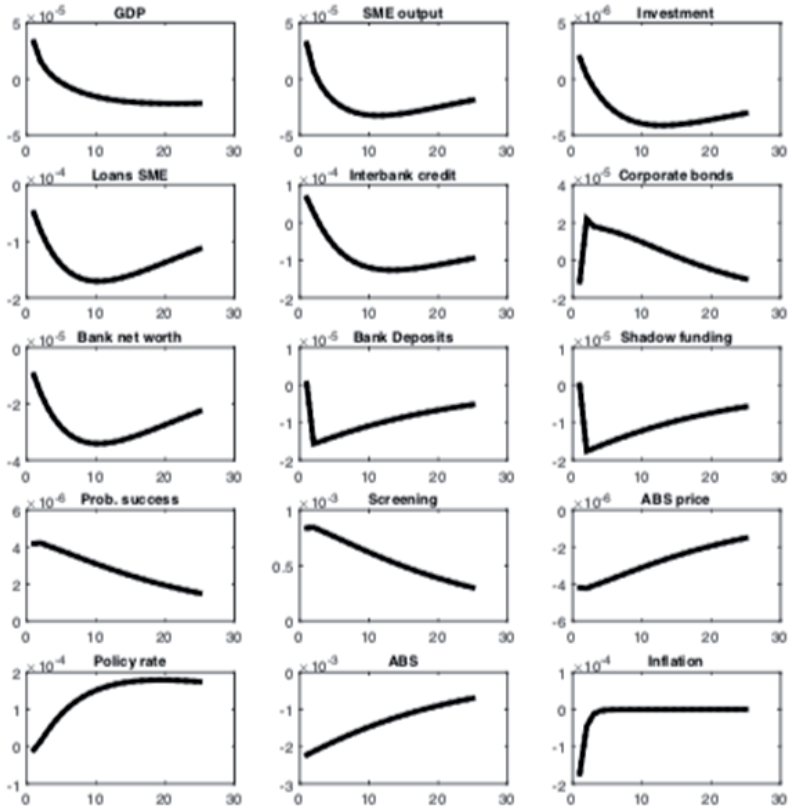
NOTE: The capital requirement is initially set at 20% (or leverage $\kappa^B = 5$), and the securitization cap at $\kappa = 0.5$.

unchanged. Thus, increasing screening is the only way to ensure capital accumulates faster. Exerting costly effort to ensure that project failures are less likely makes them less willing to sell loans on the secondary market. Therefore, the quantity of ABS drops, as well as the price of ABS to reflect the higher opportunity cost faced by commercial banks. On impact, the supply of loans drops as a consequence of the partial ability of commercial banks to meet the regulation constraint solely by increasing the screening effort. As a consequence, the adjustment to the regulation ratio passes through the reduction of loans to small firms as well. Importantly, the presence of large firms dampens the fall in capital demand, as the downward pressure on its price triggered by small firms makes more convenient to purchase the capital good to be employed in the large firm's sector. This mechanism sustains investment and the demand of intermediate good by large firms.

A similar dynamic holds for a tightening in the securitization ratio, which makes regulatory arbitrage opportunities less likely for commercial banks. The consequent limited capital redeployment opportunities force commercial banks to increase

Chart 5

REGULATION SHOCK. IMPULSE RESPONSE OF SELECTED KEY MACROECONOMIC VARIABLES CONDITIONAL ON THE REALIZATION OF A 1% TIGHTENING OF THE SECURITIZATION RATIO



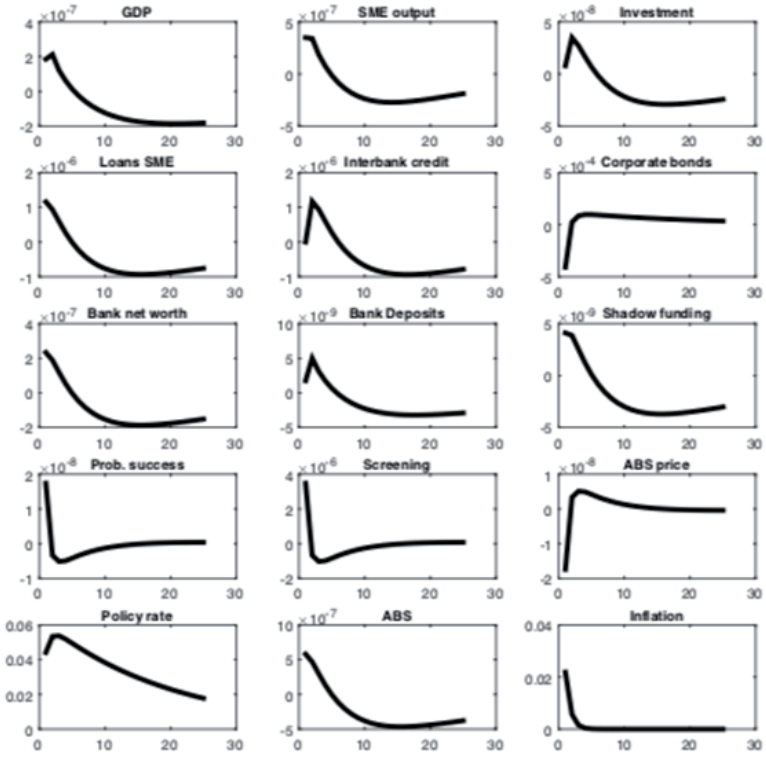
screening and reduces the positive effects on banking capital accumulation induced by securitization. Banking capital drops, so that commercial banks cut on the loans supply to small firms, feeding downward pressures on the price of the investment good. The initial drop of small firms' investment, however, is counteracted by the increase in large firm's demand of capital good, which increase their loan demand thereby sustaining the demand of intermediate good and aggregate output.

4.3.4 Monetary policy shock

A tightening of monetary policy has a direct effect on the net worth of large firms as the monetary policy interest rate is used as the risk-free interest rate. Thus, an increase in the policy rate has a negative impact on large firms' net worth, which worsens their ability to finance capital purchases via internal finance. As a consequence, large firms' demand of credit to shadow intermediaries increases,

Chart 6

MONETARY POLICY SHOCK. IMPULSE RESPONSE OF SELECTED KEY MACROECONOMIC VARIABLES CONDITIONAL ON THE REALIZATION OF A 1% TIGHTENING OF MONETARY POLICY



which increases the lending rate and improves the intermediation prospects of shadow intermediaries. This attracts more deposits towards shadow intermediaries, but also to commercial banks due to the fact that the latter increase their interest rate to keep households engaging in the financial contract. To cope with the increase in the cost of funding, commercial banks increase screening to improve the likelihood of project to be successful. Thus, as described above, the price of ABSs falls to reflect the higher opportunity cost when securitization on the secondary market for loans takes place.

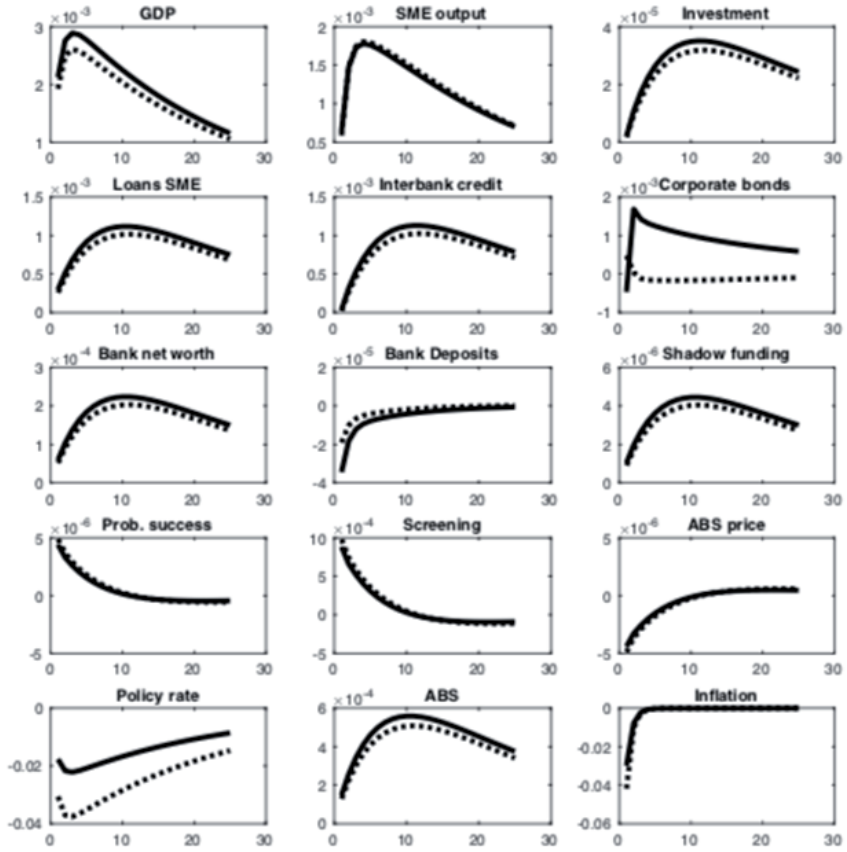
4.3.5 The role of firm heterogeneity

In this subsection, we explore the role played by firms heterogeneity in the transmission and amplification mechanism of shocks.[22] We start the analysis by assuming a drop in

22 We leave to a next version possible quantitative experiments that relax nominal rigidities in order to assess their specific contribution to business cycle amplification.

Chart 7

IMPULSE RESPONSE OF SELECTED KEY MACROECONOMIC VARIABLES CONDITIONAL ON THE REALIZATION OF THE PRODUCTIVITY SHOCK

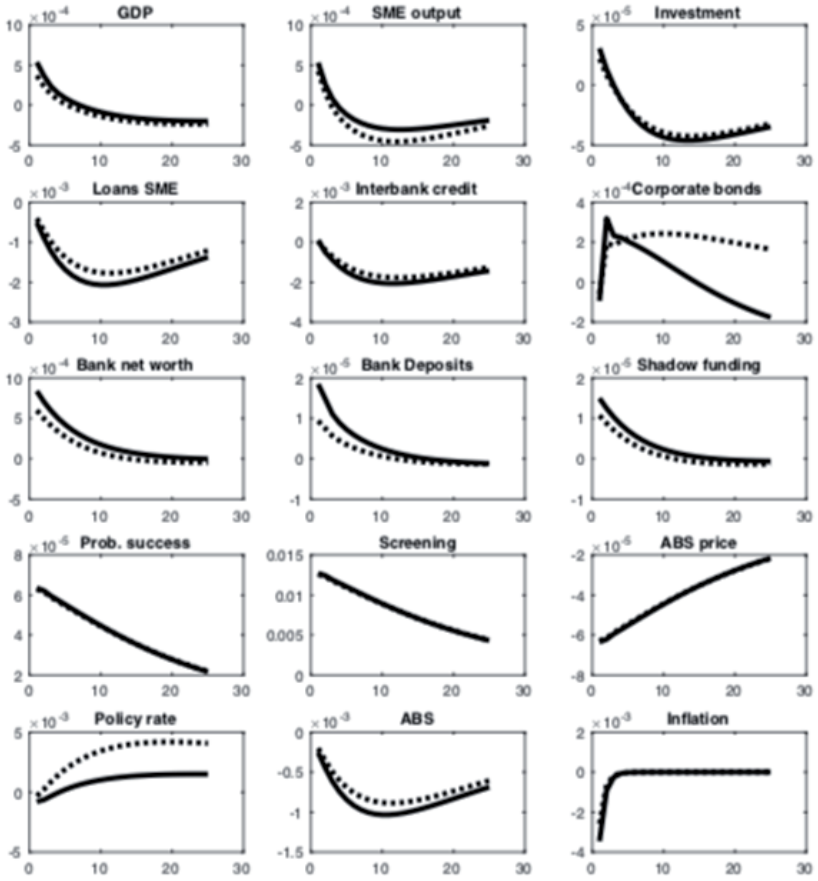


NOTE: The leverage ratio is set at $\kappa^B = 5$ $\kappa = 0.5$, and the share of SMEs at $\omega = 0.95$ (solid line) and $\omega = 0.7$ (dotted line).

the fraction of SMEs from 95% (as in the baseline parameterization) to 70%, conditional on the realization of a favorable productivity shock. Chart 7 shows the respective impulse response functions. It is worth noting how the presence of small-medium enterprises generally brings an amplification effect in response to the technology shock, as shown by the more volatile solid line than the dotted line. Moreover, the share of SMEs also affects the magnitude of the financial variables due to sectoral inter-linkages mainly working through the ability of banks of accumulating capital and extending loans, as well as by securitization incentives incorporated in the financial contract. Similar results are obtained when changes take place in the parameter γ^S, that is when changing the intensity at which the intermediate good produced by SMEs is employed by large firms as input in the production process. The intuition underlying the increasing volatility when the importance of SMEs increases rests in the presence of riskier projects of SMEs, which may be non performing loans for the commercial banks. The effects of financial frictions, such as the costly screening intensity

Chart 8

IMPULSE RESPONSE OF SELECTED KEY MACROECONOMIC VARIABLES CONDITIONAL ON THE REALIZATION OF A 1% TIGHTENING OF THE LEVERAGE RATIO



NOTE: The share of SMEs is set at $\omega = 0.95$ (solid line) and $\omega = 0.7$ (dotted line).

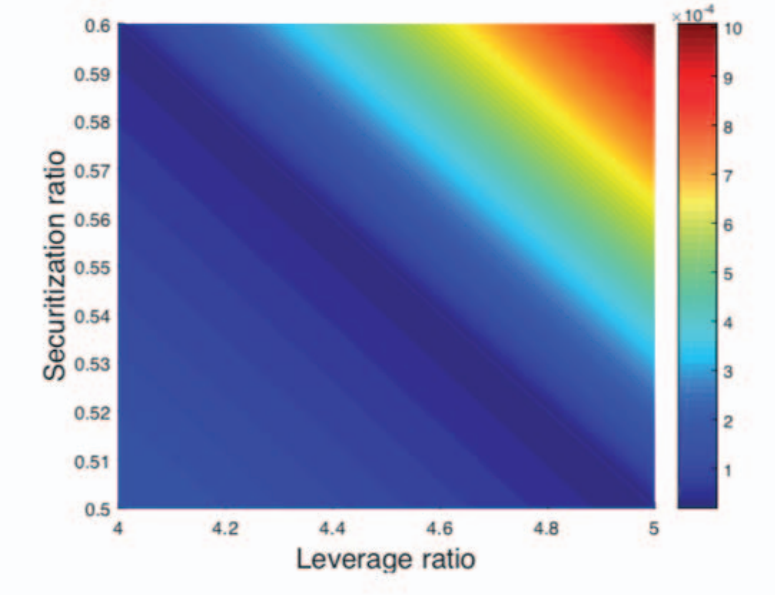
interacting with moral hazard, and the default probability of projects in the SMEs' sector make the whole economy more vulnerable to aggregate shocks due to the inter-linkages in the production chain as well as in the financial sector.

5 Macroprudential policy and welfare

To obtain a quantification of the effectiveness of the macroprudential policy tools, we study the effects of different policy regimes on output volatility and welfare. To this end, we first compute output volatility for each combination of the parameters representing the two macroprudential policy tools (i.e., caps to the leverage ratio and the securitization ratio). The results are graphically reported in Chart 9 over the state-space parameterization that ensures equilibrium determinacy.

Chart 9

MACROPRUDENTIAL POLICY AND OUTPUT VOLATILITY CONDITIONAL ON THE REALIZATION OF A POSITIVE TECHNOLOGY SHOCK



As it can be observed, loosening simultaneously both macroprudential policy tools dramatically worsens the volatility of output. The positive analysis conducted in Chart 9 suggests that when the banking sector is highly leveraged in a context of a loose securitization regulation, a macroprudential regulator may successfully induce macroeconomic stabilization by tightening both banking leverage and securitization.

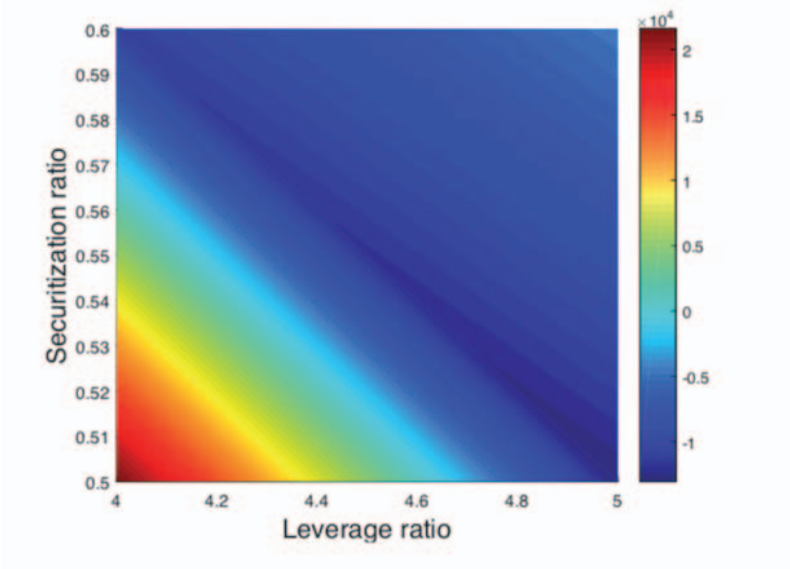
To assess this point from a normative point of view, we conduct welfare analysis following the approach found in Schmitt-Grohe and Uribe (2004) or, more recently, in Wolff and Sims (2017).

For the purpose, we define a recursive formulation of as social welfare as:

$$\text{welfare} = \mathbb{W}_t = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \mathbb{U}_t\left(C_t, N_t\right) + \beta \mathbb{E}_t \mathbb{W}_{t+1}, \qquad [68]$$

where $\mathbb{U}_t\left(C_t, N_t\right)$ is the households felicity function defined in Section 3.1 and β is their subjective discount factor. We then solve the model by performing a second order approximation around the non-stochastic steady-state. When solving the model, we include [68] as equilibrium condition and analyze how Wt behaves when changing simultaneously the two policy parameters.

Chart 10
WELFARE



The result of this welfare exercise is reported in Chart 10, which shows that tightening securitization is generally welfare improving.

In light of these results, some further considerations are warranted. The presence of trade-offs is a key aspect of the model. Such trade-offs are generated by the interaction of several financial frictions and lead to two channels of transmission: the screening channel and the securitization channel. Within the model, the effect of policy interventions is ultimately determined by the joint effect of these channels. Securitization generally worsens welfare because the screening effect dominates the securitization effect. To be more precise, in order to take on the alternative investment opportunity, the bank has two ways of raising funds. First, the bank can use screening in order to improve the likelihood of the firm's project to be successful thereby increasing banking capital accumulation. Second, the bank can generate revenues by selling loans. When the bank opts to sell loans through securitization, it abandons the first channel, screening. This exacerbates the moral hazard problem with depositors (i.e. the bank screens less than agreed in the financial contract). Lower screening leads to higher non-performing loans, while leverage remains constant due to the substitution of loans with the outside option. Although the outside option carries a slightly higher return, this is not sufficient to compensate the loss of banking capital accumulation resulting from higher non-performing loans due to less screening. The resulting situation is that the banking sector has the same leverage but higher non-performing loan levels than it would have had if it continued screening. Although securitization helps to take advantage of the alternative option, this is the reason why it leads to an externality. More specifically, it amplifies moral hazard and eases regulatory arbitrage. For the same reason, placing a cap on securitization

forces banks to resort to more screening for increasing funds thereby improving the likelihood of projects to be successful.[23]

6 Concluding remarks

The recent financial crisis and the subsequent Great Recession have changed the way economists think about the importance of the shadow financial system and its interaction with the rest of the economy. Only recent standard DSGE models have started to incorporate a fully-fledged financial sector with banks assumed to be the only financial intermediary.

In this paper, we take a step forward by bringing shadow financial intermediaries into a standard NK-DSGE model. The objective is to study the pass-through of shocks between the real sector and the financial sector within a heterogeneous agent model economy in which small and large firms are vertically linked in a production chain. Small firms' risky projects are financed by commercial banks, whose behavior may be subject to moral hazard that induces them to securitize loans and sell them to shadow intermediaries upon the arrival of a more remunerative investment alternative. Large firms' projects are financed by shadow intermediaries, which also provide interbank credit to commercial banks. Macroprudential policy is imposed both as a limit to the leverage ratio in the traditional banking sector and as a cap to the fraction of loans that can be securitized. The adopted normative analysis suggests that loosening the limits to securitization and to leverage ratio in the banking sector may be harmful for financial stability as it dramatically increases the size of output volatility. The welfare analysis confirms that containing leverage and securitization is welfare-improving following a technology shock.

The first key result is that macroprudential policy helps reducing the severity of the moral hazard problem by inducing banks to increase the screening intensity of the projects they finance. The possibility of securitization helps limiting the drop of credit potentially available to small firms resulting from tight regulation. As shown by the banking capital accumulation equation, in fact, higher securitization increases bank capital and therefore the potential availability of credit supply to small firms. Moreover, securitization allows the pass-through of risk of potentially non-performing loans

23 Clearly, the effects of these trade-offs rely on our modeling framework and crucial parameters. One important parameter in shaping these results is the return of the outside option (λ). If this parameter were high enough, the securitization channel would generate higher gains than costs. Nevertheless, the outside investment opportunity is an asset whose excess return must be positive, but rather small, in order to receive the same regulatory treatment. For this reason, we refrain from performing exercises with higher values of this parameter since it would lead the asset to a different regulatory treatment.

from the traditional banking sector to shadow intermediaries, generally more specialized in the management of risky assets.

However, if the moral hazard problem is very severe, resorting to securitization may ultimately result in a worsening of aggregate volatility due to feedback effects that are in place through the shadow financial intermediation system and impact the real economy through the financing channel of large firms. Shadow intermediaries, in fact, are interconnected both with the banking sector and with the productive sector, as they provide credit both to commercial banks and to large firms.

The transfer of risk from traditional banks to shadow intermediaries, that might be beneficial at a first glance, feeds back into the former sector through the interbank market and into the productive sector through corporate loans, making the effects of securitization controversial.

As shown by the impulse responses to a financial shock, an increase in the probability of banks to receive a better outside investment opportunity and, thus, a worsening of the moral hazard problem leads to a drop in the screening intensity, bank net worth, investment and output. A regulator might help smooth business cycle amplification and improve social welfare by implementing a set of macroprudential policy tools as a macroeconomic stabilization policy, whose simultaneity may be powerful. In particular, our results find that both macroprudential policy tools are effective in smoothing business cycle volatility and increase welfare following the shock. On the contrary, the simultaneous loosening of both limits undermines financial stability.

In our model, therefore, securitization offers potentially large benefits especially for targeting resources towards more efficient redeployment. However, they might come at the cost of higher volatility when the banking sector is already highly leveraged and in welfare costs. In these situations, tighter securitization caps together with limits to leverage ratio should be activated.

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Financial system interconnectedness

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Abstract

Interconnectedness between financial institutions – banks and other financial agents – is an inherent characteristic of developed financial systems that adds flexibility to investment and to the financing of the economy. However, at times of crisis, it may also contribute to propagating stress through the system. This article presents an overview of interconnectedness in the Spanish financial system, with emphasis on (i) the direct linkages between the different resident financial sectors and with non-resident financial sectors, and (ii) the indirect interconnectedness between resident sectors. The changes in recent years in two measures of interconnectedness are also examined: the degree of portfolio overlap between banks, investment funds, insurance companies and pension funds, and a measure of portfolio similarity based on the correlation coefficient of each sector's holdings. The analysis shows significant cross-border interconnectedness, a growing presence of the non-bank sector in the Spanish financial system overall and significant similarity between certain sectors' portfolios.

1 Introduction

In most developed economies the financial sector is made up of a network of entities with different corporate structures and subject to different regulatory regimes but which in some cases pursue similar activities. Within the financial sector, banks tend to be the most relevant agents. Yet other agents also pursue key activities and, in some cases, provide other economic agents with financing similarly to the way banks do.

Non-bank financing is an alternative to bank financing that fosters competition and broadens sources of funding. The existence of alternative financing sources offers economic agents greater flexibility for securing funds for investment or consumption and can further diversify the risks assumed by the financial system.

However, as the non-bank sector expands worldwide and becomes increasingly involved in activities traditionally belonging to the banking sector (liquidity or maturity transformation, imperfect transfer of credit risk, or leveraging), it may become a source of risk, either directly or as the result of its interconnectedness with the banking sector. Moreover, the increase in banking regulation has prompted doubts as to the extent to which growing regulatory pressure may be driving activity towards less regulated environments. Questions about this possible regulatory

arbitrage have arisen, even though most of the non-bank sector is subject to regulatory frameworks designed to address some of the most relevant risks they are exposed to. From this starting point, in recent years work has been undertaken at the international level in order to get a more accurate mapping of the financial sector and analyse potential risk propagation channels. Analysis of the interconnectedness of the financial sector has been central to this work.

Interconnectedness is a natural development in any mature financial system. It allows financing to flow from areas where savings build up to others that seek funding, thus ensuring credit supply to the real economy. It also provides for diversification and risk-sharing between agents. Yet as was observed in the last great financial crisis, imbalances or shocks in one sector (or specific group of entities within one sector) can pass through to the rest of the financial system. The longer and more complex the credit intermediation chains, the greater this risk of contagion may be, since it is more difficult to take measures if there is little information available regarding these links. The interlinkages embedded in the financial system architecture could turn even relatively small subsectors into sources of systemic risk.

After the outbreak of the crisis, various international bodies began working on improving monitoring and analysis of these risks and also the regulatory framework associated with their assessment and containment. Since 2011 the Financial Stability Board (FSB) has been publishing annual reports – the *Global Monitoring Report on Non-Bank Financial Intermediation* (previously, the *Global Shadow Banking Monitoring Report)* – that include a section on interconnectedness among financial sectors, a relevant indicator of potential contagion risk. The report also has thematic sections that have analysed specific aspects of interconnectedness in certain jurisdictions in greater depth.[1]

At the European level, since 2016 the European Systemic Risk Board (ESRB) has published an annual report – the *EU Non-bank Financial Intermediation Risk Monitor* (previously, the *EU Shadow Banking Monitor)* – that also analyses interconnectedness and the risk of contagion across financial sectors. This report has likewise included specific analysis of interconnectedness within the non-bank sector.[2] In addition, the European Central Bank (ECB) has included analysis of interconnectedness in the financial sector in its *Financial Stability Review.*[3]

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1 See, for example, the box on interconnectedness in Brazil (p. 41 of the 2017 report, published in March 2018), or the box on indirect interconnectedness in the euro area (p. 36 of the 2018 report, published in February 2019).

2 See, for example, Box 2 in the 2018 report (published in September 2018) on Irish non-securitisation special purpose entities, or Box 2 in the 2017 report (published in May 2017) on EU banks' exposures to shadow banking entities.

3 See, for example, section 3.2 of the ECB's *Financial Stability Review* of November 2018, especially Chart 3.24 and related paragraphs.

Moreover, some sections of the regulatory reforms of recent years have addressed the risks generated through interconnectedness: from the measures introduced to strengthen the regulatory frameworks for money market funds or securitisations to the steps taken to mitigate risks in the securities lending markets, or the sections of Basel III that limit certain types of exposures.

For the more in-depth analysis carried out in this article we will use the standard classifications developed by the previously mentioned work on interconnectedness, which tends to distinguish between two types:

— Direct interconnectedness, where two entities are direct counterparties through debt instruments, shares or other contractual relationships. In general, analysis of these interlinkages focuses on cross-holdings: instruments issued by one financial institution and held by another financial institution belonging to the same or a different financial sector.

— Indirect interconnectedness, where financial institutions hold common exposures to certain sectors, markets or instruments, form part of the same collateral chains, belong to the same corporate groups, or are exposed to reputational risk owing to financial support provided to subsidiaries or similar entities aside of contractual relationships (step-in-risk).

2 Developments in the resident financial system

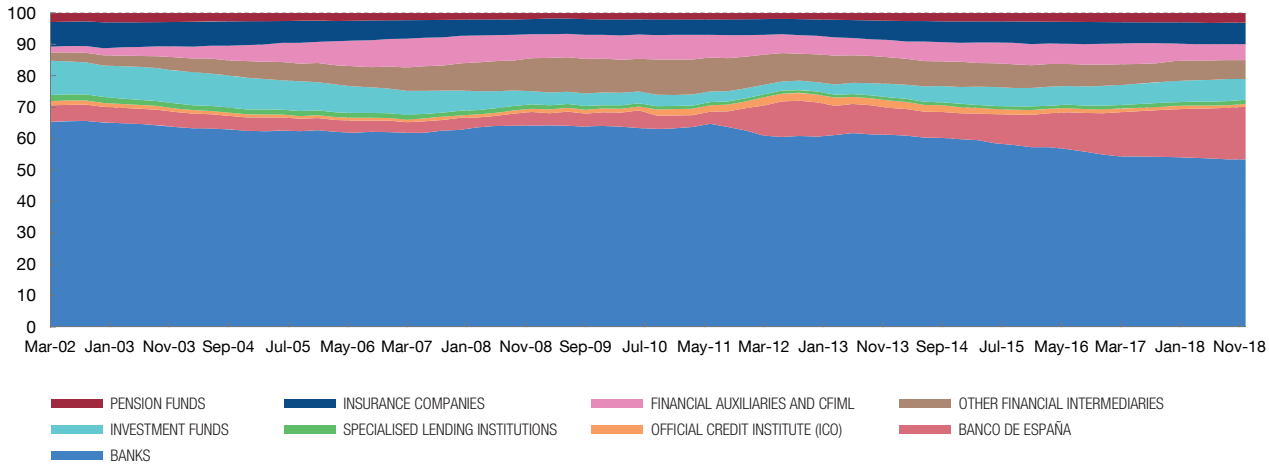
In Spain, the financial system's total financial assets amounted to €4.5 trillion in December 2018. According to FSB published data, at December 2017 the Spanish financial system accounted for 6% of the euro area's financial system. In Spain, the banking sector is the main component of the financial system, with a larger share than in other developed economies. As Chart 1 shows, at December 2018 the banking sector held 53% of the financial assets of the financial system.[4] Within the non-bank sector (which holds 29% of financial assets), the largest subsectors in Spain are insurance companies (7%), investment funds (6%) and Other Financial Intermediaries (6%).[5]

4 According to the FSB's "Global Monitoring Report on Non-Bank Financial Intermediation 2018", at December 2017 the share of the banking sector in Spain (55%) was much higher than in other developed economies such as Luxembourg (5%), Ireland (11%), the Netherlands (21%), the United States (24%), Switzerland (37%), the United Kingdom (48%), Italy (49%) or Japan (49%) and was similar to that in others such as Germany (53%) or France (55%).

5 The Other Financial Intermediaries category comprises securities dealers, asset securitisation special purpose vehicles (SPVs), venture capital companies, bank asset funds, central counterparties and asset management companies (sector S.125 in National Financial Accounts nomenclature).

Chart 1

COMPOSITION OF THE SPANISH FINANCIAL SYSTEM (% OF FINANCIAL ASSETS)



SOURCE: *Financial Accounts of the Spanish Economy* (July 2019) - Banco de España.
NOTE: Captive financial institutions and money lenders (CFIML) is sector S.127 of the Financial Accounts. It comprises holding companies holding shares of financial and non-financial corporations controlled by non-residents and residents (if they have decision-making autonomy), special purpose entities (SPEs) and companies issuing preference debt instruments and the like.

Chart 1 also shows how the weight of banks in the financial sector has declined since 2011 (when it stood at 65%). This is due to the decrease in banks' assets (chiefly owing to the decline in credit), but also to other factors such as the effects of the accommodative monetary policy that has given a significant boost to financial assets held by the Banco de España (17% at end-2018 compared with 4% in 2011).

While in the global financial system the non-bank sector has grown continuously since 2011,[6] in Spain its share has remained steady around 30%. Yet its composition has changed: investment funds have grown (after losing relevance during the crisis) and also insurance companies, albeit to a lesser extent, while Other Financial Intermediaries, which in 2011 accounted for 11% of the financial system, have declined (owing, for example, to the decline in securitisation SPVs).

Following on from the work started by the Banco de España in its Spring 2019 *Financial Stability Report,* this article seeks to analyse interconnectedness in the Spanish financial sector in greater depth. The analysis will draw on National Financial Accounts data to describe direct interconnectedness. It will also draw on Securities Holdings Statistics by Sector (SHSS)[7] data to obtain a greater

6 According to the FSB's Global Monitoring Report on Non-Bank Financial Intermediation 2018, the share of non-bank intermediaries in the financial sector in the 29 jurisdictions that participated in the exercise rose from 45% in December 2011 to 49% in December 2017.

7 This database contains granular data on the portfolio composition of the different euro area financial sectors. It is managed by the ECB, which centralises data received from the national competent authorities (NCAs). For more information, see section 3.3.

breakdown of these direct linkages and explore the indirect interconnectedness resulting from portfolio overlap.

3 Direct interconnectedness

3.1 Direct interconnectedness between resident financial sectors

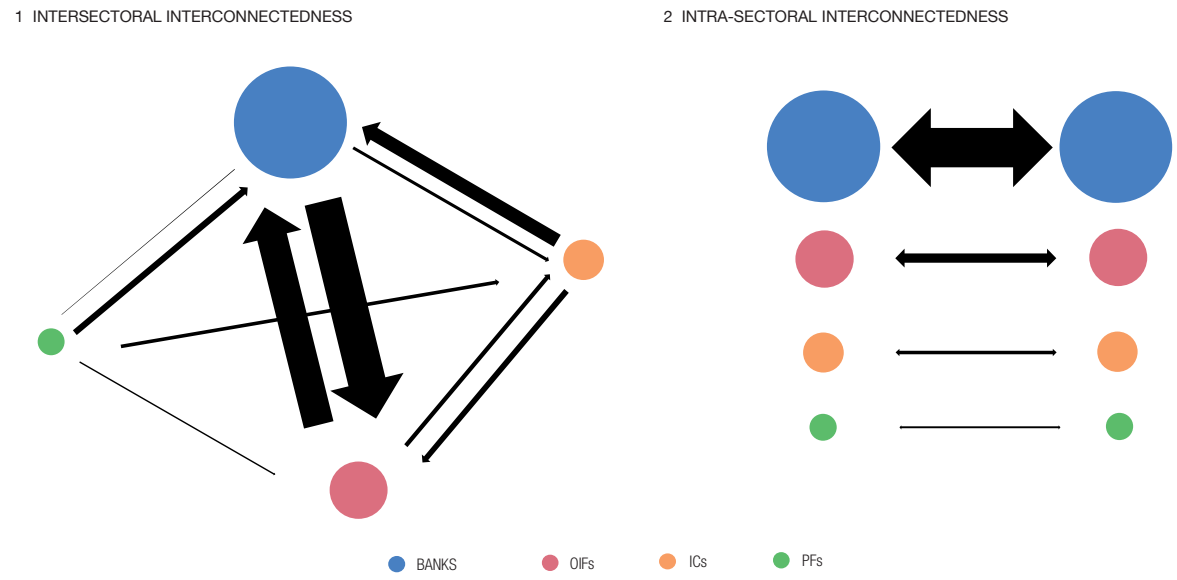
In Spain, banks play a central role in the activities of the resident financial system. The main interconnectedness between sectors by volume is between banks and Other Financial Institutions (OFIs)[8] (see Figure 1, where the size of the circles is proportional to the size of each sector and the thickness of the arrows to the scale of the interconnectedness (the volume of exposures that each sector holds with the others). Figure 1.1 depicts the direct interconnectedness between the different sectors of the financial system. For instance, banks' exposures to OFIs, which are the largest by volume, amount to approximately €97 billion, while banks' exposures to insurance companies (the smallest by volume) are around €8 billion. Figure 1.2 depicts the intra-sectoral direct interconnectedness (the volume of exposures that entities in each sector hold with others in the same sector). For instance, interconnectedness amounts to €108 billion between resident banks and to €24 billion between resident OFIs.

As the figure shows, the smallest sector – pension funds – is also the least connected sector. Intra-sectoral direct interconnectedness (between different agents in the same sector) is highest between banks (4.3% of their total financial assets), followed by OFIs (3.9%), pension funds (3.5%) and insurance companies (3.1%).

Banks' direct interconnectedness with each of the other sectors accounts for a relatively small share– in no case more than 5% – of banks' financial assets (see Chart 2). This interconnectedness has evolved rather differently from the pattern observed at the global level described in the FSB's reports (growth in interconnectedness in the pre-crisis years followed by decline since 2009). In Spain the level of interconnectedness, for example between banks and OFIs, has remained relatively steady around 5% (for liabilities to OFIs) and 3%-4% (for assets) of bank's financial assets. Just two significant changes are observed: growth in banks' liabilities to OFIs in 2005, which is associated with the entry into force of Circular 4/2004 which placed stricter conditions on derecognition by banks of securitisation-related assets (which increased the volume of loans on banks' balance sheets and, consequently, liabilities to OFIs);

8 Not to be confused with the Other Financial Intermediaries category in the Financial Accounts which, as explained in the note to Figure 1, is just a part of the Other Financial Institutions sector.

Figure 1
DIRECT INTERCONNECTEDNESS IN 2018 Q4



SOURCE: *Financial Accounts of the Spanish Economy* (July 2019) - Banco de España.
NOTE: The abbreviations OFIs, ICs and PFs denote Other Financial Institutions, insurance companies and pension funds, respectively. The OFI category comprises several sectors in the Financial Accounts: Other Financial Intermediaries, specialised lending institutions, investment funds (money market and non-money market funds), financial auxiliaries, and captive financial institutions and money lenders. The 2018 Q4 data on interconnectedness and the change in those data differ somewhat from the figures published in the Spring 2019 *Financial Stability Report* owing to a review of the methodology used.

and growth in 2012 in banks' assets with OFIs, which is associated with the decline in the consolidation of some securitisation SPVs and the creation of Sareb[9] (banks hold a significant amount of debt issued by Sareb).

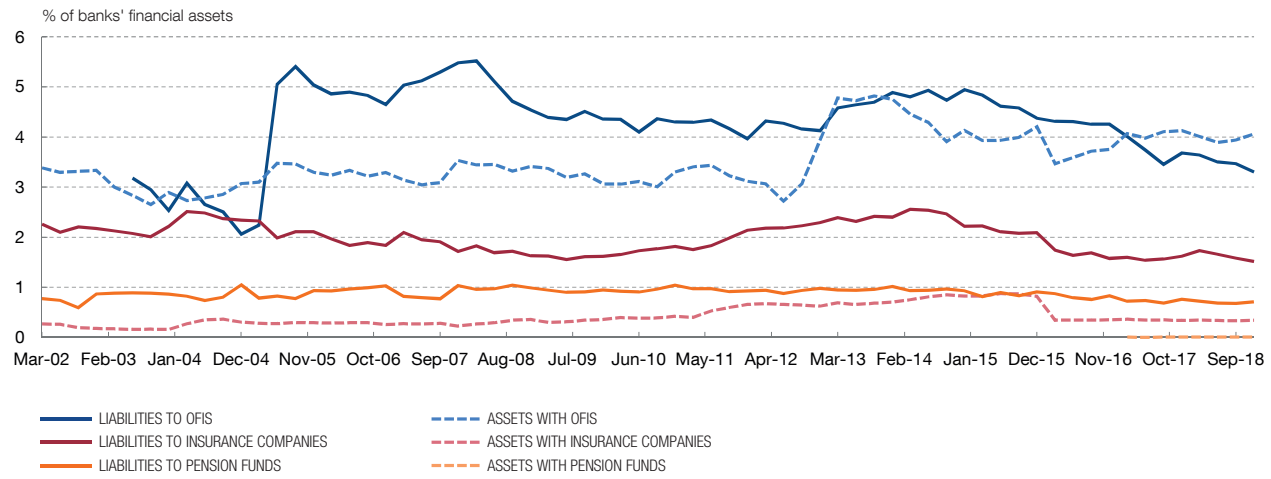
Although the volume of direct interconnectedness appears to be contained at the aggregate level, it may be significant for certain entities. For that reason a more granular analysis is needed that will provide insights on the degree of concentration and the specific characteristics of these linkages.

In a stressed environment, for instance, financing difficulties might arise for banks if other financial sector entities that had acquired bank debt were to experience difficulties and were unable to refinance the debt upon maturity. There could also be problems if the financing granted by banks was concentrated on a specific group of financial or other sector entities, which could trigger a chain of defaults in the event of sector-specific problems. Conversely, in the event of stress in the banking sector, entities reliant on bank lending could lose their access to financing. The consequences of this would be more marked if they were highly interconnected entities, or entities playing a key role in the supply of financing to the real economy.

9 The Spanish asset management company for assets arising from bank restructuring, which belongs to the Other Financial Intermediaries category (S.125 in Financial Accounts nomenclature).

Chart 2

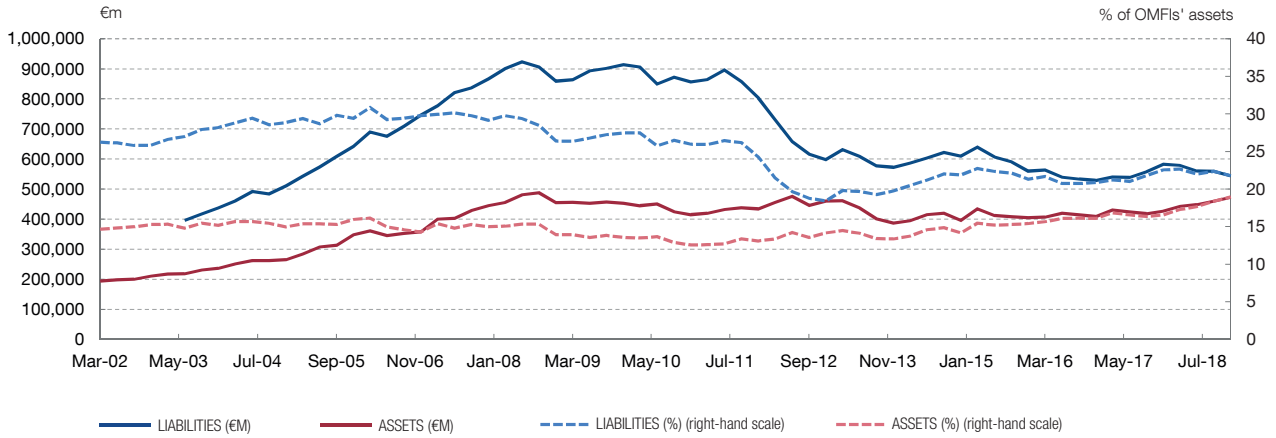
BANKS' INTERCONNECTEDNESS WITH OTHER FINANCIAL SECTORS (% OF BANKS' FINANCIAL ASSETS)



SOURCE: *Financial Accounts of the Spanish Economy* (July 2019) - Banco de España.
NOTE: Data on banks' assets with pension funds available only from 2017.

Chart 3

OMFIs' INTERCONNECTEDNESS WITH THE REST OF THE WORLD



SOURCE: *Financial Accounts of the Spanish Economy* (July 2019) - Banco de España.

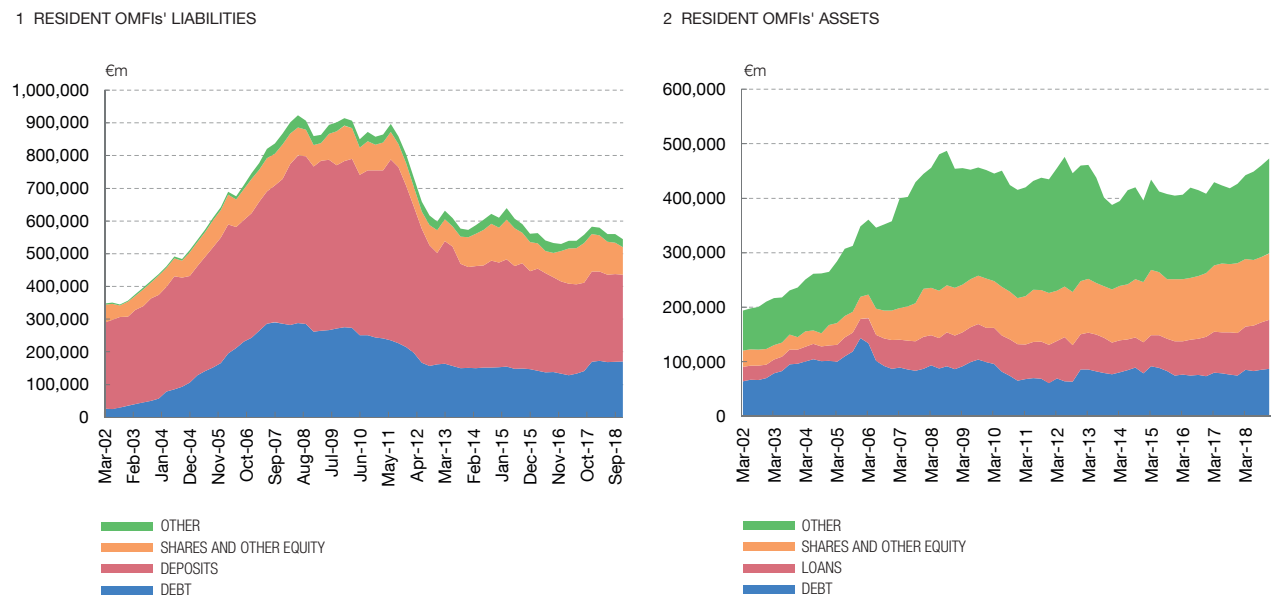
3.2 Exposures to the Rest of the World

Chart 3 depicts the interconnectedness of Other Monetary Financial Institutions (OMFIs)[10] with the rest of the world: claims on and liabilities to financial and non-financial agents of other countries. The lack of more granular data in the Financial Accounts for this broad category and the absence of information on the sector to

10 OMFIs include banks, specialised lending institutions, the Spanish Official Credit Institute (ICO) and money market investment funds.

Chart 4

RESIDENT OMFIs, LIABILITIES TO AND ASSETS WITH THE REST OF THE WORLD, BREAKDOWN BY INSTRUMENT



SOURCE: *Financial Accounts of the Spanish Economy* (July 2019) - Banco de España.

which the counterparties belong make it impossible to distinguish the non-resident sectors with which these linkages are established.

The chart shows how the interconnections between resident OMFIs and agents domiciled in other countries evolved between December 2002 and December 2018. The blue lines depict the change in liabilities by volume (left-hand axis, dark blue line) and as a percentage of their total financial assets (right-hand axis, light blue line). The red lines depict the change in financial assets by volume (left-hand axis, dark red line) and as a percentage of their total financial assets (right-hand axis, light red line).

As the chart shows, while assets with the rest of the world have recorded a more stable trend, liabilities have declined in value since the crisis. Currently, liabilities to the rest of the world account for 22% of OMFIs' total financial assets, while claims on the rest of the world account for 19%. A slight decline is observed in resident OMFIs' liabilities to the rest of the world in the last year and an increase in claims compared with December 2017.

Chart 4 depicts these changes by type of instrument. In this respect, on the liabilities side, deposits from the Rest of the World (49%) stand out, and on the assets side, the Other category (37%) which are mainly Spanish banks' deposits at non-resident entities. These are also the two instrument categories that define the changes observed both in liabilities (a decline in deposits since the crisis) and claims (in this case, also shaped by the growth in shares and investment fund units).

3.3 Available data sources

Direct interconnectedness between resident financial sectors seems relatively limited, but it could entail vulnerability according to the degree of concentration and typology. However, the lack of granularity of the data held in the Financial Accounts impedes more in-depth analysis.

Moreover, the rest of the world data do not permit identification of the foreign financial sectors interconnected with the resident financial sectors. The fact that neither the entities responsible for this interconnectedness nor their nationality can be identified makes it impossible to assess their significance for financial stability or determine which are the relevant transmission channels. These problems are in keeping with those identified by:

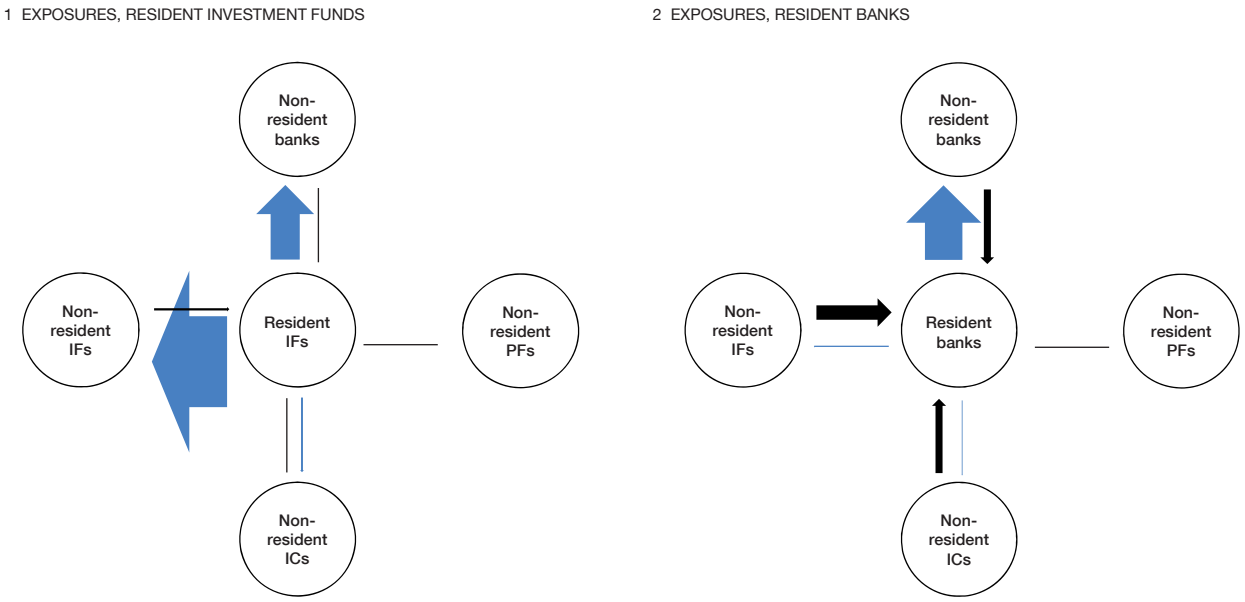
1 The FSB, which in its *Assessment of Shadow Banking Activities* prepared for the G20 (July 2017) set out recommendations for addressing data gaps and improving supervision of the non-bank sector. One of the main recommendations was to improve the granularity of the data on cross-border interconnectedness.

2 The ESRB, which in its annual *EU Non-bank Financial Intermediation Risk Monitor* identifies four key risks or vulnerabilities (see July 2019 report). One of these is always interconnectedness and the risk of contagion across sectors (both at the domestic and the cross-border level). Another is data gaps, with specific mention of the gaps that need to be addressed to better understand interconnectedness and contagion risk.

To solve these problems, other data sources in addition to the Financial Accounts are needed. For this purpose we have explored the SHSS database, which has additional information on types of interconnectedness (instruments) and counterparties (including foreign counterparties). Moreover, as will be seen in the next section, these data permit analysis of indirect interconnectedness. This complements the work on direct interconnectedness, helping to better understand the possible contagion risks and vulnerabilities in the financial sector.

The SHSS database contains granular data, on a security-by-security basis, on euro area financial agents' holdings of securities. It permits identification of almost all holdings at the sectoral level and provides data on a series of key variables associated with each holding (such as instrument type, maturity, country and sector of issuer and holder and market or issue value on each date). The database does not have information on loans granted or deposits held by financial sectors and does not include unlisted equity instruments.

Figure 2
EXPOSURES TO NON-RESIDENT FINANCIAL SECTORS



SOURCE: SHSS.
NOTE: The abbreviations IFs, ICs and PFs denote investment funds (money market and non-money market funds), insurance companies and pension funds.

The data provide, among other things, more information on direct interconnectedness, as they include domestic financial sectors' holdings of securities issued by both domestic and foreign financial sectors. Accordingly, they complement the information provided by the Financial Accounts, especially on interconnectedness with Rest of the World financial sectors.

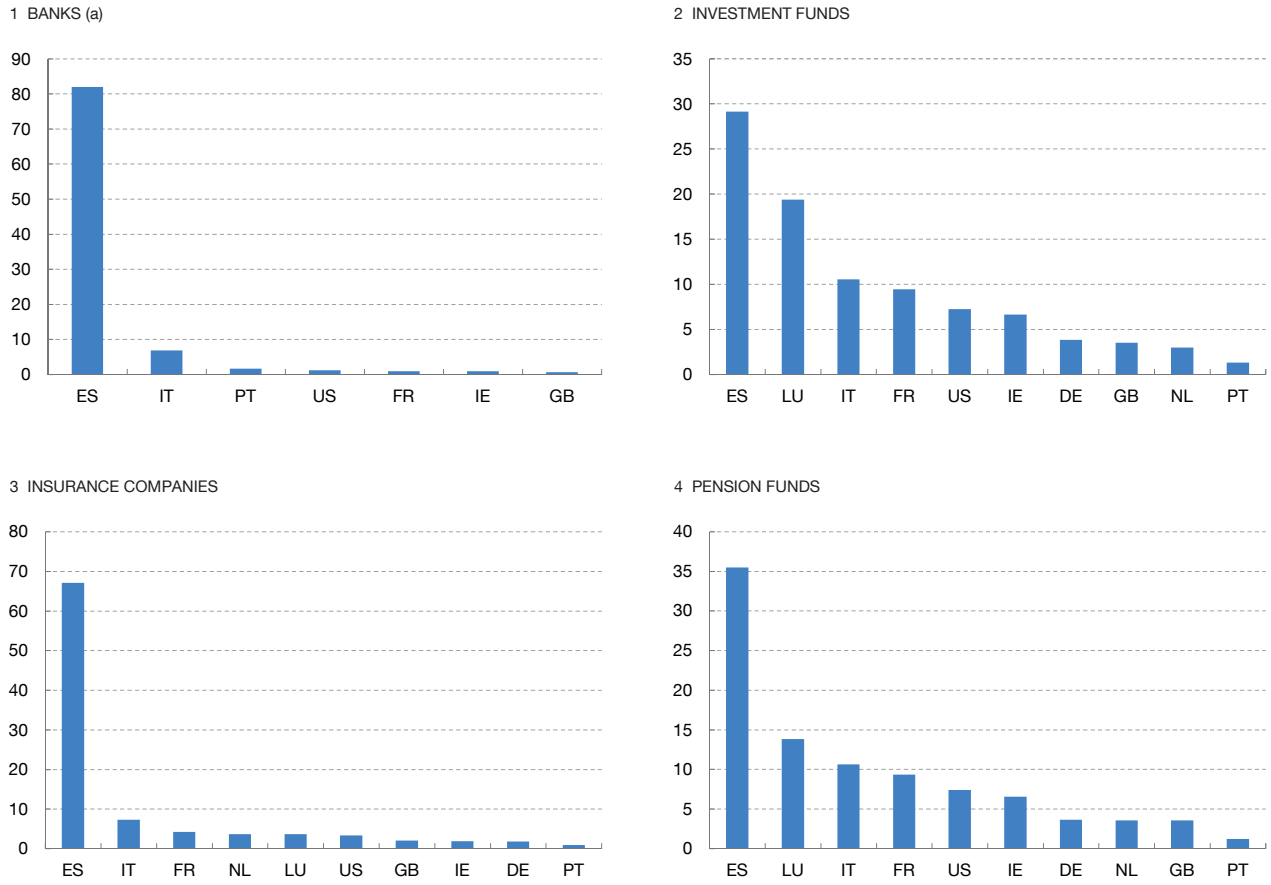
By way of illustration, Figure 2 shows: (i) instruments issued by investment funds and banks domiciled in Spain (their liabilities) and held by foreign financial institutions (black arrows); and (ii) resident funds' and banks' holdings (assets) of instruments issued by non-resident sectors (blue arrows), in both cases at December 2018. The value of the holdings is market value; the thickness of the arrows is proportional to the scale of the interconnectedness (the volume of exposures that each sector holds to the others).

Figure 2.1 depicts the direct interconnectedness between investment funds domiciled in Spain and other sectors of the non-resident financial system. The largest direct cross-border linkages by volume – amounting to €70 billion – are through instruments held by resident investment funds and issued by non-resident investment funds.

Figure 2.2 depicts the direct interconnectedness between banks domiciled in Spain and other sectors of the non-resident financial system. In the case of resident banks,

Chart 5

MAIN ISSUERS OF RESIDENT FINANCIAL SECTORS' HOLDINGS (% OF TOTAL PORTFOLIO)



SOURCE: SHSS.

a Includes own shares (with the information available in the database it is not possible to distinguish issues retained by banks).

the largest linkages in terms of volume – €29 billion – are through their holdings of instruments issued by non-resident banks.

Both figures show that the main direct cross-border linkages are through resident entities' holdings of instruments issued by non-resident entities. However, some significant linkages are also observed in the opposite direction, such as instruments issued by banks domiciled in Spain held by non-resident investment funds.

The SHSS data permit identification of the specific securities in the different sector portfolios, including both the sector and the nationality of each agent. In this respect, Chart 5 shows some of the most significant issuing countries in the portfolios of the four resident financial sectors analysed (banks, investment funds, insurance companies and pension funds), calculated as a percentage of the total portfolios of each of these resident sectors.

As the chart shows, the main issuers of all four sectors' holdings are Spanish. This is especially so in the case of banks (more than 80% of their holdings) and insurance companies (almost 70%). Investment funds are the most diversified sector by issuer country, with issuers from six countries (Spain, Luxembourg, Italy, France, the United States and Ireland) accounting on aggregate for more than 5% of the portfolios. These issuers also have certain features in common by sector: the general government sector is generally a major issuer in Spain or Italy, while investment funds are the main issuers in Luxembourg or Ireland.

4 Indirect interconnectedness

As indicated at the beginning, there may be different types of indirect interconnectedness between financial sectors. For example, they may hold exposures to the same issuers or group of issuers (portfolio overlap), the distribution of securities in their portfolios may be very similar (portfolio correlation), or they may form part of the same collateral chains, belong to the same corporate groups or be exposed to reputational risk owing to financial backing provided aside of contractual relationships. Here we will cover the first two aspects.

4.1 Portfolio overlap

Different financial sectors hold similar securities (issued by financial or non-financial sectors) in their portfolios. These are the common holdings that give rise to what is known as portfolio overlap, which may become a contagion mechanism.[11] For example, in the event of a shock in the investment fund sector, investment funds may need to sell assets that are also held by banks or insurance companies. These fire sales may drive down the prices of these assets, prompting valuation losses for other sectors, with the corresponding implications for financial stability.

Figure 3.1 shows, at December 2018, the common securities holdings for four sectors of the Spanish financial system (banks, insurance companies, investment funds and pension funds). The size of the circles is proportional to the size of each sector's portfolio. The figure shows, for each sector, the volume of holdings they have in their securities portfolio that are also held by each of the other three sectors (the analysis reflects the overlap on a security-by-security basis).[12] Each arrow denotes, for the sector from which it starts, the volume of common holdings

11 For more details, see reference in footnote 3.

12 For example, if a bank and an investment fund hold in portfolio the same debt security issued by a non-financial company (identified through its ISIN, a unique code assigned to each issue), the amounts of that issue held by the bank and the investment fund are counted to measure portfolio overlap.

with the sector to which it points. As each sector holds a different amount of the overlapping exposures, the arrows are not symmetrical. The figure also shows these volumes as a percentage of the total sector portfolios; the thickness of the lines denotes the scale of the holdings. For instance, of the common holdings (identical securities issued by the same issuer) between banks and investment funds, banks hold some €284 billion (blue arrow), which is 47% of their total portfolio, while investment funds hold €114 billion (green arrow), which is 47% of their total portfolio. In both cases, based on the market value of the holdings reported by the entities (or, where appropriate, their fair value).

As the figure shows, the banking sector has the largest portfolio (the largest circle).[13] In consequence, it is also the sector that has most common holdings with the other sectors by volume. The most significant linkages are with investment funds (€284 billion), insurance companies (€276 billion) and pension funds (€274 billion), which account for 47%, 45% and 45%, respectively, of the banking sector portfolio.

The insurance company sector has the second largest number of common holdings with the other sectors (€510 billion, mainly with banks and pension funds). In addition, these common holdings are significant in relative terms for the insurance company sector portfolio, since by volume the securities that insurance companies share with banks, pension funds and investment funds amount to 69%, 76% and 59%, respectively, of the portfolio.

In relative terms, these holdings are also particularly significant for pension funds, since the securities they share with banks, insurance companies and investment funds amount to 56% 78% and 85%, respectively, of the pension fund sector portfolio. However, since this is the smallest of the four sectors analysed, these are the smallest common holdings by volume (€244 billion).

Figure 3.2 shows the same information as at March 2014.[14] At that date, for instance, of the common holdings (identical securities issued by the same issuer) between banks and investment funds, banks held some €452 billion (blue arrow), which was 55% of their total portfolio, while investment funds held €104 billion (green arrow), which was 68% of their total portfolio.

Comparing Figures 3.1 and 3.2 shows that while the banking sector's portfolio has decreased in size (by 26% between the two dates), the other sectors' portfolios have grown (especially those of investment funds and insurance companies, by 59% and 57%, respectively).

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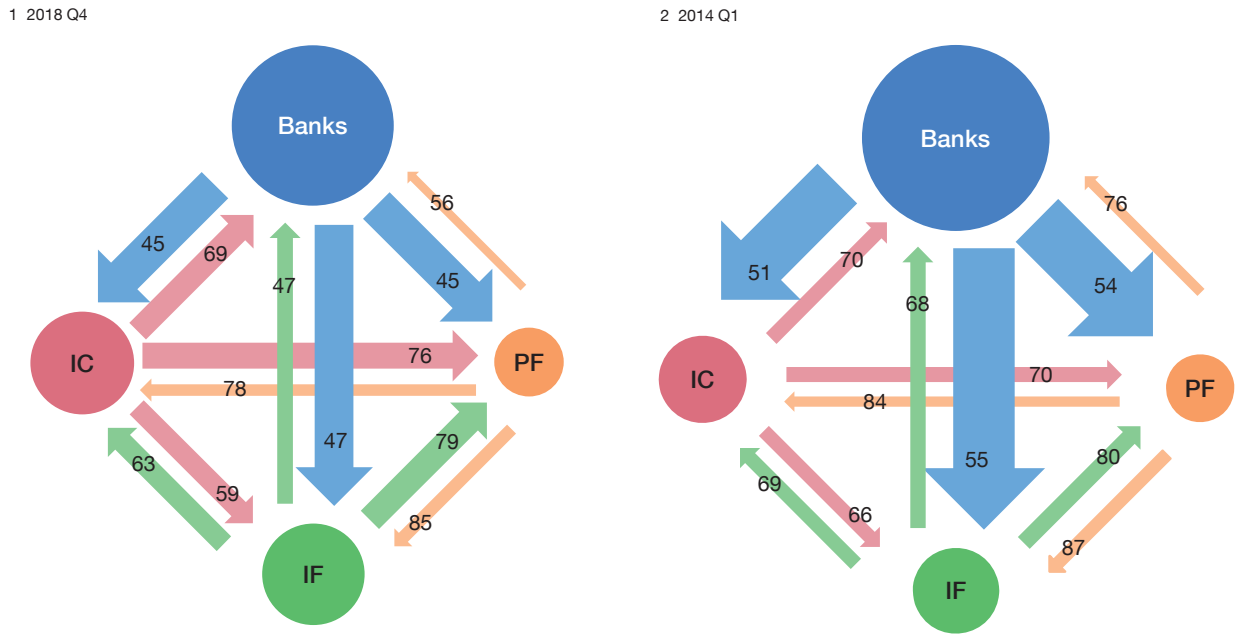
13 As indicated earlier, the bank portfolio includes retained issues (such as securitisations) that cannot be excluded using SHSS data.

14 Data compilation for creation of the database became compulsory in 2013 Q4.

Figure 3

FINANCIAL ENTITIES' PORTFOLIO OVERLAP (a)



SOURCE: SHSS.

a Sectors: banks, insurance companies (IC), investment funds (IF) and pension funds (PF).

These changes also shape the changes in the volume of common holdings. Thus, while the banks' common holdings with each of the other sectors have decreased, the opposite is true for the other sectors (except in the case of pension funds' common holdings with banks which have fallen by 13%). This growth is especially significant in the case of insurance companies, whose total common holdings with the other sectors increased by 56%.

The change in the share of these common holdings as a proportion of each sector's total portfolio may also be analysed. In relative terms, this analysis shows a widespread decrease (save in the case of insurance companies' common holdings with pension funds, which rise from 70% to 76%). The common holdings of investment funds and pension funds with banks reflect the most pronounced declines in share, from 68% to 47% of investment funds' portfolio and from 76% to 56% of pension funds' portfolio.

To conclude, these data suggest that as the banking sector's portfolio has shrunk, so have its common holdings with the other sectors (a decline of 36%). The opposite is true for the other sectors, whose portfolio size and common holdings have increased. However, the relative share of these common holdings in portfolio has declined in all sectors. Insurance companies are the sector least affected by this decline: the volume of securities they hold in common with banks and investment funds has fallen only

slightly, from 70% to 69% and from 66% to 59%, respectively, while the share of their common holdings with pension funds has increased.[15]

Portfolio overlap on a security-by-security basis offers an incomplete picture of indirect interconnectedness. This exercise does not include exposures to the same issuer through holdings of different securities (for example, debt securities or equity instruments). Calculated for the total holdings of securities issued by each issuer, portfolio overlap would be larger.

4.2 Portfolio correlation

Data on securities holdings may also be used to calculate other measures of similarity between portfolios and how they evolve. For instance, by calculating the correlation coefficient of the holdings of each sector pair on each date it is possible to estimate the extent of similarity of the distribution of the securities in their portfolios.[16] This measure does not depend on portfolio size and, therefore, is not affected by the differences in total volume of each sector's holdings.

A positive correlation between two sectors would suggest, for example, that holdings whose volume is above the average of the portfolio total in one sector would generally also have a higher than average value in the portfolio of the other sector. Conversely, a negative correlation would suggest that holdings whose volume is below the portfolio average in one sector would have a higher than average value in the other sector. In addition, the smaller the dispersion of the value of the holdings in each portfolio around their average value, the greater the correlation between the portfolios.

Chart 6 shows the change in the correlation coefficients between 2013 Q4 and end-2018. The highest correlation observed, throughout the period analysed, is between the portfolios of investment funds and pension funds. Moreover, while for all other pairings the correlation has decreased, between investment funds' and pension funds' portfolios it has remained steady around 60%.[17]

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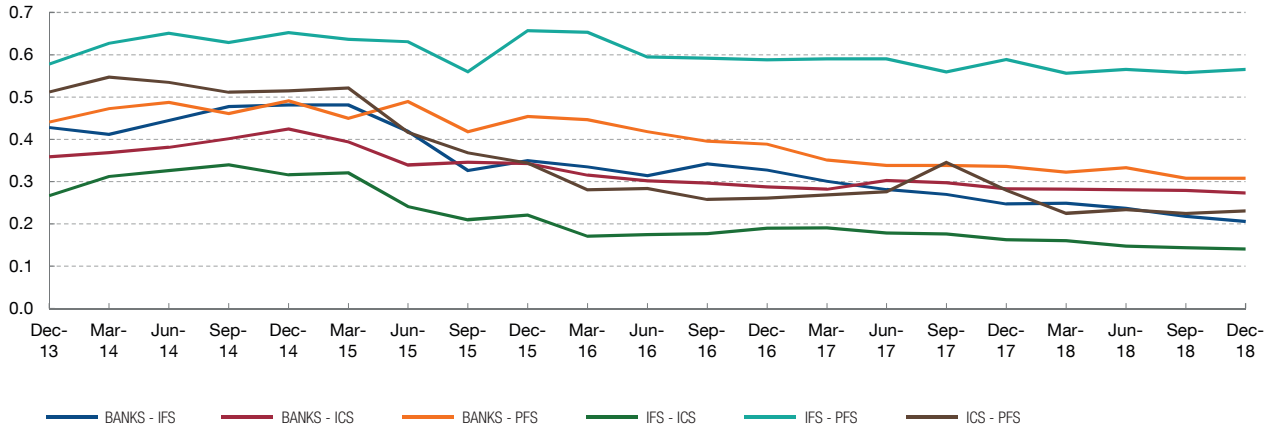
15 See Annex 2 for the changes over time in these common holdings, both by volume and as a proportion of each sector's portfolios.

16 The Pearson correlation coefficient is calculated between each sector pair on each date, using the market value of the holdings of each individual security (expressed in euro) in the portfolio of the financial sectors. The correlation coefficient is defined as the ratio of the covariance of the holdings of each sector pair to the product of the variances of those holdings on each date.

17 As when measuring portfolio overlap, if the correlation is calculated at the level of issuers (grouping together all securities issued by a single issuer), the correlation coefficients between the different sectors' portfolios could be higher.

Chart 6

CORRELATION COEFFICIENTS BETWEEN SECTOR PORTFOLIOS (2014-2018)



SOURCE: SHSS.

5 Future work

In recent years much work has been focused on analysing the different components of the financial system. But a more granular analysis is needed, to identify the specific areas where risk may be higher. To date, the lack of more granular databases precludes this type of analysis. For instance, it was impossible to identify specific entities in the interconnectedness network, or the instruments that defined the linkages, or the non-resident sectors linked to resident entities.

The emergence of new databases, such as the SHSS database, makes it possible to begin to explore these issues and to perform more effective analyses, so as to comprehend transmission channels within the financial sector. The granularity of these data allows counterparties to be identified, along with their nationality and the interconnecting instruments. It also facilitates analysis of the indirect linkages that arise as a result of portfolio composition, thus enriching the analysis of the financial system.

This growing data availability facilitates deeper analysis and comprehension of the financial system. To benefit from these possibilities, systematic combination of databases is needed. In addition, the globalisation of the financial system demands greater cooperation and exchange of information between supervisors, to allow the identification of risk and risk transmission channels.

However, despite the growing volume of data available, there are still data gaps that must be addressed. For example, the data used do not provide information on portfolios at the highest level of consolidation, but only data on holdings of resident entities, thus making it impossible to exclude intragroup interconnections. They

need to be combined with information from other databases, which requires sufficient data consistency and granularity.

In addition to addressing these data gaps, deeper analysis of the information available is also needed. For instance, future work should be concentrated on areas such as:

— Identifying and analysing the main issuers of securities that make up common holdings. This would also permit more in-depth analysis of the most important countries and sectors for resident sectors and entities.

— Identifying and analysing the main securities that give rise to interconnections for entities domiciled in Spain.

— Linking these data to data from other sources, to obtain a more complete picture of the interconnectedness of the financial system. This would allow other relevant variables relating to securities holdings to be taken into account, such as the credit rating of the issue or issuer or the sector of activity of the issuers according to the statistical classification of economic activities in the European Union (CNAE). This would help complete the analysis of interconnectedness and would allow bank lending to corporates to be included in the calculation of measures of portfolio similarity.

— Developing models that describe possible contagion dynamics and that may help detect possible financial system vulnerabilities.

6 Conclusions

Analysis of the interconnectedness between the various agents in the financial system is essential to understand the relations between them and the possible transmission channels for the risks generated in each sector. A first step is to comprehend the direct relationships between these agents. In Spain, the importance and size of the banking sector afford it a central role in the financial system. The National Financial Accounts data used to date showed that, at an aggregate level, the volume of interconnectedness was contained and relatively stable.

For a more in-depth analysis and a higher level of detail, additional data sources, such as the SHSS database, may be used. As seen, these data provide complementary information, for example:

— The scale of cross-border interconnectedness is significant and deserves the same level of attention as domestic interconnectedness. At the cross-

border level, Spanish entities' main connections are through resident entities' holdings of instruments issued by non-resident entities. In addition, although the banking sector continues to play a key role at the cross-border level, investment funds also play a significant part in channelling funds and, therefore, they too should be monitored.

— Indirect interconnectedness shows that, despite the banking sector's central role in the Spanish financial system, the share of the other sectors has grown in recent years (the banking sector's common holdings have decreased as the size of its portfolio has shrunk, while the opposite is true for the other sectors). It also suggests that the share of common holdings is significant for the portfolios of some sectors, such as pension funds, and that the correlation between portfolios, calculated on a security-by-security basis, has decreased in recent years.

Analysis of this kind is key from a financial stability standpoint, since once the interconnections have been identified, headway can be made to analyse potential risks and develop measures to address them. For example, the conclusions presented above suggest that non-bank sectors are gaining importance in the Spanish financial system. This makes it essential to progress in the development of macroprudential tools for non-bank sectors, as suggested by various voices within the European Union.[18] There is a pressing need for headway to be made, not only to address possible financial stability risks in these sectors, but also to prevent any decline in the efficiency of the banking sector framework (for example, as a result of regulatory arbitrage).

The scale of cross-border flows also indicates the importance of cooperation and exchange of information between authorities and jurisdictions. In this respect, the work led by the FSB has been key in fomenting analytical work and regulatory developments in the fields of interconnectedness and the non-bank sector. Given the global nature of the financial system, risk analysis and the development of regulatory frameworks also require this global consistency.

18 See the work of the ESRB, the speech given by Philip R. Lane (ex-Governor of the Central Bank of Ireland), "The Management of Systemic Risks: Current Priorities" (27 September 2018), the address given by Mario Draghi (ex-President of the ECB and Chair of the ESRB), "Welcome remarks at the third annual conference of the ESRB"(27 September 2018), or the speech given by Luis de Guindos (Vice-President of the ECB), "Coming to the forefront: the rising role of the investment fund sector for financial stability in the euro area" (12 November 2018).

Brexit: Uncertainties and challenges in the financial sector

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Abstract

The European Union's financial services map is changing as financial institutions relocate ahead of Brexit and financial centres become more dispersed. This transformation has been especially motivated by the uncertainty surrounding the withdrawal process and the possibility of a no-deal Brexit. Added to which there is the lack of definition of the framework for the future relationship.

There has been little discussion of financial services during the exit negotiation process. As no other solution for future relations with the United Kingdom has emerged, this article focuses on the third-country regimes and equivalence. These regulatory frameworks were not designed to address relations with a country that decides to leave the European Union and with which there is extensive cross-border activity. In addition, the possibility of financial services being largely provided by a third country raises concerns regarding appropriate supervision and potential financial stability risks.

In this setting it is more important than ever that the financial markets of the EU27 (exUK) become more deeply integrated. The capital markets union opens up a window of opportunity to curb the market fragmentation that may be prompted by Brexit and fill the role currently played by the UK markets. Brexit has also reopened the debate on the model for integrated European capital markets and the degree of ambition desired for the project.

1 Introduction

Today, the financial services markets of the European Union and the United Kingdom are highly interconnected, a reflection of more than three decades of internal market deepening.

The United Kingdom's financial services exports to the rest of the European Union amount to almost €31 billion, and its financial services imports from the other Member States to approximately €5 billion. The European Union is the United Kingdom's biggest export market for financial services, accounting for 43% of total net exports of these services. In turn, the United Kingdom makes up 24% of the European Union's financial sector, although the figures vary by

market segment[1] [see European Parliament (2017a), TheCityUK (2018) and PWC (2018) on Eurostat data].

This extensive cross-border activity has largely been pursued under EU passporting rights, with no need to establish a subsidiary to gain access to the respective markets. In 2016, the year of the Brexit referendum, 8,008 financial institutions in the European Economic Area (EEA)[2] were using 23,532 European passports to provide financial services in the United Kingdom, while 5,476 financial institutions established in the United Kingdom were using 336,421 European passports to gain access to the EEA [see European Parliament (2017a)].

Given the essentially regulated nature of the financial services industry, much of the current cross-border activity will not be able to continue after Brexit, or it will foreseeably be pursued in a more restricted, unstable and/or costly environment.

Numerous financial institutions have anticipated the consequences of the break-up, expanding structures already in place or setting up new legal entities that will grant them continued access to the respective markets. Thus, despite the costs that this entails, financial institutions are relocating operations, assets and staff. This is especially significant in the case of the United Kingdom, where many international groups have their European headquarters. By March 2019, when the United Kingdom was originally set to leave, 39% of the 222 largest financial services firms with significant operations in the United Kingdom had opted to relocate part of their business to the European Union. The assets transferred are estimated at almost £1 trillion, with some 7,000 employees affected [see EY (2019) and New Financial (2019)].

This incipient transformation of the European financial map is a direct consequence of the high level of uncertainty surrounding the Brexit process.[3]

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1 The United Kingdom's share of EU financial markets is higher in asset management (41%) than in the banking sector (26%) or insurance (22%). In infrastructures it plays an essential role; thus, for example, the United Kingdom accounts for more than three-quarters of euro-denominated interest rate derivatives clearing activity in the European Union [see European Parliament (2017a) and PWC (2018) on Eurostat data].

2 The EEA comprises all EU Member States, plus Norway, Liechtenstein and Iceland which participate fully in the EU internal market. These three countries are, in turn, members of the European Free Trade Association (EFTA), together with Switzerland which does not belong to the EEA.

3 On 25 November 2018, the European Council endorsed the draft Withdrawal Agreement and approved the Political Declaration setting out the framework for the future relationship between the European Union and the United Kingdom. The Withdrawal Agreement had to be ratified by 30 March 2019, which was the original date set for the United Kingdom to leave the European Union according to the deadline envisaged in Article 50 of the Treaty on European Union (TEU). However, on 20 March 2019 the United Kingdom submitted a request for an extension of that deadline, provided for in Article 50(3) TEU, up to 30 June. That extension was approved by the European Council up to 12 April or 22 May 2019, according to when the House of Commons approved the Withdrawal Agreement. In view of the difficulties for the Withdrawal Agreement to be passed by the House of Commons, on 5 April 2019 the United Kingdom submitted a request for a further extension. On 11 April 2019 the European Council agreed to a further extension up to 31 October 2019.

More than three years since the Brexit referendum, it is still not certain when the present regulatory framework will cease to apply, either in the near term or in several years' time, nor whether the move towards a new framework – yet to be determined – will be abrupt or eased by a transition period.

Added to the political uncertainty is the fact that the negotiations have barely touched on financial services.

There are no specific provisions in the Withdrawal Agreement on the financial sector, for example to ensure the continuity of financial transactions or resolve unwanted situations arising as a result of Brexit. Accordingly, although the Withdrawal Agreement guarantees the status quo for a time-limited transition period,[4] at the end of that period there is a risk of disruption for the financial sector. This could be mitigated in some subsectors insofar as the European Union and the United Kingdom first recognise their respective equivalence (see section 3).

The Political Declaration setting out the framework for the future relationship between the European Union and the United Kingdom attached to the Withdrawal Agreement[5] provides no more than a glimpse of the outline of the possible future regime for access to the respective financial markets, which is expected to have the equivalence regimes at its core.

Accordingly, the specific framework for access and the definitive consequences of Brexit will not be known until there is an agreement on the future framework.

It seems unlikely, however, that such an agreement will be reached in the near future. The European Union has refused to enter into formal talks on the future relationship until after the Withdrawal Agreement has been ratified.[6] Moreover, owing to the scope and the political and economic implications of the framework for the future relationship, these negotiations are far more complex than has been the case for any other international agreement entered into so far by the European Union.[7] In this case national interests will be paramount, so perhaps

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After negotiation of a revised text of the Withdrawal Agreement and, specifically, of the Protocol on Ireland and Northern Ireland, and of the Political Declaration setting out the framework for the future relationship between the European Union and the United Kingdom, on 29 October 2019 the European Council, in agreement with the United Kingdom, approved a further extension up to 31 January 2020.

4 The Withdrawal Agreement provides for a transition period (initially up to 31 December 2020, although it may be extended by up to two years) during which the European Union will treat the United Kingdom as a Member State, but without the right to participate in EU institutions and governance structures.

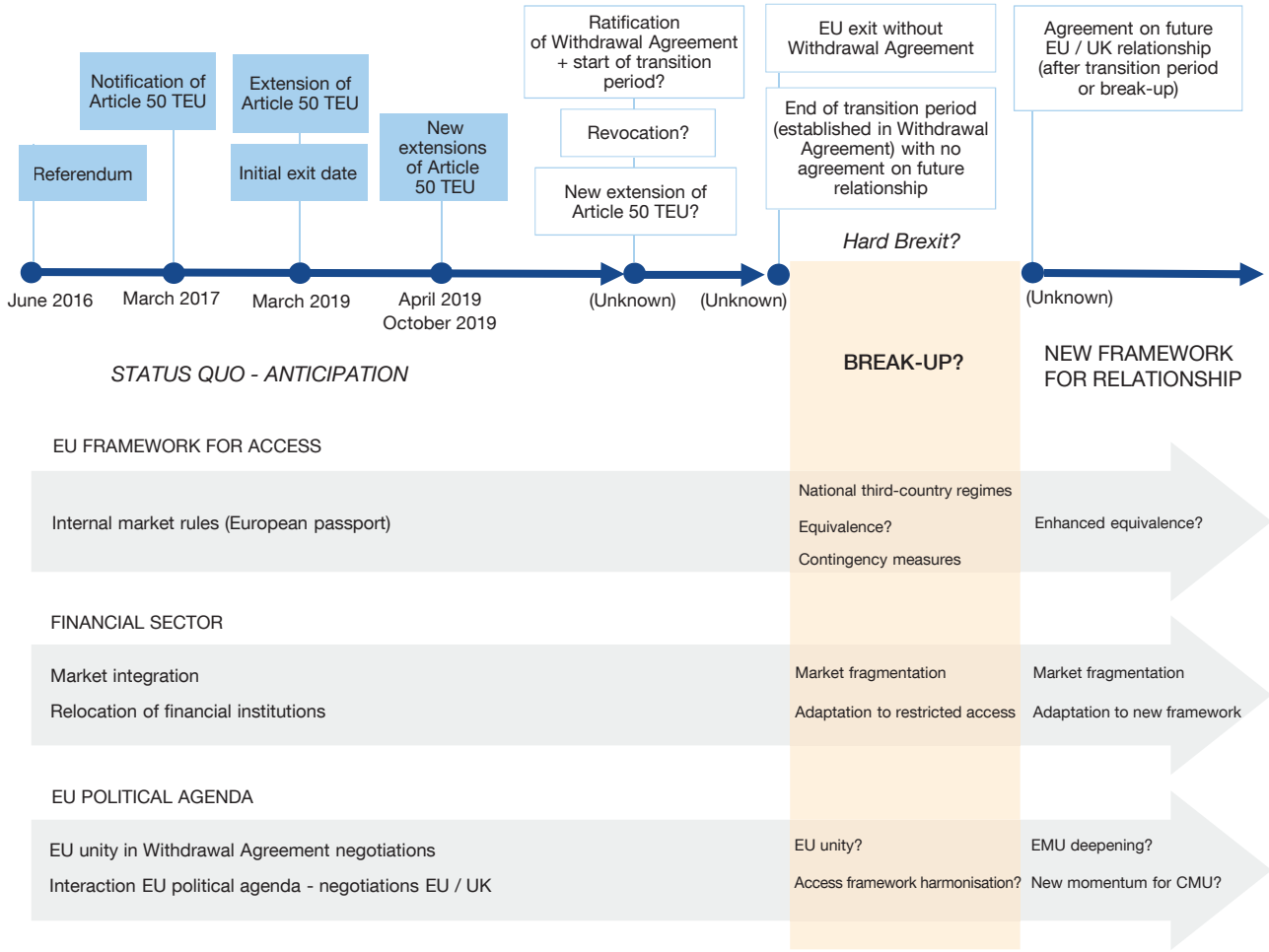
5 See footnote 3.

6 See European Council conclusions of 13 December 2018.

7 The process for approval of the most ambitious trade agreement entered into to date – the Comprehensive Economic and Trade Agreement between the European Union and Canada (CETA) – ran for seven years from the start of the talks. This may serve to indicate the difficulties that defining the even more complex framework for the relationship between the European Union and the United Kingdom will involve.

Figure 1

BREXIT: UNCERTAINTIES AND CHALLENGES IN THE FINANCIAL SECTOR



SOURCE: Devised by authors.

we cannot expect the same level of unity between the Member States as has been observed to date. Considering also the need for a unanimous Council decision on international agreements of this kind, and the particularities of the different national ratification processes, it seems unlikely that the framework for the future relationship may come into force in the near future. In this respect, it would be desirable for financial services to be subject to a specific agreement not depending on progress in other areas. Paragraphs 118 and 119 of the Political Declaration (agreements outside the general agreement, with their own governance) appear to envisage this possibility.

We are faced, therefore, with a highly uncertain situation, characterised by prolongation of a more or less imperfect status quo, combined with a risk of

disruption until a new framework for the relationship between the European Union and the United Kingdom is in place.[8]

This prolonged uncertainty is not only transforming the financial map, but it is also reflected in the European Union's political agenda.

The influence of Brexit on some of the legislative initiatives is evident. This is the case, for instance, of moves to strengthen the supervision of central clearing counterparties (CCPs) or make changes to the prudential framework for investment firms, and of the Commission's proposal to involve the European Supervisory Authorities (ESAs) in the monitoring of equivalence decisions [see European Parliament (2019)].

This influence is also especially evident in the case of the capital markets union (CMU), a project which, as analysed below, should be revitalised to strengthen EU capital markets after Brexit.

2 Frameworks for access for third-country financial institutions

In the absence of an agreement, once the framework for access for third-country financial institutions is applied to British financial institutions, their access to EU financial markets will be much more limited, restricted and fragmented than at present under the European passport regime.

In order to gain access to EU financial markets, British financial institutions, as third-country institutions, will have to establish a subsidiary in a Member State (and operate throughout the European Union through that subsidiary under EU passporting rights) or obtain authorisation in each Member State in which they wish to provide services. In this case, they will have to check, on a case-by-case basis, if it is possible to provide a specific financial service in the Member State concerned, and on what conditions. As an alternative form of access, some EU regulations allow third-country financial institutions to provide certain financial services throughout the European Union on the basis of the authorisation granted by the competent authorities in their home country in cases where the regulatory and supervisory framework is recognised as equivalent by the Commission.

8 Unless the United Kingdom revokes its decision to withdraw from the European Union. The Court of Justice of the European Union (CJEU) has ruled that this is possible for as long as the withdrawal has not taken place [see Wightman and others (Case C-621/18)].

Table 1
FRAMEWORKS FOR ACCESS TO EU FINANCIAL MARKETS

Framework	Legal provisions	Financial institutions	Access		Authorisation
			Services	Territory	
Passport	EU	EU institutions	All (in principle)	EU	Home Member State
Equivalence	EU	Third-country institutions	Limited	EU (in principle)	Third country (+ equivalence decision)
National regimes	Member State (+ EU limitations)		Limited	Member State	Host Member State

SOURCE: Devised by authors.

2.1 National third-country regimes

The provision of financial services in the European Union by third-country institutions is essentially subject to national regimes and conditions. By and large these national regimes are not harmonised and nor are they subject in general to strict limitations at EU level.

Thus, for example, CRR II[9]/CRD V[10] allow Member States to authorise third-country branches in their respective countries but they make no mention of direct provision of services from third countries. In turn, MiFIR[11]/MiFID II[12] allow Member States to decide on the provision in their respective countries of investment services to professional clients and eligible counterparties by third-country institutions, for as long as the Commission does not adopt an equivalence decision. By contrast, under the Payment Services Directive, only Member States' institutions may provide payment services in the European Union.

9 Capital Requirements Regulation II. Regulation (EU) 2019/876 of the European Parliament and of the Council of 20 May 2019 amending Regulation (EU) No. 575/2013 as regards the leverage ratio, the net stable funding ratio, requirements for own funds and eligible liabilities, counterparty credit risk, market risk, exposures to central counterparties, exposures to collective investment undertakings, large exposures, reporting and disclosure requirements, and Regulation (EU) No. 648/2012.

10 Capital Requirements Directive V. Directive (EU) 2019/878 of the European Parliament and of the Council of 20 May 2019 amending Directive 2013/36/EU as regards exempted entities, financial holding companies, mixed financial holding companies, remuneration, supervisory measures and powers and capital conservation measures.

11 Markets in Financial Instruments Regulation (EU) No. 600/2014 of the European Parliament and of the Council of 15 May 2014 on markets in financial instruments and amending Regulation (EU) No. 648/2012.

12 Markets in Financial Instruments Directive 2014/65/EU of the European Parliament and of the Council of 15 May 2014 on markets in financial instruments and amending Directive 2002/92/EC and Directive 2011/61/EU.

Within these limitations, national regimes are essentially heterogeneous and do not grant the freedom to provide services or the right of establishment in other EU Member States. Some Member States do not allow third-country institutions to provide certain financial services in their countries, or if they do, they require some form of physical presence, or place limits on the type of clients to whom the services may be provided, or establish other conditions. The scope of supervisory powers also varies; they may be focused on prudential supervision, or they may have other objectives such as, for example, investor protection. In consequence, the level of scrutiny over institutions varies considerably according to the Member State in which they provide their services.

2.2 Equivalence regimes

In cases where it is provided for in the applicable sectoral regulations at EU level and has been effectively recognised by the European Commission, equivalence grants third-country financial institutions more uniform, albeit limited, access to EU financial markets.

Equivalence is the process whereby the Commission assesses and determines that a third country's regulatory and supervisory framework is equivalent to that of the European Union. An equivalence decision enables EU competent authorities to recognise the third country's framework for the purposes of assessing compliance with certain EU regulatory or supervisory standards. Specifically, equivalence regimes prevent duplication of obligations and allow for a less burdensome prudential regime to be applied or for access to be granted to EU markets [see European Commission (2017a)].

There is no single equivalence framework for all financial services; rather, each sectoral legal act determines its respective scope, the criteria and conditions applicable and the process for granting of equivalence.

Equivalence permits only partial access to EU financial markets. Many core banking or financial services, such as deposit taking, lending or provision of investment services to retail customers are not covered by an equivalence-based regime for market access. In addition, some equivalence regimes allow Member States to apply exceptions and thus limit the possibility of financial services being provided in their countries.

Also, some equivalence frameworks include extra conditions for institutions or other market participants that effectively place constraints on access for third-country institutions. This is the case, for example, of the requirement for registration with or

Table 2
DIRECT ACCESS TO EU MARKETS UNDER EQUIVALENCE REGIMES

Sector	Direct access to EU markets under equivalence regimes	
	Professional	Retail
Banking (lending/deposit-taking)	No	No
Payment services	No	No
Investment services	Yes	No
Alternative investment funds	Yes	No
Undertakings for the collective investment in transferable securities (UCITS)	No	No
Regulated markets (MiFID)	Yes	
Market infrastructures (EMIR)	Yes	
Credit rating agencies	Yes	
Central securities depositories	Yes	
Trade repositories	Yes	
Financial benchmarks	Yes	

SOURCE: European Parliament (2019). "Third country equivalence in EU banking and financial regulation", In depth analysis, March.

recognition by the ESMA (MiFID II, CSDR[13]) or of the imposition of certain substantive provisions (AIFMD[14]).

Accordingly, if British financial institutions become subject to equivalence regimes, even if combined with national access frameworks, it is difficult to envisage how the current level of UK-EU trade relations will be maintained [see Hohlmeier and Fahrholz (2018)].

The European Commission (DG FISMA) is responsible for assessing equivalence, with the technical support, where envisaged, of the ESAs (EBA, ESMA, EIOPA).[15] The assessment generally also includes dialogue with the competent authorities of the third country. The Commission has no set time period for this process, which generally runs for two to four years before the relevant administrative decision is taken.[16] Equivalence decisions may be granted for an indefinite or time-bound duration [see European Commission (2017a)].

13 Regulation on settlement and central securities depositories. Regulation (EU) No. 909/2014 of the European Parliament and of the Council of 23 July 2014 on improving securities settlement in the European Union and on central securities depositories and amending Directives 98/26/EC and 2014/65/EU and Regulation (EU) No. 236/2012.

14 Alternative Investment Fund Managers Directive 2011/61/EU of the European Parliament and of the Council of 8 June 2011 on Alternative Investment Fund Managers and amending Directives 2003/41/EC and 2009/65/EC and Regulations (EC) No. 1060/2009 and (EU) No. 1095/2010.

15 European Banking Authority, European Securities and Markets Authority and European Insurance and Occupational Pensions Authority.

16 Equivalence decisions may take the form of a Commission Delegated Decision (thus granting some voice to the European Parliament) or a Commission Implementing Decision (involving the representatives of the Member States on the corresponding regulatory committee).

The decision whether or not to grant equivalence is ultimately at the discretion of the Commission, which is free to launch the process and to amend or revoke the equivalence granted. This offers market operators little certainty.

2.3 Implementing third-country regimes in the context of Brexit

Applying third-country regimes to British financial institutions poses varies difficulties and challenges for the European Union.

The European Union and the Member States have already had to address the disruptive effects of a possible no-deal Brexit with no transition period to allow institutions and other market players to adapt to the new situation.

The European Commission has adopted a limited number of contingency measures to mitigate significant disruptions in strictly defined areas where public measures at the European level were considered necessary. In the financial field, the Commission has only deemed it necessary to adopt measures to address financial stability risks relating mainly to the derivatives markets.[17]

Individual Member States have taken a relatively disparate approach, guided solely by a series of general principles set out by the European Commission in successive Communications on Brexit preparedness [see European Commission (2018a), (2018b), (2018c), (2019a), (2019b) and (2019c)].

Not all the Member States have adopted contingency measures for the financial sector. Some have introduced temporary authorisation regimes that will allow British financial institutions to continue to provide mainly investment services in their countries (Italy, Austria, Sweden, Finland, Denmark and Ireland), while others have concentrated on ensuring the continuity of financial services contracts entered into before Brexit. This was the aim of Royal Decree-Law (RDL) 5/2019 of 1 March 2019[18] approved by the Spanish government, which grants British financial institutions a period of nine months from the date of withdrawal to terminate or transfer pre-existing contracts or to request authorisation in Spain to operate as a Spanish or third-country institution.[19] These measures are similar to the contingency measures

17 Specifically, the Commission has adopted two temporary and conditional equivalence decisions, one on CCPs and the other on CSDs, and has drawn up two Delegated Regulations to facilitate the novation of certain derivatives contracts not traded on regulated markets.

18 Royal Decree-Law (RDL) 5/2019 of 1 March 2019 on contingency measures ahead of the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union without the agreement envisaged in Article 50 TEU.

19 The RDL seeks to ensure legal certainty and to safeguard financial stability and the interests of financial services customers. It states that pre-existing contracts will remain valid and with full effect after the United Kingdom's withdrawal, even though British financial institutions will have lost their EU passporting rights [Article 19(1)]. It also sets out the cases where, without prejudice to the above, new authorisation will be

adopted in Germany, which grant British financial institutions a period of 21 months to continue to provide financial services, on the condition that such services are closely related to a pre-existing contract.

With these measures, both the European Union and the Member States have sought to establish a balance between ensuring legal certainty and protecting financial stability, on the one hand, and safeguarding the European Union's negotiating position, on the other. This explains why the main responsibility for making the necessary preparations has been left in the hands of economic operators. It also explains the limited scope of the public measures taken.

Apart from the contingency measures, at a second stage the European Union will also have to address the effects of the widespread use of third-country national regimes by UK financial institutions.

The large-scale provision of certain financial services from outside the European Union raises, in particular, financial stability concerns.

The power to supervise the provision of financial services through branch offices or directly from a third country lies not with the European Central Bank (ECB) but with the national authorities. This could circumvent the ECB's supervisory expectations, designed to ensure, in the context of relocation, that all risks are managed at the local level.[20] National authorities, for their part, lack a complete picture of the activities pursued by third-country institutions in the European Union, and also the capacity or power to respond to aggregate risk in the euro area [see Lautenschläger (2019)]. In this setting, a subsidiary-based market access model that would fully ensure risk management from within the European Union might be appropriate.[21]

Lastly, regulatory fragmentation becomes particularly important when a significant portion of EU financial services is provided from outside the Union. In this respect, Brexit should prompt reflection on the advisability of some harmonisation of the

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required to manage pre-existing contracts and thus ensure their continuity [Article 19(2)]. Moreover, for cases in which new authorisation is required to manage pre-existing contracts, the RDL provides that the authorisation initially granted by the competent British authority will provisionally remain in force for a period of nine months from the date of entry into force of the RDL, to allow institutions to terminate or transfer the contracts or to request authorisation in Spain to operate as a Spanish or third-country institution [Article 19(3)] [see Banco de España (2019)].

20 The ECB has indicated that it will not accept "empty shells" in the banking union and that it will limit practices such as conferring dual responsibilities on managers or providing services to customers in the banking union through branches of banking union institutions in the United Kingdom.

21 The requirement included in CRD V that activities pursued in the European Union by large third-country banking groups be consolidated under EU intermediate parent undertakings (IPUs) is along these lines. This amendment has been welcomed by the ECB, which had however suggested that not only subsidiaries but also branches be included in the IPUs.

national frameworks for market access by third-country institutions, to limit regulatory arbitrage and guarantee the level playing field in the European Union.

3 Framework for the future relationship: enhanced equivalence?

According to the Political Declaration setting out the framework for the future relationship, after Brexit the provision of financial services will be governed by equivalence.

The wording of the Political Declaration envisages a relationship based on autonomous equivalence frameworks that, in short, preserve the respective regulatory and decision-making autonomy of the United Kingdom and the European Union in a setting of close cooperation on regulatory and supervisory matters. On this basis, both parties undertake to keep their equivalence frameworks under review and to cooperate in the process of granting and withdrawal of equivalence decisions that affect them (in a transparent manner and by means of consultation), and in regulatory and other issues of mutual interest (by means of information exchange and consultation).

The European Union and the United Kingdom also undertake to start assessing equivalence with respect to each other as soon as possible after the United Kingdom's withdrawal, endeavouring to conclude these assessments by the end of June 2020. Recognition of equivalence in areas where this is possible would facilitate the transition towards a new framework for the relationship.

The Declaration entails that, in the future, both parties will be free to maintain, extend or limit the activities that may be pursued under an equivalence regime, and ultimately to determine the level of access they wish to grant to third-country institutions. In this respect, there is no specific agreement between the United Kingdom and the European Union that seeks to allow broader access to their respective markets than that envisaged in the current frameworks. In addition, the Political Declaration implies that, in principle, the United Kingdom and the European Union will not grant each other special treatment in terms of access compared with the treatment they generally grant to third countries.

Nevertheless the outlines of the Political Declaration are flexible, so the future framework for relationships may to some extent go beyond the current undertakings. Thus, the United Kingdom and the European Union could eventually agree on a structured cooperation framework that would provide for a high level of financial market integration. In this respect, the undertaking included in the Political Declaration to keep their present equivalence frameworks under review could, in practice, permit consensual or parallel measures between the two parties.

In the end, the level of cooperation achieved will largely depend on the will of both parties to maintain the greatest possible level of access to their respective markets, although this will, in any event, be necessarily far removed from the benefits stemming from participation in the internal market.

Initially the United Kingdom had advocated a system of mutual recognition which, in short, would grant both British and European financial institutions broad and privileged access to their respective markets. More recently, it proposed an enhanced equivalence regime which, among other aspects, would cover a broader range of activities and provide for the implementation of common principles and formal cooperation mechanisms.[22]

Ultimately, from the EU standpoint, the limits lie in the need to preserve the integrity of the internal market. This, in short, is contrary to granting full access to EU markets to third-country financial institutions.

In any event a reflection on the equivalence regimes seems appropriate, in this new environment in which the United Kingdom – to date the European Union's main provider of financial services – will no longer be part of the Union.

Improvements are clearly needed in the process of adoption and withdrawal of equivalence decisions. Some of these improvements are not necessarily linked to Brexit [see European Commission (2017a)],[23] but others are particularly significant in this context. Specifically, insofar as this does not compromise financial stability, extending the scope of the equivalence regimes to new services could be considered. This would make for more uniform access to EU financial markets. Moreover, in a setting in which a significant portion of the demand for financial services is met from outside the Union, ensuring a level playing field for open and fair competition becomes especially important. To this end, equivalence should ensure that third countries' regulations on State aid, competition policy, taxation, environmental issues, labour protection and money laundering are taken sufficiently into account.

4 The future of EU financial markets - CMU

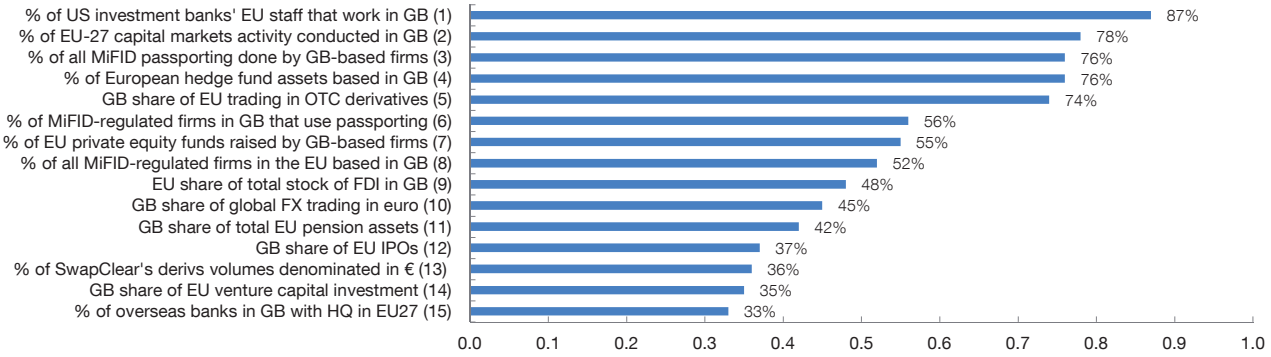
The United Kingdom's withdrawal from the European Union also prompts reflection on the model of financial market integration in the EU-27. There is no question of the influence the United Kingdom has had to date on the governance and functioning of

22 White paper on "The future relationship between the United Kingdom and the European Union".

23 For example, strengthening the role of the supervisory authorities, setting in place mechanisms to monitor ongoing compliance with the relevant regulatory and supervisory standards, or enhancing cooperation with third-country competent authorities.

Chart 1

INTERCONNECTION BETWEEN EU AND GB CAPITAL MARKETS (a)



SOURCES: (1) Bruegel; (2) Oliver Wyman; (3) EBA; (4) AIMA; (5) BIS; (6) Invest Europe; (7) EBA; (8) ONS; (9) BIS; (10) New Financial; (11) New Financial; (12) New Financial; (13) SwapClear; (14) New Financial; (15) Bank of England.

a Chart based on New Financial chart [see New Financial (2016)].

the financial markets. In the present setting, the CMU project becomes more important and delivery needs to be stepped up.

4.1 The CMU-27 project

The CMU is an EU initiative that was launched in 2015, aimed at deepening and integrating EU capital markets. The CMU Action Plan comprises a package of measures to be implemented between 2015 and 2019 [see European Commission (2015)].

Since the start there have been two contrasting views of the CMU model. The first holds that progress has to be gradual, avoiding politically sensitive issues in the short term and eschewing institutional change. From this viewpoint, there would be no need for competencies to be transferred to a single European supervisor, with coordination between national supervisors being upheld as the most practical option. The opposing view holds that deep reforms are needed from the start and should necessarily include some institutional change [see Ständer (2016)].

The outcome of the Brexit referendum had a major impact on the CMU project. The United Kingdom had been one of the main drivers of the CMU and had played a key role in the technical and ideological design of the programme. Jonathan Hill, the British Commissioner in charge of the initiative, resigned following the Leave vote and was replaced by Valdis Dombrovskis. Lord Hill shared the United Kingdom's position advocating gradual progress and opposing institutional change; with the arrival of the new Commissioner the priorities changed [see Quaglia (2017)] and

issues such as harmonisation of the insolvency frameworks, taxation and institutional matters gained protagonism [see Juncker (2016)].

Almost four years since the launch of the CMU progress has been made. This is reflected in how EU capital markets have evolved. For example, shares issued by non-financial corporations have risen as a proportion of EU GDP from 36% in 2014 to 41% in 2018, and debt securities from 8% to 10%. Moreover, the international distribution of investment funds with an EU label has also increased continuously [see European Commission (2019a)].

Yet from the very beginning progress has been slower than might have been expected and the project is far from complete. The European business sector is still highly reliant on bank finance and capital flows remain fragmented by country [see Hernández de Cos (2018)]. A new industry study reveals that recent headway has been limited. Despite the launch of initiatives in the framework of the CMU, in 2018 the ecosystem of the EU capital markets deteriorated and market integration improved only slightly [see AFME (2019)].

Clearly the Brexit vote has had an impact on the pace of capital market integration in the European Union. Since the referendum, European institutions have shifted their attention to the question of how to manage the future relationship with the United Kingdom. This has led to postponement of the approval of some components of the CMU initiative, awaiting the outcome of the negotiations[24] [see Wright, Benson and Hamre (2019)].

4.2 Relaunching the CMU after Brexit

The UK capital market is the largest in the European Union and has been a benefit to the Union overall. Free market participation currently means that the EU27's real economy can access a much higher volume and range of financial resources than are accessible in the EU27 itself.[25] After Brexit, this access to British capital markets could be lost. Figure 4 shows a selection of measures that reflect the high level of interdependence between the United Kingdom and the European Union.

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24 This is the case, for instance, of Regulation (EU) 2017/2402 laying down a general framework for securitisation and creating a specific framework for simple, transparent and standardised securitisation which was delayed significantly in its passage through parliament owing to its possible influence on the negotiations on the Withdrawal Agreement and the framework for the future relationship [see Brunsden and Hale (2017)].

25 On average, the depth of British capital markets relative to GDP is double that of the other EU markets. The depth of the EU27 bond markets is three quarters that of the UK market and that of the equity markets is approximately half that of the UK market [see Wright and Asimakopoulos (2018)].

Moreover, developed capital markets contribute to financial stability, as they weaken the sovereign-bank link and permit cross-border risk distribution. The recent crisis showed how underdeveloped capital markets, combined with a high level of reliance on bank finance, can multiply the negative effects of downturns. In addition, developing private risk-sharing channels can reduce the need to resort to public risk-sharing mechanisms such as fiscal transfers [see Cimadomo et al. (2018)]. Given the difficulties that are thwarting progress towards fiscal union in the euro area, the development of an alternative channel through which adverse shocks may be addressed becomes particularly important.

London is a leading global financial centre for which the EU27 has no clear substitute. In consequence, the business moving out of London since the referendum is not all heading to a single destination. This dispersion is resulting in greater fragmentation of the European financial market.

Against this backdrop it is essential that greater efforts be made to complete the CMU and to fill the role currently played by the British markets. The Commission has repeatedly stressed that the United Kingdom's withdrawal means that delivery of the CMU needs to be stepped up and requires that the work programme be modified [see European Commission (2017b), (2018d), (2019d) and (2019e)].

4.3 CMU model ex-UK

We are now at a key stage of the CMU project. The period for completing the measures envisaged in the 2015 Action Plan ends this year and the future direction the initiative should take must be considered.

It is a question not only of speeding up the pace of progress but also of restarting the project in more ambitious terms. A large portion of European capital market activity is currently supervised by a single body – the United Kingdom's Prudential Regulation Authority – since the bulk of this activity is concentrated in the United Kingdom. This business is now being moved to other parts of the EU27 without a sufficient degree of regulatory and supervisory harmonisation having been achieved [see Sapir et al. (2018)], with adverse consequences for regulatory and supervisory consistency.[26] This aspect is key to ensure that the EU capital market is attractive worldwide. It is vital, therefore, that progress be made in cooperation and coordination between national authorities and that the potential development of centralised supervisory

26 The recommendations suggested by the industry for the next phase of the CMU project include asking the European Union to continue to adopt incremental measures to improve supervisory practices and legal frameworks and achieve further convergence (especially as regards insolvency regimes and securities legislation). A further recommendation is that the European Union facilitate global regulatory convergence [see AFME (2019)].

arrangements for pan-European markets be considered. Possible institutional reform is clearly one of the issues that generates most controversy. An analysis of how the Single Supervisory Mechanism (SSM) has performed may be useful to assess the different options.

A genuine capital markets union will not be possible without headway being made on particularly sensitive political issues such as harmonisation of the insolvency frameworks, taxation or institutional reform. Here the approach must be ambitious, but it must also be realistic and pragmatic, to avoid political deadlock. The work of the Next CMU High-Level Group is a step forward in this respect.[27] The numerous measures proposed by the Group include moves to advance in these politically sensitive areas. Thus, for example, it advocates the harmonisation of insolvency regimes applicable to credit institutions, the implementation of a harmonised procedure for repayment of tax withholdings to investors, and the design of a supervisory framework for the different components of regulated capital markets according to their respective levels of integration [see The Next CMU High-Level Group (2019)].

In addition, practically coinciding with the publication of the conclusions of the above-mentioned Group, the European Commission has called for experts from different sectors to participate in a High-Level Forum on CMU. The Forum has been created to support the Commission in speeding up progress, preparing targeted recommendations.

These initiatives are welcome, but the question of which of the measures suggested are top priority will have to be addressed and those measures will have to be embodied in sufficiently ambitious specific legislative proposals.

It is also essential that capital market developments go hand in hand with advances in other initiatives. The CMU seeks not to replace but to complement bank finance. Accordingly, the project is closely connected and complementary to the banking union project, which is also still incomplete. So progress must continue, and especially in the development of a European Deposit Insurance Scheme (EDIS). Indeed progress is a priority in both initiatives, as they are both key elements for strengthening Economic and Monetary Union (EMU). The European Union's next institutional cycle will be essential to move forward in these two areas.

27 The Group, set up in May 2019 on a proposal from the German, French and Dutch finance ministers, is made up of experts from Germany, France, the Netherlands, Italy, Spain, Poland and Sweden with experience in the public and private sector and in academia. The conclusions were set out in a report published in October 2019.

5 Conclusions

The present third-country regimes and equivalence regime were not designed to handle relations with a country that decides to leave the European Union and with which there is extensive cross-border activity in financial services.

This prompts a reflection on the need for adjustments to be made, to achieve greater harmonisation of third-country regimes and enhanced equivalence. The limits lie in the need to preserve the integrity of the internal market, which is contrary to granting full access to EU markets to third-country financial institutions.

In a scenario of more fragmented financial services as a result of Brexit, the CMU opens up a window of opportunity to move towards greater integration of the EU27. Brexit should serve as an incentive to rethink the financial services model, and at the same time to fill the role currently being played by the British markets. Moreover, the CMU would appear to be the least controversial of the initiatives included in the package of reforms aimed at strengthening EMU.

Considering the uncertainty surrounding the future framework for financial services between the European Union and the United Kingdom, the CMU project should be a priority on the former's political agenda and should be restarted on more ambitious terms.

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Second Financial Stability Conference of the Banco de España and of the CEMFI Madrid, 3 and 4 June 2019

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SECOND FINANCIAL STABILITY CONFERENCE OF THE BANCO DE ESPAÑA AND OF THE CEMFI MADRID, 3 AND 4 JUNE 2019

The Banco de España, in cooperation with the CEMFI, organises a biennial conference on financial stability. The papers presented at it are selected by a scientific committee from those received in response to a call for papers. The committee for the 2019 conference consisted of Ócar Arce (Banco de España), Steven Ongena (University of Zurich), José Luis Peydró (Universitat Pompeu Fabra), Rafael Repullo (CEMFI), Hélène Rey (London Business School), Tano Santos (Columbia Business School), Jesús Saurina (Banco de España), Isabel Schnabel (University of Bonn) and Javier Suárez (CEMFI).

The second conference was held at the headquarters of the Banco de España in Madrid on 3 and 4 June and attended by around 100 participants. The topics broached and discussed included the macroeconomic effects of capital requirements, regulatory implications of the simultaneous bankruptcy of banks and firms, the effects of capital buffers on credit, the effectiveness of macroprudential measures based on borrowers' characteristics, the financial determinants of macroeconomic risk and the relationship between monetary policy and systemic risk, and macroprudential policy.[1]

The opening address was given by Governor Pablo Hernández de Cos and, in addition, there were two keynote speakers: Agustín Carstens, general manager of the Bank for International Settlements (BIS), and the Nobel Prize winner Lars Peter Hansen, of the University of Chicago. There were five sessions of presentations and discussants, followed by a general debate in which the audience participated. The sessions closed with a panel discussion on governance of the institutions responsible for macroprudential policy, chaired by Margarita Delgado, Deputy Governor of the Banco de España. Set forth below, by order of intervention in the conference, is a summary of the addresses by the four speakers mentioned above.

— Pablo Hernández de Cos, in his address entitled "A framework for the CCyB", highlighted the major role that may be played by countercyclical capital buffers (CCyB) in both boom phases and economic recessions. In the first situation, the activation of the CCyB combats excessive credit growth, while in a cyclical downturn the availability of the previously accumulated CCyB reduces the risk of credit contraction by banks and thus helps to mitigate the fall in economic activity and the deterioration of bank profits. Arguably, then, it is desirable to build up (activate) the CCyB in periods of economic growth, even in the absence of excessive credit

1 The conference programme, the papers discussed and the presentations made by the participants are available at the Banco de España website (https://www.bde.es/bde/en/secciones/sobreelbanco/Conferencias/Segunda_Confere_c056e94ac91a661.html).

growth, so as to use (release) the buffer in subsequent recessions. However, taking a broad time perspective, the effects of building up and running down capital buffers are not symmetric.

According to a recent study of 150 years of financial cycles in Spain,[2] an increase of 1% in the CCyB may reduce credit growth in the cyclical downturn by 1% if the buffer is activated before the expansionary phase of the credit cycle, and by 6% if it is activated in the boom phase. The different elasticities indicate that the cost of late activation may be much higher than the cost of early activation. It is also necessary to analyse whether it is better to deactivate the CCyB all at once or gradually. As regards the adoption of decisions, it seems more appropriate to act according to the principle of "guided discretion". This is because an automatic rule would be premature in the current situation, in which the use of macroprudential instruments has been extended to include their interaction with monetary policy, a development which must be studied in depth. The activation of any instrument requires an impact analysis, both an ex ante one including the various options available, and an ex post one studying the efficiency of the tools used.

— Agustín Carstens, in his presentation entitled "The role of regulation, implementation and research in promoting financial stability", highlighted the importance of academic research after the last crisis, because of its contribution to understanding financial stability and designing new regulations. Academic analysis has helped the authorities and, in particular, the Basel Committee on Banking Supervision (BCBS) to identify and assess financial vulnerabilities of both a structural and a cyclical nature. In this way, academia has helped to build a more robust financial system.

Financial regulation has changed significantly following the crisis. Previously the basic element consisted of the capital ratios then in force. The current framework, however, has added major additional elements such as liquidity standards, macroprudential instruments and higher loss-absorbing requirements for systemically important banks. A larger number of measures provides protection from regulatory arbitrage and from the erosion of those measures over time.

The BCBS has made use of academic research to design and calibrate of the post-crisis measures. Specifically, the Committee studied in depth the existing literature on capital requirements and their long-term economic

2 M. Bedayo, Á. Estrada and J. Saurina (2018), *Bank capital, lending booms, and busts. Evidence from Spain in the last 150 years,* Working Papers, No. 1847, Banco de España.

impact, and that on the design of the macroprudential framework, particularly of the CCyB. Academics can enlighten regulators, furnishing the analytical rigour and empirical evidence required by the authorities to implement their policies against financial system vulnerabilities. The agenda of researchers for the near future may take into account the issues that are currently of most concern to regulators most concern, such as the risk appetite of investors in a low interest rate environment, the exposures of the non-bank financial sector, the risks inherent in new financial market players and the risk concentration of central counterparties.

— Lars Peter Hansen presented the paper "Pricing uncertainty induced by climate change", which uses the framework of decision theory under uncertainty to address the challenges posed by research into the economics of climate change. In particular, he highlights three components of uncertainty: risk (with probabilities given by a model), ambiguity (with unknown weights for alternative models) and uncertainty over proper model specification.

  The assessment of potential government policies on, for example, carbon emission taxes, requires the building of structural dynamic models of the relationship between the economy and climate change in which uncertainty plays a key role. The aim is not to provide accurate estimates of how big the adverse effects will be or when they will occur, but rather to analyse the likelihood of major long-term economic consequences that are difficult or impossible to reverse. From this standpoint, waiting until we know exactly what will be the ongoing effect of carbon emissions may mean that the measures to be taken will end up being extremely costly.

— Margarita Delgado emphasised that the model of macroprudential policy governance in the various countries is key to understanding the challenges faced by the authorities. Specifically, the structure in the European countries is particularly complex, with three levels which have to be coordinated: i) the European Systemic Risk Board (ESRB), set up in 2010 to ensure financial stability in the EU; ii) the European Central Bank, which, through the Single Supervisory Mechanism (SSM), has macroprudential responsibilities for the euro area since 2014; iii) national authorities, that in Spain being the Spanish Macroprudential Authority – Financial Stability Board (AMCESFI by its Spanish abbreviation) since March 2019.

  Within the national authorities, the diversity of models in place, the number of institutions participating and the different distribution of tasks among them indicate that there is no optimum model for the design of the authority and of macroprudential policy. Moreover, the decision-making process is

intricate in some countries, with the consequent risk of a potential bias towards inaction by the authorities. The role of governments – acting through finance ministries – in macroprudential policy poses a trade-off between greater legitimacy and greater independence. Against this backdrop, the next financial crisis, come when it may, will be the litmus test of the efficacy of the various governance models.

To wind up, the Deputy Governor underscored the valuable work of the scientific committee and the participants in the various sessions and thanked them for their contribution to the success of the Conference. This biennial event has become a key feature on the Banco de España's calendar, and it is in line with the traditional importance it attaches to financial stability issues, as shown by the many papers published since 2001 in the *Financial Stability Review* and, of course, by the dynamic provisions established to address credit cycles, in force from 2000 to 2016.

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