



RESEARCH UPDATE

Spring 2021

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Welcome to the Banco de España Research Update

The Banco de España is pleased to announce the release of the Spring 2021 issue of its Research Update. The Update aims to inform both academic and policy-oriented economists and financial specialists about publications, conferences, and other research activities at the Banco de España, during the semester from October 2020 to April 2021.

As usual, this issue includes several feature articles summarizing policy-relevant findings from recent Banco de España projects in diverse areas of research. First, J. Andrés, O. Árce and P. Burriel analyse how the dampening of the estimated co-movement between the output gap and inflation noticed in recent decades can be rationalized through a model that incorporates the increase in polarization observed in several industries. Second, D. Serrano-Puente evaluates the optimal progressivity of the Spanish personal income tax scheme through the lens of a general equilibrium model featuring rich household heterogeneity. He finds that there is room for welfare improvement by means of modifying the effective average tax rates, at the expense of efficiency losses. Third, A. Alonso and J. M. Carbó study the economic impact for financial institutions of using machine learning (ML) models for credit default predictions. They find that, although ML models outperform traditional ones, more complex algorithms do not imply better predictions. Fourth, F. Holub, L. Hospido and U. Wagner estimate the impact of air pollution on the incidence of sick leaves on a representative panel of employees affiliated to the Spanish social security system. Controlling for several possible confounding factors, their evidence points towards an impact of air pollution on the incidence of sick leaves, especially for women with pre-existing conditions. Finally, P. García-Perea, A. Lacuesta and P. Roldán-Blanco document that the increase in mark-ups in Spain during the financial crisis can be explained by the response of relatively small and unproductive firms to the drop in their sales and the increase in average costs.

In addition, the Update reports on other research news such as conferences and recent publications, including the Financial Stability Review, a half-year journal published by the Banco de España. This issue also covers an interview with Enrique Moral-Benito, Head of the Sectoral Analysis Division, covering his research agenda, the policy developments at the Banco de España related to the ongoing Covid19 crisis, as well as recent efforts to develop and leverage large and granular datasets in order to tackle research and policy questions.

We highlight these and other research developments at the Banco de España in hopes that they will interest the broader research community in Spain and internationally, and thereby contribute to an improved understanding of economic policy

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Market polarization and the Phillips curve

JAVIER ANDRÉS, ÓSCAR ARCE AND PABLO BURRIEL

Summary of Banco de España Working Paper no. 2106

The Phillips curve has flattened out over the last decades. We develop a model that rationalizes this phenomenon as a result of the observed increase in polarization in many industries, a process along which a few top firms gain an increasing share of their industry market. In the model, firms compete à la Bertrand and there is exit and endogenous market entry, as well as optimal up and downgrading of technology. Firms with larger market shares find optimal to dampen the response of their price changes, thus cushioning the shocks to their marginal costs through endogenous countercyclical markups. Thus, regardless of its causes (technology, competition, barriers to entry, etc.), the recent increase in polarization in many industries emerges in the model as the key factor in explaining the muted responses of inflation to movements in the output gap witnessed recently.

SUMMARY FOR THE APRIL RESEARCH UPDATE

In this paper we set up a model consistent with many of the features highlighted by the empirical industrial organization literature, to argue that these changes might be behind the muted response of inflation to shocks to the marginal costs that has been observed lately. The flattening of the Phillips curve that has taken place over the last twenty years poses a challenge for monetary authorities. On the other hand, the availability of large data sets containing firm level information on a number of relevant variables has uncovered a series of facts that speak of profound changes in the distribution of firms in many industries with repercussion in the response of macroeconomic variables to exogenous shocks.

The pattern of inflation rates across most advanced economies in recent years defies the traditional explanations based on the Phillips curve relation between inflation and the output gap. In spite of the implementation of an

unprecedented set of non-conventional monetary policy measures after the global financial crisis (GFC), inflation and inflation expectations in most advanced economies remained chronically subdued even before the Covid-19 crisis. Some argue that this comes from afar and potentially well before the GFC (Blanchard, 2016). Prominent among the potential explanations for the weak reaction of prices to cyclical conditions are the decline of labor power, the rise of globalization and international trade, and the impact of positive supply shocks caused by new technologies.

These factors do not exhaust the list of possible causes behind the diminishing effect of cyclical fluctuations on prices. A related strand of literature is placing increasing attention on some ongoing significant changes in the industrial structure in advanced economies. These changes include, among others, the rise in market shares in many industries, industrial polarization along different dimensions (e.g. firm size, productivity, etc.), the rise in markups, intensification of competition spurred by technology and the decline of the labor share. In particular, the case for market concentration over the last decades has been forcefully established on empirical grounds (Covarrubias, Gutiérrez and Philippon, 2019). Yet, so far little consensus can be found about the likely effect of these factors on the inflation rate or, more precisely, on the link between inflation and the economic slack (Van Reenen, 2018). The importance of the new technological giants in shaping the way economies respond to shocks, the archetypal case being the disinflationary impact of Amazon, is in stark contrast with the long held view in mainstream macroeconomics, according to which market concentration has been considered a source of inflationary pressure.

Our model sheds light on the connection between the rise in market polarization (increase in market shares and widening gap in size and productivity across firms in the same industry) and the flattening of the Phillips curve. Contrary to the previous standard view, in our model the rise in market shares is neither inflationary nor deflationary per se, but it reduces the slope of the Phillips curve, which is consistent with the recent empirical literature (Del Negro, Lenza, Primiceri, and Tambalotti, 2020). In particular, the slope of the Phillips curve derived in conventional New

Keynesian DSGE models (regardless of whether price inertia is of the Calvo or the Rotemberg type) gets augmented in our model by a factor that decreases with the market share of the firm, as shown in equation (1).

$$\pi_t^s = \underbrace{\beta E_t \pi_{t+1}^s + \frac{(1-\theta_p^s)(1-\beta\theta_p^s)}{\theta_p^s} mc_t^s}_{\text{Standard NKPC}} + \underbrace{\frac{s^s(1-\theta_p^s)}{(1-s^s)(\varepsilon(1-s^s)-1)\theta_p^s} (s_t^s - \beta\theta_p^s E_t s_{t+1}^s)}_{\text{heterogeneity effect}} \quad (1)$$

where π_t^s , represents inflation of firms of size s , mc_t^s , their real marginal costs and s_t^s , their market share.¹

Key to this result is the fact that markups depend positively on the firm’s market share. The endogeneity of markups hinges critically on the joint effect of two core features of the industrial structure of the economy. We assume that firms have access to different TFP levels and choose among them optimally taking into account the costs of moving up or down in the technology ladder. Furthermore, as in Etro and Rossi (2015), Andrés and Burriel (2018), and, more recently, Wang and Werning (2020), we assume that firms compete à la Bertrand taking into account the expected reaction of other competitors when setting their prices. Thus, substituting for the endogenous market shares in equation (1) and solving, we get a Phillips Curve with the usual drivers of inflation, expected inflation and marginal costs, pre-multiplied by a factor smaller than 1, which depends on the firms’ steady state market shares (s^s), as shown in equation (2).

$$\pi_t^s = \left(\frac{1 + \theta_p^s \xi_N^s}{1 + \xi_N^s} \right) \beta E_t \pi_{t+1}^s + \left(\frac{1}{1 + \xi_N^s} \right) \frac{(1-\theta_p^s)(1-\beta\theta_p^s)}{\theta_p^s} mc_t^s \quad (2)$$

¹ In the model size and productivity level are interchangeable. The parameter $1-\theta_p^s$ represents the share of firms that are allowed to change their prices every period according to the Calvo price-setting mechanism, β is the discount factor and ε the elasticity of substitution between intermediate goods.

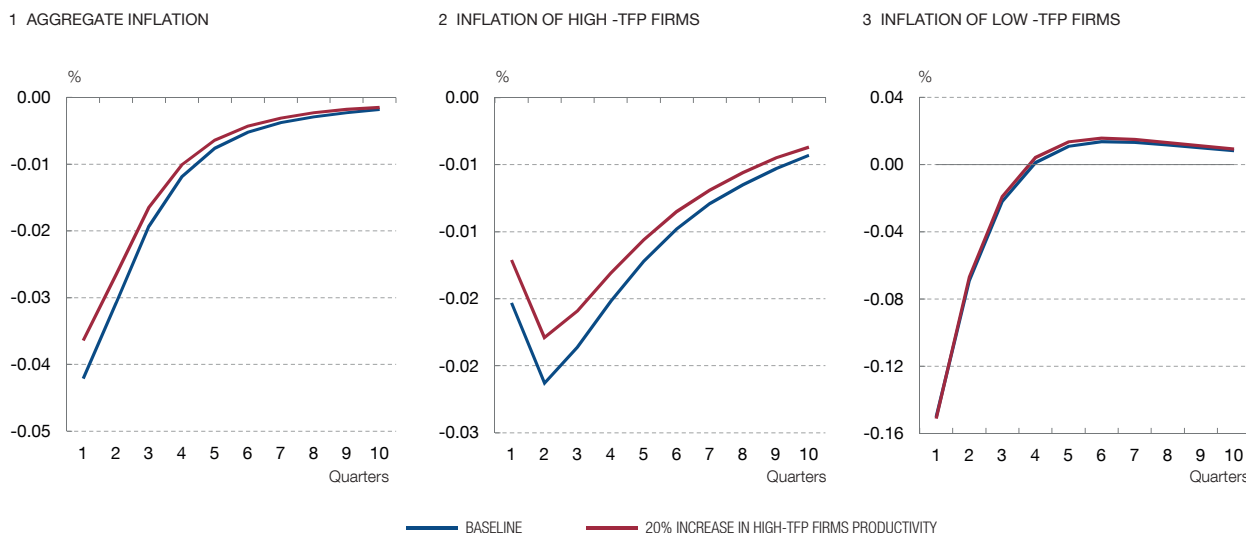
$$\text{where } \xi_N^s = \frac{s^s(\varepsilon-1)}{(1-s^s)(\varepsilon(1-s^s)-1)} > 0, \frac{\partial \xi_N^s}{\partial s^s} > 0.$$

Therefore, when a firm faces a positive shock to its marginal cost it raises prices, which in turn undermines its market share and hence its desired markup; this dampens the inflationary effect of the shock. The strength of this effect increases with the firm’s market share. Hence, in an economy featuring highly polarized industrial structures, with a few large and many small competitors in each industry, much in line with the aforementioned recent evidence, the response of inflation to shocks becomes more muted than it would be in a similar economy with a more balanced distribution of firms. In our simulations, small variations in the drivers of market concentration deliver significant changes in the slope of the Phillips curve. While strategic price interactions barely affect the markup of smallish firms, they do condition the desired markup of large firms in a material manner (Amiti, Itskhoki, and Konings, 2019). This moderates the response of prices set by the latter to shocks, which in turn (upon aggregation) exerts a significant dampening effect on the volatility of aggregate inflation. In fact, in the chart below we show how a 20% increase in the productivity of larger firms, which increases their market share, reduces the response of their inflation to a negative TFP shock significantly (by 28%), while the response of smaller firms to the same TFP shock remains unaltered. As a consequence, the response of aggregate inflation is also more moderate (by 26%). A similar result is obtained after an increase in the degree of competition as measured by the elasticity of demand. Moreover, these findings are also found for other standard shocks, like an increase in policy rates, or negative preference or labour supply shocks.

To further assess the relevance of the mechanism analyzed in the paper, we investigate the medium term response of the industrial structure to increases in technological divergences, the elasticity of substitution among goods and barriers to entry, three factors that Covarrubias, Gutiérrez and Philippon (2019) identify as the main drivers of market concentration in recent decades. The model predictions are consistent with the main facts reported by

Chart 1

IMPULSE RESPONSE OF INFLATION AFTER AN INCREASE IN TFP UNDER DIFFERENT PRODUCTIVITY SCENARIOS



a The variables are presented as percentage differences with respect to the steady state.

the empirical literature: (1) Sustained increase in concentration in most industries (Bajgar, Berlingieri, Calligaris, Criscuolo, and Timmis, 2019); (2) concentration in employment but less intense than in sales (Autor, Dorn, Katz, Patterson, and Van Reenen, 2019); (3) increase in polarization along other dimensions like productivity (Berlingueri, Blanchenay and Criscuolo (2017); (4) sustained increase of markups, mostly at the top of the markup distribution (De Loecker, Eeckhout, and Unger (2020); (5) steady decline in firm entry in most industries (Akcigit and Ates, 2019); (6) generalized fall in investment rates in many advanced economies (Eggertsson, Robbins, and Wold (2018); and (7) decline in the labor share accompanied by a fall in capital share in most industries too (Barkai, 2019).

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Optimal Progressivity of Personal Income Tax: A General Equilibrium Evaluation for Spain

DARÍO SERRANO-PUENTE

Summary of Banco de España Working Paper no. 2101
Published in SERIEs - Journal of the Spanish Economic Association, vol. 11(4), pp. 407-455, November 2020

Is the Spanish economy positioned at its optimal progressivity level in personal income tax? This article quantifies the aggregate, distributional, and welfare consequences of moving toward such an optimal level. A heterogeneous households general equilibrium model featuring both life cycle and dynastic elements is calibrated to replicate some characteristics of the Spanish economy and used to evaluate potential reforms of the tax system. The findings suggest that increasing progressivity would be optimal, even though it would involve an efficiency loss. The optimal reform of the tax schedule would reduce wealth and income inequality at the cost of negative effects on capital, labor, and output. Finally, these theoretical results are evaluated using tax microdata and describe a current scenario where the income-top households typically face suboptimal effective average tax rates.

Many modern governments implement a redistributive fiscal policy, where personal income is taxed at an increasingly higher rate, while transfers tend to target the poorest households. The taxation of personal income is not a minor issue, since most of the OECD economies obtain a large proportion of their tax collection through it.¹ Raising taxes on higher incomes may be potentially justified by the increase in income and wealth inequality in recent years in Spain, especially after the 2007 crisis, as documented by Angel et al. (2018). Beforehand, one is likely to consider that raising taxes on the income-rich households could reverse the growing concentration at the top. However, this type of policy could be very costly in terms of efficiency in advanced market

economies. For that reason, the optimal design of a redistributive tax system is subject to many constraints, as argued by Bakis et al. (2015). This is why having a quantitative theory that accounts accurately for the observed income and wealth inequality is crucial when assessing the aggregate, distributional, and welfare implications of certain policies. For that purpose, a heterogeneous households general equilibrium model is here calibrated to replicate some characteristics of the Spanish economy and used to compare the steady-state consequences of setting an optimal progressivity level in the Spanish personal income tax. This frames the setup here presented in literature of general equilibrium models with heterogeneous agents to explore the relationship between fiscal policy variables and the endogenous cross-sectional distribution of income and wealth in Spain. Examples of this body of literature are Pijoan-Mas and González-Torrabadella (2006), Díaz-Giménez and Pijoan-Mas (2019), and Guner et al. (2020), among others.

The theoretical framework of this paper is built for Spain following Castañeda *et al.* (2003). The model is devoted to (i) account for income and wealth inequality and (ii) study decisions of households that face labor income processes that are random, household-specific, and uninsurable. In these model-based economies, households accumulate wealth in part to smooth their consumption. Heterogeneity is introduced in this setup via distinct labor market opportunities using an uninsurable process on the endowment of efficiency labor units that features non-linear dynamics. Given the labor market opportunity, the households choose their work effort. In other words, the labor choice is set here to be endogenous. Life cycle characteristics are modeled using aging and retirement and dynastic links are modeled in a way that households are altruistic toward their descendants (hybrid model with retirement and bequests). Households face a progressive tax schedule modeled through the Heathcote *et al.* (2017) specification, a function that allows for assessing average level of taxes and progressivity separately. The model is properly calibrated to match some empirical statistics of the Spanish economy and replicates the distributions of income and wealth in very much detail (also at the very top tails of those distributions).

¹ The OECD average of the share of personal income tax revenues over total tax revenues (excluding social security contributions) has been around 30-35% in recent years.

Once the theoretical framework is defined, a bunch of potential progressivity reforms are assessed through the calculation of many different general equilibria (one equilibrium for each degree of progressivity evaluated). Then a Benthamite social planner, who takes into account all households in the economy by putting the same weight on each of them, discerns the optimal progressivity reform that leaves the aggregate tax burden and transfers-to-output levels unchanged. The findings suggest that aggregate social welfare is maximized when the level of progressivity of the Spanish personal income tax is increased to some extent. More precisely, in the optimally reformed scenario (setting the optimal level of progressivity), welfare gains are equivalent to an average increase of 3.08% of consumption.

By decomposing the aggregate welfare change, it is shown that most of the welfare gains are obtained from a majority of households facing a lower tax rate, i.e. the poorest households facing lower effective income tax rates and richest households affronting higher effective income tax rates. On the contrary, the general equilibrium effects of the optimal reformed economy (higher interest rate and lower wage) and the effects resulting from changes in the equilibrium distribution of households across income levels (larger mass of households at lower income levels) show a welfare loss, but these losses are so small that together cannot overpass the welfare gains directly coming from the reformed tax system, jointly resulting in positive aggregate welfare changes. These welfare gains are

decomposed by household type, where it is observed that the poorest working and non-working households are the ones who benefit the most from the reform. Contrarily, the most efficient working households and the wealthiest ones (either working or non-working) are those who experience the largest trade-off between (i) positive welfare effects derived from higher income (due to an increased interest rate that pushes up capital returns) and (ii) adverse effects emerging from higher tax payments (due to the increase in progressivity of the income tax that discourages labor and savings). The losses from this trade-off are particularly high in top parts of the income and wealth distributions and clearly offset the potential welfare gains of the households populating such areas. Therefore, knowing that these agents would be the losers of the reform, despite positive aggregate welfare effects, the consequences on aggregate capital, labor, and output would be negative, which means that the economy would experience an efficiency loss. Moreover, looking at the distributional implications, this reform would reduce income and wealth inequality.

Finally, the theoretical results are evaluated with Spanish tax micro data. From the point of view of a Benthamite social planner, households between the 20th and the 80th percentiles would experience a decrease in their average tax rates under the optimal progressivity reform. For example, the effective average tax rate encountered by a household situated within the 40th and the 60th percentiles of the

Figure 1
AGGREGATE WELFARE CHANGE

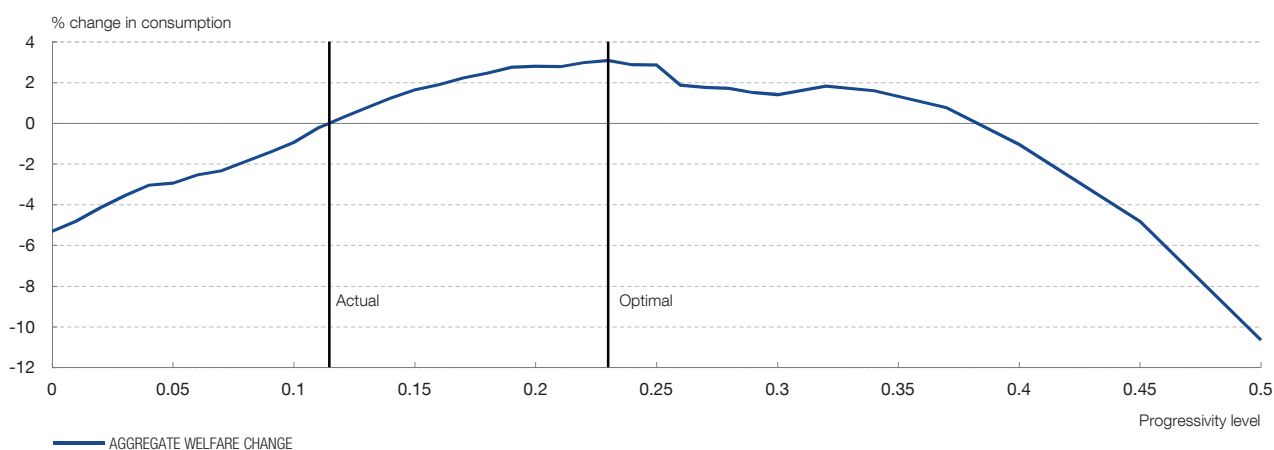
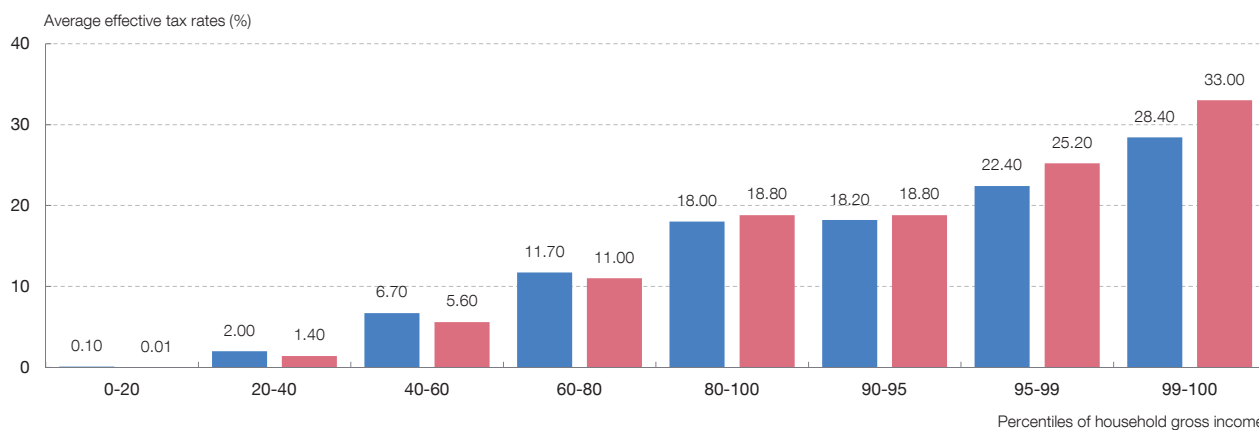
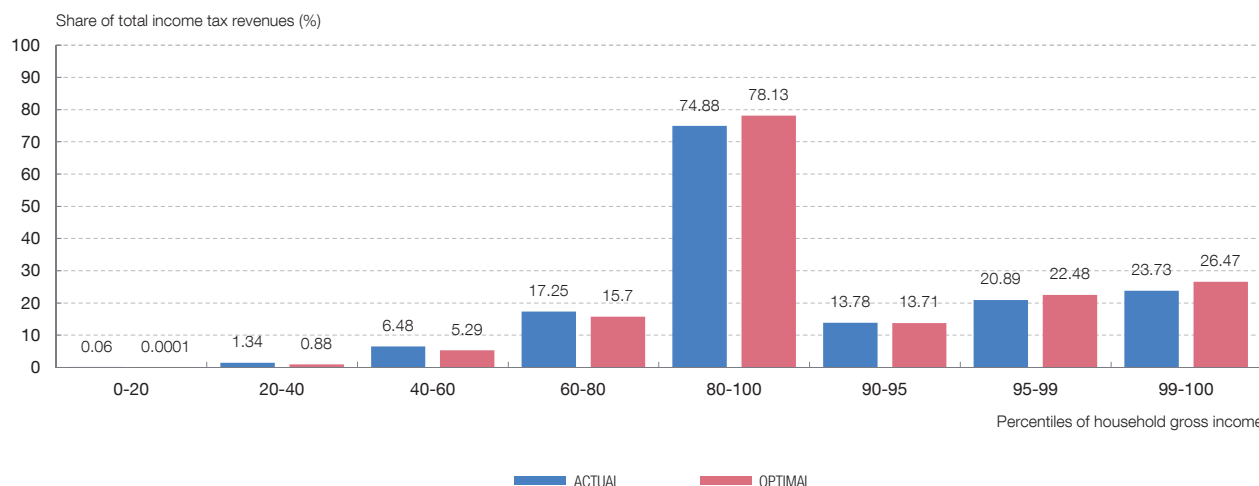


Figure 2
AVERAGE EFFECTIVE TAX RATES AND SHARE OF TAX REVENUES

1 AVERAGE EFFECTIVE TAX RATES



2 SHARE OF TOTAL INCOME TAX REVENUE



income distribution would drop from 0.067 to 0.056, which involves a change of 1.1 p.p.. On the other hand, households above the 80th percentile would experience a drastic increment in their effective average tax rate. For instance, the top 1% households of the gross income distribution would go from confronting an average tax rate of 0.284 in the actual scenario to dealing with an average tax rate of 0.330 in the optimal one.

In conclusion, as policy implications arising from this study, what the model (jointly with the data) indicates is that, in terms of aggregate welfare, it would be optimal to increase the progressivity of the personal income tax. In

addition, the reform would reduce income and wealth inequality. However, this would lead to an efficiency loss of the economy, since it discourages work and savings mainly by penalizing the top-working and wealthiest households.

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Understanding the performance of machine learning models to predict credit default: a novel approach for supervisory evaluation

ANDRÉS ALONSO AND JOSÉ MANUEL CARBÓ

Summary of Banco de España Working Paper no. 2105

We study the economic impact for financial institutions of using machine learning (ML) models in credit default prediction. We do so by using a unique and anonymized database from a major Spanish bank. We first measure the statistical performance in terms of predictive power, both in classification and calibration, comparing models like Logit and Lasso, with more advanced ones like Trees (CART), Random Forest, XGBoost and Deep Learning. We find that ML models outperforms traditional ones, although more complex ML algorithms do not necessarily predict better. We then translate this into economic impact by estimating the savings in regulatory capital that an institution could achieve when using a ML model instead of a simpler one to compute the risk-weighted assets following the Internal Ratings Based (IRB) approach. Our benchmark results show that implementing XGBoost instead of Lasso could yield savings from 12.4% to 17% in capital requirements, depending on the type of underlying assets.

Recent surveys show that financial institutions are increasingly adopting Machine Learning (ML) tools in several areas of credit risk management, like regulatory capital calculation, optimizing provisions, credit-scoring or monitoring outstanding loans (BoE, 2019; Fernández, 2019). While ML models usually yield better predictive performance, from a supervisory standpoint they also bring new challenges, like interpretability of the results, stability of the predictions and governance of the models (EBA, 2020; BdF, 2020). Given the novelty and complexity of some ML models, defining an adequate supervisory model evaluation approach is not an easy task. Therefore, before conducting any model risk analysis, it is essential to understand the real economic gains that financial

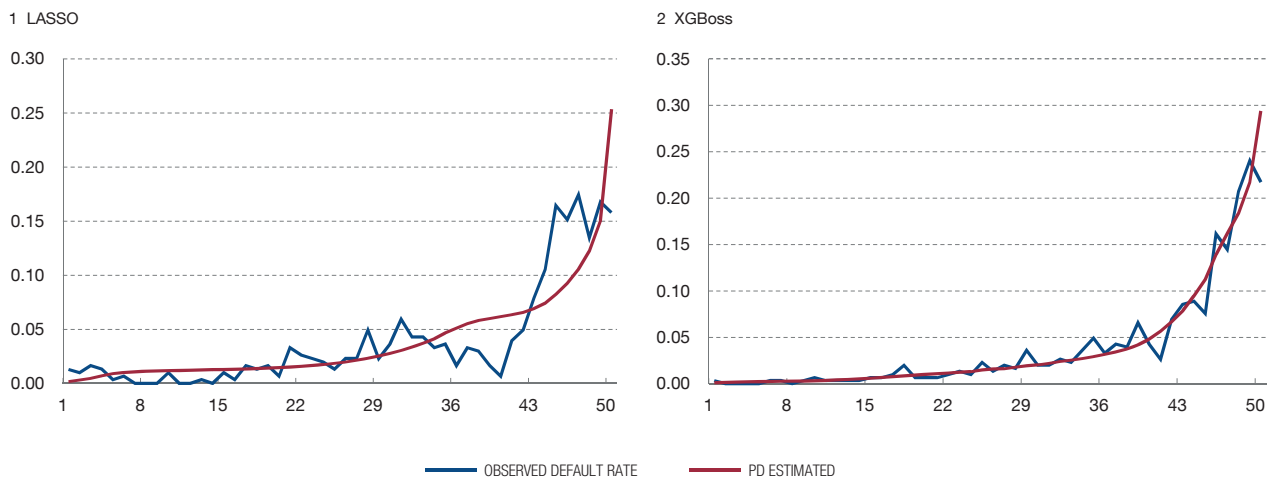
institutions could realize by using different ML algorithms. While there exists an extensive and growing literature on the predictive gains of ML in credit default prediction, usually the findings are based on different sample sizes and different types of underlying assets, making any conclusion not robust enough. Furthermore, the economic impact of the use of ML in credit default prediction remains understudied.

To tackle this research gap we use a unique and anonymized database provided by one of the most important Spanish banks. We first measure the relative performance of the following ML models, comparing it with a logistic regression (Logit): Lasso penalized logistic regression, Classification And Regression Tree (CART), Random Forest, XGBoost and Deep Neural Networks. To this purpose we calculate the benefits in terms of statistical performance assessing the predictive performance under different circumstances such as different sample sizes and different amount of explanatory variables. This allows us to test whether the better statistical behavior of ML models comes from an information advantage (associated to the access to big amounts of data) or model advantage (associated to ML as high-end technology). We find that ML models outperform Logit both in classification and in calibration, particularly XGBoost, existing a model advantage that can be statistically isolated from an information advantage. Nevertheless, most complex models like Deep Learning (Neural Networks), do not necessarily predict better.

Second, we propose a novel approach to translate this statistical performance into actual economic impact of using ML models in credit default prediction. Taking as a basis the Basel formulas for risk-weighted assets (RWA) and the regulatory capital requirements in the Internal Ratings-Based (IRB) approach, we compute the savings in terms of minimum capital requirements which could be achieved by using more advanced algorithms, in particular XGBoost, compared to traditional techniques like Lasso. We perform a step-by-step computation of the capital requirements for both methods. Out of nearly 75,000 loans in our dataset, we use around 60,000 to train the models and make predictions of the probability of default (PD) over

Figure 1

RANKING PDS PER MODEL



the remaining 15,000 loans.¹ We organise the predictions proportionally into 50 buckets (about 300 loans in each bucket), from lower to higher values of PD. The results are displayed in Figure 1. The discrepancy between the observed default rate (blue line) and the average PD (red line) is greater for Lasso than for XGBoost, as Lasso tends to both overestimate and underestimate the fraction of default.

In order to get the approval from a supervisor, the classification into buckets must comply with two criteria: (i) risk heterogeneity between buckets, and (ii) risk homogeneity within buckets. To meet both criteria, we sequentially reduce the number of buckets. Out of the 50 starting buckets, we end up with six for Lasso and eight for XGBoost. Lasso finds fewer buckets because we are constrained by its underlying PD distribution, which presents important flat areas, undifferentiated, that do not allow further disaggregation (Figure 1 left).

Once we have our final bucket classification for Lasso and XGBoost, we calculate the capital requirements (K) for each bucket, and find that the average K can be up to

17% lower for XGBoost than for Lasso. These capital savings come from two sources. First, the difference in the distribution of loans in buckets between models. Lasso's PD distribution is particularly flat in areas with low PD (Figure 1), accumulating a disproportionately large amount of loans at around 1.5% of PD. According to the Basel formulas, the K function of a group of loans is mainly concave and increases with the PD of the loans, particularly for low PDs. Second, the difference in the number of buckets found within each model. Since XGBoost's PD distribution (Figure 1 right) fits the observed default better than Lasso's, XGBoost ends up with more buckets in the final rank (eight instead of six). This implies, due to the concavity of the RWA Basel function over the parameter PD, a difference in capital requirements in its favour.

Our results indicate that ML models, due to their better statistical performance, could generate significant savings for financial institutions in terms of regulatory capital requirements compared to traditional statistical models. The magnitude of our results suggests that supervisors need to thoroughly investigate the risks associated with the use of these models, both from a micro and macro-prudential perspective, in order to ease the adoption of this innovation in the market.

¹ Different train-test partitions do not affect the results of this section.

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Urban air pollution and sick leaves: Evidence from social security data

FELIX HOLUB, LAURA HOSPIDO AND ULRICH J. WAGNER

Summary of Banco de España Working Paper no. 2041

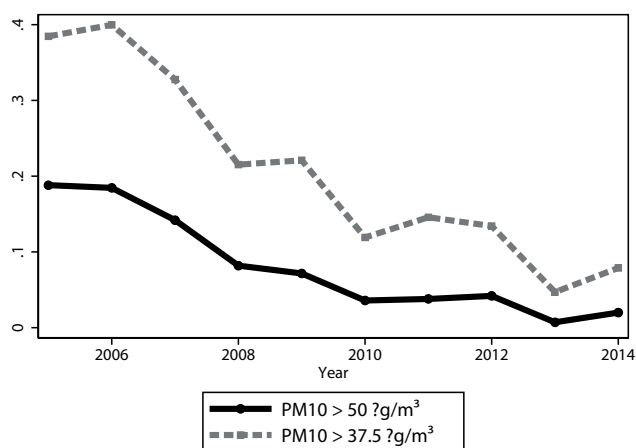
Air pollution poses a major threat to public health by shortening lives (Deryugina et al., 2019) and increasing acute morbidity (Schlenker and Walker, 2016). Air pollution causes additional damage by reducing productivity on the job (Graff Zivin and Neidell, 2012) and by hindering human capital accumulation (Currie et al., 2009; Ebenstein et al., 2016). Recent research has provided credible evidence that air pollution damages the economy also via reductions in labor supply in the context of emerging economies (Hanna and Oliva, 2015; Aragón et al., 2017), but little is known so far about this relationship in post-industrial societies where pollution levels are low and productivity is high.

Our paper provides the first causal estimates of how many work days are lost due to air pollution concentrations typically

observed in post-industrial economies. Our empirical analysis is based on a novel administrative dataset from the period 2005-2014 that links rich information on personal and occupational characteristics of Spanish workers to the frequency, length, and diagnosis, of sick leaves taken. We estimate the impact of air pollution on workers' propensity to call in sick, based on weekly variation in ambient concentrations of particulate matter (PM₁₀) across 99 cities in Spain. Our baseline model is a linear regression of the share of sick-leave days on the share of high-pollution days and weather variables. To control for non-random assignment of pollution across workers, we include city-by-year, year-by-quarter, and worker fixed-effects. Possible remaining endogeneity is addressed in an instrumental-variables (IV) regression that exploits exogenous variation in PM₁₀ driven by dust storms in Northern Africa. Under certain meteorological conditions, storms in the Sahara Desert stir up dust into high altitudes. These dust clouds can travel very long distances and reach European territory several times a year. The arrival of Sahara dust occurs throughout all of Spain, and it is most frequently observed on the Canary Islands, due to their geographical proximity to the Sahara, where the phenomenon is popularly known as "Calima". Because

Figure 1
TRENDS IN POLLUTION, EMPLOYMENT AND WAGES 2005-2014

1 SHARE OF HIGH-POLLUTION DAYS (a)



2 EMPLOYMENT AND PRODUCER WAGES (b)



NOTES: Figure 1.1 displays the share of worker days with PM₁₀ concentration exceeding EU 24-hour limit of 50 mg/m³ (solid line) and the share of worker days with concentration in excess of 75% of the limit value (dashed line). The figure is based on our sample of 99 Spanish cities with at least 40,000 inhabitants. PM₁₀ concentrations are weighted by the number of social security affiliates in each city and year. Figure 1.2 displays the number of workers affiliated with the General Social Security Regime on our sample of 99 Spanish cities with at least 40,000 inhabitants (solid line) and the daily producer wage, expressed in constant 2018 Euros (dashed line).

Calima events substantially increase non-anthropogenic PM_{10} concentrations, the cities affected by this phenomenon are allowed to discount the measured 24-hour-mean concentration for this effect. Official PM_{10} discounts constitute a valid instrument for pollution because they shift local PM_{10} concentrations in ways that are plausibly orthogonal to local conditions that drive sick leaves, after conditioning on weather.

Our IV estimates imply that a 10%-reduction in high-pollution events reduces the weekly absence rate by 0.0213 percentage points, i.e. by 0.8% of the mean absence rate (2.79%). The estimation results allow us to compute a lower bound on the benefits of improving urban air quality in Spain. We proceed in two steps. First, we calculate the reduction in sick days caused by a specific improvement in air quality. To translate this into a monetary benefit, we then multiply this number by the average daily producer wage. Under the assumption that workers are paid their marginal product, this approximates the value of incremental production enabled by the reduction in sick days. While improving air quality yields sizable additional benefits by reducing mortality, human suffering, and medical treatment costs, we focus on foregone production because this component of the social costs of air pollution is directly linked to our outcome variable and has not yet been quantified in previous research.

In particular, we evaluate the cumulative benefits of the actual air quality improvements that have taken place in urban Spain over the period. The left-hand side graph of Figure 1 shows that worker exposure to PM_{10} concentrations exceeding the EU 24-hour limit of $50 \mu\text{g}/\text{m}^3$ decreased from 18.8% in 2005 to just under 2% in 2014. This improvement in ambient air quality saved at least €503 million in foregone production by reducing worker absence by more than 5.55 million days. It is important to note that this calculation is affected by major economic fluctuations that occurred during the sample period, depicted in the right-hand side graph of Figure 1. We account for this by using annual values of employment and wages.

We uncover two important sources of treatment heterogeneity. One relates to preexisting medical conditions that we infer from a worker's sick leave record. We estimate that the health

response of vulnerable workers (defined as those belonging to the top-five percentile of the distribution of sick leaves taken during the pre-estimation period) is more than three times stronger than the response of healthy workers. Furthermore, our analysis reveals that job security matters, in that workers with a high predicted risk of losing their job respond less strongly to a pollution shock than others. This finding suggests that exacerbated presenteeism could adversely affect future health outcomes and lower productivity in this tier of the labor market. These interactions of behavior and labor market institutions have a large impact on estimates of the external costs of air pollution that arise from changes in labor supply. If we adjust the above-mentioned benefits of air quality improvements to account for presenteeism, the impact estimates imply a corresponding increase in production worth €706 million. Irrespective of which number one prefers, this exercise shows that the productivity-related benefits of air quality improvements that occurred in Spain between 2005 and 2014 were both economically and statistically significant.

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Raising Markups to Survive: Small Spanish Firms during the Great Recession

PILAR GARCÍA-PEREA, AITOR LACUESTA
AND PAU ROLDAN-BLANCO

Summary of Banco de España Working Paper no. 2033

Over the past few decades, profit rates and various other measures of market concentration have been on the rise in the United States (De Loecker et al, 2020). These patterns of the data have attracted much attention recently in both academic as well as policy circles for their impact on productivity dynamics, the composition of industries and ultimately consumer welfare. The evidence points to rapidly growing and highly productive firms as the drivers of this phenomenon, with these firms leading the increase in markups and the decline in the labor share (Autor et al. 2017 and 2020). However, these trends seem to be less pronounced in Europe, and be driven by factors seemingly unrelated to the dynamics of superstar companies.

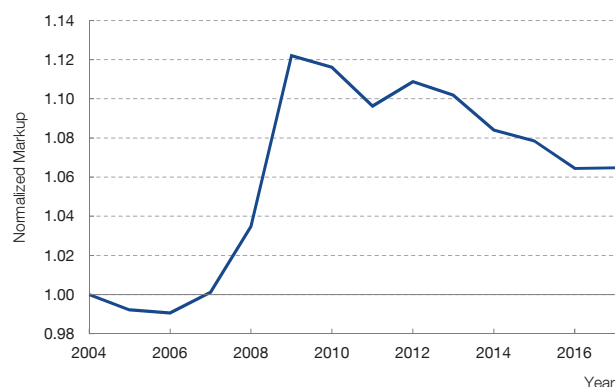
In this article, we exploit rich balance-sheet data from the Banco de España to document the behavior of markups at the aggregate level in Spain, and perform various decompositions to help us identify the main drivers behind their evolution over the period 2004-2017. Our main finding is that, contrary to the United States, markup dynamics were primarily led by small and unproductive firms. Particularly in response to the Great Recession of 2008, these firms were unable to increase their productive efficiency when their average costs rose due to a sharp increase in the fixed part of their production costs, and this translated into higher price markups. This behavioral response, related to the composition of the structure of costs, seems to indicate that these firms, when faced with economic hardship, may have preferred to increase their markups in an attempt to survive in their sector even if this may have come at the expense of losing some market share in the process.

Measuring price markups (defined as the ratio of a firm's final output price to the marginal cost of producing it) is challenging because of at least two reasons. First, marginal

costs are a theoretical construct, so one needs a proxy for them. Second, output price data at the firm level is scarce, if not inexistent. For this reason, we rely on recent methodological advances in production function estimation (e.g. De Loecker and Warzynski, 2012), measuring firm-level markups as the ratio of a variable input's elasticity to output on that input's share of total sales. The Banco de España data proves to be an excellent resource because not only is it highly representative of the Spanish economy (containing a large amount of firms and a very high percentage of aggregate value added), but it also contains very disaggregated information on the structure of costs, allowing us to disentangle variable inputs (e.g. materials and labor expenses from workers with fixed-term contracts) from fixed inputs (e.g. other operating expenses and labor expenses from open-ended contracts with large firing costs). It is this latter aspect which allows us to make the main point of the paper: the evolution of firm-level markups in Spain can be explained by firms' efforts to rebalance their cost structure between variable and fixed inputs, a behavioral response to the cycle, rather than by reasons of a more structural nature. Therefore, in the case of Spain, the evolution of markups may not reflect aggregate changes in the competitive structure of markets, but rather an idiosyncratic response of firms to economic conditions.

The figure above shows the evolution of the sales-weighted average markup (measured relative to materials) over the period 2004-2017. The average markup has been

Figure 1
SALES-WEIGHTED AVERAGE MARKUP (2004 = 1)



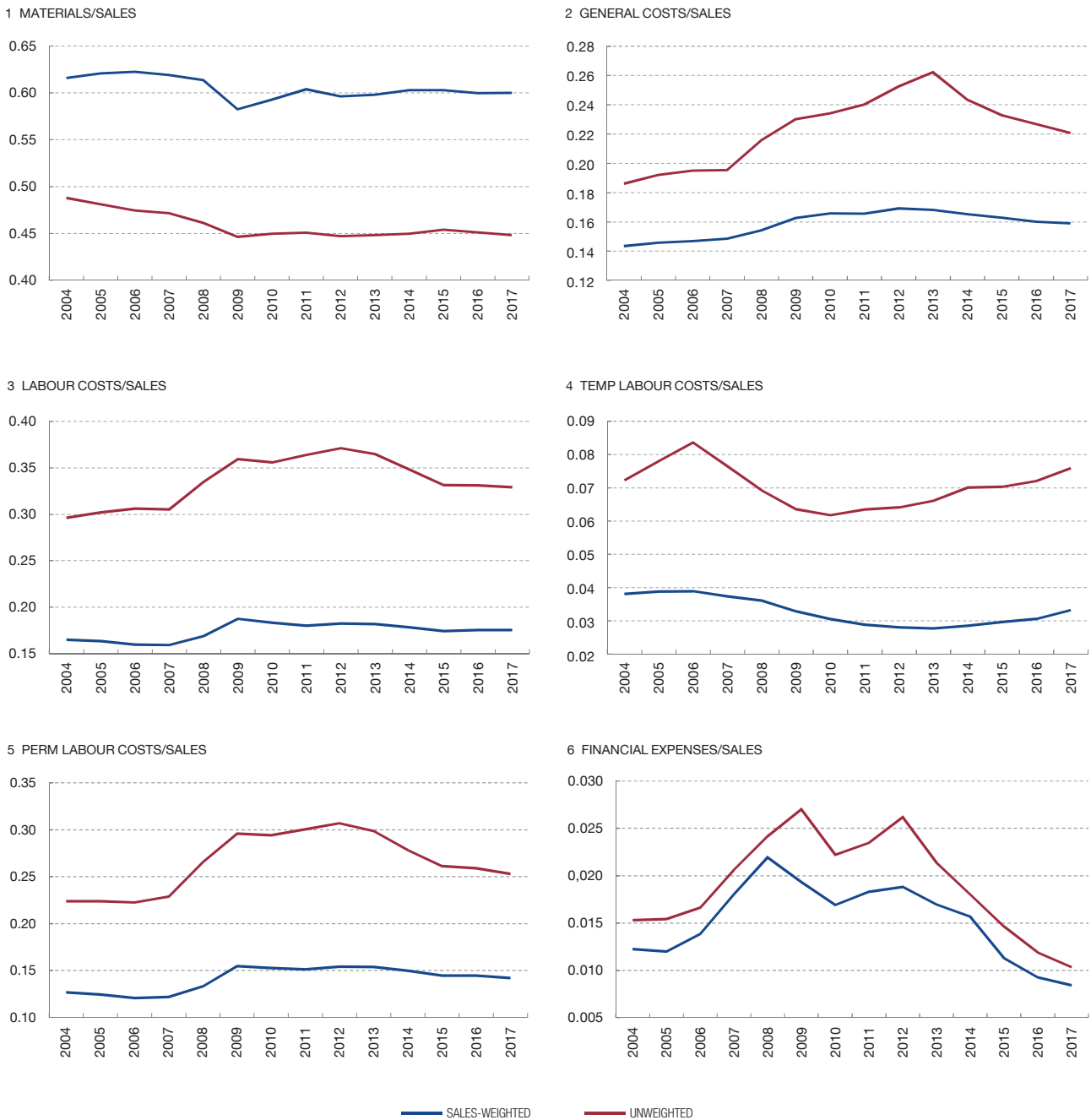
normalized to one in 2004. We observe that markups are countercyclical, rising by about 13ppt between 2004 and 2009, and declining slightly thereafter. The behavior in the first part of the sample is roughly common across most sectors of activity, albeit markups continued to rise

in some specific sectors after 2009, most notably in Construction, Supplies and Real Estate.

Most importantly, we find that the behavior of average markups is driven by small and unproductive firms. First,

Figure 2

SALES-WEIGHTED AND UNWEIGHTED AVERAGE INPUT COSTS SHARES, RELATIVE TO FIRM SALES, BY TYPE OF INPUT



most of the increase during the Great Recession is due to the firms at the very top of the markup distribution, who happen to be firms with relatively low levels of productivity and low market shares. Second, the firms that increase their markup the most (in relative terms) during this period were precisely this group of small and unproductive companies.

To understand what is behind this phenomenon, we next turn to the behavior of different variable and fixed costs over this period. In the figure, the black line is the sales-weighted share of each input relative to firm turnover (sales), while the red line is an unweighted average. By construction, when the sales-weighted average is above the unweighted average, smaller firms (in terms of sales) have a lower input share of sales. As seen in the figure, there exist sizable differences in the terms of the cost structure of firms by firm size, especially regarding the contribution of materials and labor expenses. First, larger firms devote a larger share of their sales to paying for material inputs (the variable input relative to which our markup estimates are computed). In response to the Great Recession, all firms decreased the share of their sales that pays for material expenses, but this ratio decreased disproportionately more for smaller firms, explaining the stronger response in markups for these firms. This phenomenon is reversed for inputs with higher adjustment costs, such as general costs and labor expenses related to permanent workers on open-ended contracts with high firing costs. In both cases, the share of sales paying for these fixed inputs increased, indicating that in response to the adverse economic shock, continuing firms shifted their resources away from variable costs into fixed ones, perhaps in an attempt to soften the adverse effects of the shock on their economic profits and their chances at survival.

To complement this analysis, we conclude on the evolution of firm demographics and measures of market concentration during this period. We show that, in spite of the aforementioned behavioral responses at the firm level, we do observe a decline in firm entry (from about 11% to about 7% only in the period 2007-2009) and a rise in firm exit (from about 4% to 8% in the same period), as well as a mild increase in the share of industry sales captured by the ten largest firms (on average, from 47% in 2008 to 56% in 2017).

However, we find that most of the evolution of the sales-weighted markup is explained by changes in the composition of industries among surviving firms, as well as by changes in the markups of these firms themselves, rather than by the extensive margin of entry and exit of firms.

All in all, our study demonstrates that understanding the structure of firm's balance sheets is key to understand the behavior of markups in Spain. Rather than reflecting change in market power per se, the rise in markups during the Great Recession seems to have been driven by a reshuffling of cost expenditures away from variable and into fixed inputs. This was particularly the case among small and unproductive firms, who may have behaved in this manner in order to soften the blow of the shock onto their profits, and thereby increase their chances of survival.

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Economics Letters

Recent conferences

[Link to conferences page](#)

[EUI-BANCO DE ESPAÑA MINI-CONFERENCE ON SOCIAL SECURITY REFORMS IN EUROPE](#)

On-line, 8 April 2021

This on-line mini-conference, jointly organised by the Pierre Werner Chair of the European University Institute and the Banco de España, focused on social security reforms that can help to prevent the crisis of social security pay-as-you-go systems due to the demographic tsunami that many countries will undergo in the next decades.

In the first part, three research papers were presented and discussed, focusing on the design and financial aspects, as well as an overall alternative to the pay-as-you-go system.

On a second part, a panel discussed the challenges and reforms of European pay-as-you-go systems.

[Conference program](#)

[1ST IBERO-AMERICAN CENTRAL BANK CONFERENCE](#)

On-line, 12 April 2021

The Banco de España and the Ibero-American General Secretariat (SEGIB) jointly organised on 12 April 2021 the 1st Meeting of Ibero-American Central Banks to debate their response to the COVID-19 crisis. The meeting was part of a series of events prior to the 28th Ibero-American Summit of Heads of State and Government (Andorra, 21 April 2021).

[Conference program](#)

[BANCO DE ESPAÑA - EUROPEAN INVESTMENT BANK CONFERENCE: RECOVERING SWIFTLY TO LIMIT COVID-19 SCARRING OF SPANISH CORPORATES](#)

On-line, 29 April 2021

The Banco de España and the European Investment Bank (EIB) will be organising an online conference on “Recovering swiftly to limit COVID-19 scarring of Spanish corporates” on 29 April 2021.

[Conference program](#)

Recent economic research seminars

[Link to seminars page](#)

[DECOMPOSING THE FISCAL MULTIPLIER](#)

ÒSCAR JORDÀ

San Francisco Fed

7 October 2020

[DO WOMEN SHY AWAY FROM PUBLIC SPEAKING? A FIELD EXPERIMENT](#)

MARIA DE PAOLA

Universita della Calabria

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[GROWTH-FRIENDLY FISCAL RULES? SAFEGUARDING PUBLIC INVESTMENT FROM BUDGET CUTS THROUGH FISCAL RULE DESIGN](#)

ALEJANDRO IZQUIERDO

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TARUN RAMADORAI

Imperial College London

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CARLES VERGARA-ALERT

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University of Mannheim

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Columbia Business School

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17 March 2021

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NÚRIA RODRÍGUEZ-PLANAS

CUNY

21 April 2021

BANK CAPITAL AND REAL GDP GROWTH

NINA BOYARCHENKO

NY Fed

28 April 2021



ENRIQUE MORAL-BENITO

Head of the Sectoral Analysis Division
DG Economics, Statistics and Research

You joined the Banco de España (BdE) right after your PhD at CEMFI, and with experience both in the private sector as well as an international institution such as the World Bank. What drove you towards a policy-based environment at a Central Bank?

When I finished high school, I started to work as a warehouse worker because I was not sure whether to start working or to keep studying. Luckily, my mother convinced me to go to the university. When I finished my degree at the University of Las Palmas, I moved to London with some friends and started to work as a night cleaner because I was not sure whether to start working or to keep studying. Luckily, professor Antonio Alvarez convinced me to apply to the Master program at CEMFI. When I finished my master's degree at CEMFI, I did several job interviews because I was not sure whether to start working or to do a PhD. However, after interviews with consulting firms as well as talks with Manuel Arellano and Rafael Repullo, it became clear to me that I wanted to enroll in the PhD at CEMFI in order to get a job as an economist in the Servicio de Estudios of Banco de España. The combination of its research-oriented environment, its proximity to policy-relevant issues and decision-making, its Madrid-based location, and its salary-stability mix, made me see my future clear for the first time in my life.

With all the responsibilities that being a Head of Division (since 2018) entails, you are however still actively involved in several research projects. What has been your strategy in managing the policy-research mix?

It's easy, the strategy is simply to work extra-hours during Saturday nights... All kidding aside, once you get some experience and decide to make the transition from researcher to central banker, you must also assume that research projects represent only a relatively minor part of your responsibilities. Along this transition, you gradually devote more time to managerial duties and issues that are of interest to the bank rather than the questions that are of interest to you. At least in my case –coming from a PhD in econometrics–, I think there is some sort of convergence process by which you eventually reach the first-best equilibrium: working on policy-oriented issues that are very close to your research-oriented interests.

In any case, I also think that it is not fair to label our work as either policy or research, I think there is a third category that you can label as research-oriented policy or policy-oriented research. This category aims to fill the (still large) gap between academic research and applied policy work. Bringing the two worlds together is a challenge that I enjoy a lot and I think fits well our duties as central bankers. Indeed, I also realized that it is worth the effort of keeping in touch with academic research and out-of-the-box issues so that

you are always exposed to new and different questions that take you out of your comfort zone.

In addition to strong methodological contributions, your research has been characterized by the exploitation of large and granular datasets to tackle policy-relevant questions. How has the BdE's effort on this front evolved in recent years, and how has it shaped your research interests?

In my opinion, it's amazing the progress that Banco de España has made over the last few years on this front. There are several initiatives such as the Banco de España Data Laboratory (BELab) and the recent agreement between INE, Agencia Tributaria, Seguridad Social and Banco de España, that represent a giant step in the development of micro-level databases for scientific purposes of public interest. The more researchers can access these data the better. Imagine you have the option of hiring hundreds of researchers for analyzing different questions of the Spanish economy. Now, imagine you can get these researchers for free. I think this is what we are basically getting by making these data available to the academic community. I honestly think it represents a truly impressive opportunity for getting a better understanding of so many aspects of the Spanish economy.

Most of your research projects are joint with academics and policy makers alike. What are the main complementarities of this collaboration, and how do they benefit the BdE's policy decision process?

I see co-authorships as a long-run marriage. You can be very active in some stages of the project and somehow dormant in others depending on your availability. Therefore, it is crucial to trust your co-authors and be trusted by your co-authors. This trust generally emerges if everybody has a clear understanding of the arrangement and the comparative advantage of each partner. Personally, I like to work with academics because once you have a draft ready to circulate, they take care of the diffusion, which is the part I like the least and it is very time-consuming. At the same time, I like to work with policymakers because they are, in general, more pragmatic as I am. This pragmatism results in a trade-off: holding constant the quality and novelty of the idea, you can produce two or three papers aiming for decent but not top publications, or you can produce one single paper aiming for a top journal. My impression is that the number of working hours is similar in both cases, but I always have doubts about which strategy is preferable... Therefore, I generally let my co-authors decide, and this decision usually depends on whether they work for academia or for a policy institution.

Regarding the impact of research projects on the BdE's policy decision process, I'll give you one example that I think is very illustrative. In the summer 2010, when I joined the bank, I started working on the macro impact of fiscal consolidations. By that time, expansionary austerity (fiscal consolidation episodes followed by revived GDP growth) had its momentum. After a couple of years working on this issue, we got to the conclusion that expansionary austerity effects vanished once you control for a relatively simple form of endogeneity. That is, fiscal consolidations were followed by growth episodes because they were generally adopted at the end of recession periods. This result was well-received in the Working Group of Public Finance and the European Commission so I think, or at least hope, that it contributed to the austerity debate in Europe.

The Covid19 outbreak in early 2020 implied a shift in policy and research efforts within the BdE, at least in the short run. Your division has been actively involved in drafting the path through these uncharted waters. What do you feel are the main lessons so far, policy and research -wise?

One of the main characteristics of the pandemic-induced economic crisis is probably its asymmetry across sectors. Thus, the Division of Sectoral Analysis must be very much involved in understanding its consequences... In my experience as head of this division, the current crisis has been a great example on the close relationship between policy and research that I mentioned before.

On the one hand, networks models from the academic literature –very much in vogue over the last few years with the work of Emmanuel Farhi among others– have been extremely useful in the assessment of the impact of the COVID-19 shock on the Spanish economy from a policy perspective. In particular, our forecast of GDP growth for 2020 based on this type of models was -11.6% already in June 2020, and the final figure recently published by INE was -10.8%. Our investment in research projects about networks before the pandemic was essential for having a good understanding of these tools when the quite unexpected shock hit.

On the other hand, in 2020 we also launched a firm-level survey, the so-called EBAE (Encuesta Banco de España sobre Actividad Empresarial in Spanish), in order to monitor the evolution of economic activity in real-time and inform our forecast exercises. However, given the possibility of matching the survey with balance-sheet information from Central de Balances, we also published a research-oriented working paper characterizing the heterogeneity across firms on the impact of the COVID19 shock as well as the impact of the Pfizer vaccine announcement on firms' perspectives.

These are two clear examples of the research-oriented policy / policy-oriented research I was mentioning before!

Going forward, what areas of research you envisage that are likely to be policy-relevant?

I guess you may get 100 different answers to this question if you ask 100 different people, but I'll give you mine. There are several

dimensions in which the COVID-19 shock is unique. One aspect that may be important going forward is its unprecedented boost to the digitalization process. A higher pace of digitalization may impact TFP growth and counteract the process of secular stagnation present in many developed economies. Furthermore, as some of the NGEU funds may be diverted to promote technological progress, the COVID-19 shock may ultimately generate a new set of opportunities to firms, particularly in Spain. Finally, the BdE has already stressed that the immediate impact of the COVID shock has been heterogeneous across firms and households. Given the potential structural implications of the COVID-19 shock, the inequalities and heterogeneities across agents within countries and even across countries that are being exacerbated ought to be a research focus going forward.

Upcoming conferences

[Link to conferences page](#)

FOURTH ANNUAL RESEARCH CONFERENCE

Madrid (on-line), 28-29 September 2021

On 28-29 September 2021, the Banco de España will host its Fourth Annual Research Conference, to be held online. The conference is co-organized with Jan Eeckhout (Universitat Pompeu Fabra). This year's topic will be "Market Power in the Digital Economy: Measurement, Causes, Consequences and Policies". Leading scholars such as Ufuk Akcigit (University of Chicago), Mary Amiti (Federal Reserve Bank of New York), José Azar (IESE), David Baqaee (UCLA), Corina Boar (New York University), Chiara Criscuolo (OECD), Virgiliu Midrigan (NYU), Simon Mongey (University of Chicago), Michael Peters (Yale), Fiona Scott Morton (Yale), Chad Syverson (University of Chicago), and Tommaso Valletti (Imperial College London), among others, have confirmed their participation.

JOINT CEPR AND SEVENTH BANCO DE ESPAÑA ECONOMIC HISTORY SEMINAR

Madrid, 8 October 2021

Banco de España organizes jointly with CEPR the VII Seminar in Economic History, which will be held next October 8th 2021. The Seminar aims to discuss current academic research in Economic History. The organizers encourage the presentation of papers that contribute to progress of the discipline, providing new insights in all historical periods and areas of investigation.

THIRD CONFERENCE ON FINANCIAL STABILITY

Madrid, 18-19 October 2021

Banco de España in cooperation with CEMFI organizes a series of biennial conferences to promote the research and discussion of topics related to macroprudential policy and financial stability among academics, practitioners, and policy-makers. The third conference will take place at the Banco de España's headquarters in Madrid on 18-19 October 2021.

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