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SPAIN

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Approved By
European Department

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THE FISCAL POLICY OF AUTONOMOUS COMMUNITIES: ITS MACROECONOMIC EFFECTS AND THE ROLE OF THE NATIONAL FISCAL RULE[1]

The transposition of the EU economic governance framework to national legislation provides an opportunity to reform the subnational fiscal rule, especially with regard to its regional component. While compliance by autonomous communities has improved in the last decade, the current framework has not delivered on two key objectives of subnational fiscal rules for regional governments: avoiding procyclical public spending and ensuring debt sustainability. This paper makes the case for centering a revised fiscal rule on an expenditure growth target—consistent with the formulation of the EU framework—to ensure that spending by regional governments, particularly on health and education, remains mostly acyclical while also achieving debt-stabilizing regional fiscal policy.

A. Introduction

1. Autonomous communities are a crucial component of fiscal policy in Spain. In 2021 Spain ranked third among OECD and EU economies for the size of public spending carried out by regional governments as a share of GDP—approximately 18 percent—and fifth as regards regions' share of total public sector expenditure—approximately 27 percent (OECD, 2024). This large percentage is explained by the autonomous communities' responsibility for delivering several essential public services, including education, health, long-term care, and some other forms of social assistance.

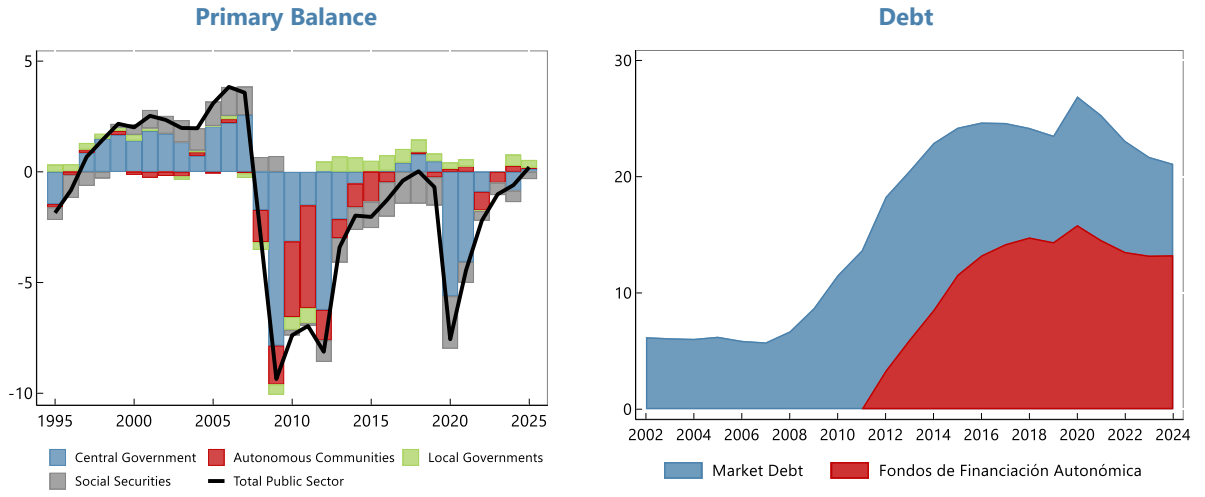
2. Regional public spending is supported by an institutional framework aiming to balance risk-sharing, redistribution, autonomy, and fiscal responsibility. Under the "common regime", applied to 15 communities, regional governments receive resources from a selection of taxes over which they have some ability to adjust rates, and have full autonomy over other taxes. Part of the revenues, together with additional transfers from the central government, are pooled into a set of funds that redistribute resources across regions to mitigate disparities in financing per capita. Meanwhile, the two communities under the "foral regime" (Navarra and País Vasco) pay a negotiated contribution to the general government's budget but retain the entirety of their tax collections. Autonomous communities can also finance spending by issuing debt. While some communities issue bonds and receive loans from banks, several of them finance part or the entirety of their debt through central-government sponsored vehicles, collectively denominated *Fondos de Financiación Autonómica*. These were established in 2014, originally as emergency instruments, to ensure access to credit at contained interest rates for all communities in the wake of the Global Financial Crisis (GFC) and the subsequent euro area crisis. Finally, a subnational fiscal rule sets yearly

[1] Prepared by Carlo Pizzinelli (EUR).

targets for communities' deficits, primary spending growth, and debt levels to safeguard fiscal sustainability and align regional budgets to the government's overall fiscal strategy.

3. Autonomous communities have historically been large contributors to Spain's fiscal deficit and debt (Figure 1). Prior to the GFC, the consolidated regional government sector regularly achieved a close-to-balanced budget, and its total debt remained stable at around 5 percent of GDP. From 2008 to 2019, however, the primary (overall) balance of autonomous communities was mostly negative, with a peak deficit of 4.6 (5.1) percent of GDP in 2011. As a result, regional debt rose pronouncedly, edging close to 25 percent of GDP in 2016. Since then, the consolidated deficits have decreased in size, with several individual communities reaching surpluses. With the exception of 2020, the first year of the COVID-19 pandemic, regional debt has declined every year, but challenges remain. By end-2025, total debt—including that issued via the government-sponsored funds—remained above 20 percent of GDP. This level amounts to a fifth of Spain's total public sector debt and is significantly above the long-term debt anchor of 13 percent envisioned in Spanish law (Organic Law 2/2012). Moreover, given their purview of health and long-term care services, autonomous communities will bear a substantial share of the large aging-related fiscal pressures that Spain is projected to face over the coming decades.

Figure 1. Primary Balance and Debt of Autonomous Communities
(Percent of GDP)



Sources: IGAE, Bank of Spain, and IMF staff calculations.

4. Overhauling the subnational fiscal rule would be a crucial step to strengthen the medium-term orientation and credibility of fiscal policy in Spain. The subnational fiscal rule is underpinned by the Organic Law on Budget Stability and Financial Sustainability 2/2012 (LOEPSF, for its Spanish name). The multiplicity of fiscal targets under the current subnational rule, as set out under the LOEPSF, has historically led to inconsistencies in the fiscal position of different communities, and compliance with its targets has been partial. Moreover, while compliance has improved over the last decade, the framework has not delivered on two key goals of subnational fiscal rules: stabilizing debt and avoiding procyclical fiscal policy. Additionally, as noted by AIReF (2025), the methodology for setting yearly targets on spending growth is not aligned with that of

the new EU economic governance framework, which became operational in 2025, leading to potential conflicts in the fulfillment of both rules. The need to align the subnational framework to the EU one therefore provides an opportunity to revise the former in order to better align it with optimal principles of regional fiscal policy and better tailor it to the nature of spending conducted by autonomous communities in Spain.

5. This paper provides new insights in support of a revised fiscal rule for autonomous communities centered on expenditure growth limits. Given their primary focus on essential public services, the expenditures of autonomous communities should remain decoupled from business cycle fluctuations. Deficit-based rules, while in principle preserving debt sustainability, would lead to procyclical spending that could exacerbate recessions and hinder long-term growth through cuts to education and health, as was the case in the GFC. Moreover, due to their limited debt-carrying capacity, autonomous communities are not well placed to conduct active countercyclical fiscal policy, as large deficits may quickly result in high debt financing costs, and the central government can in principle step in and fulfill this macroeconomic stabilization role. A viable solution would therefore be a rule centered on expenditure growth that ensures debt sustainability for individual regions, either through region-specific spending growth limits or through a common one with tighter adjustment requirements for high-debt regions whose debt is above a certain threshold—such as the 13 percent of GDP limit envisioned in the current debt rule. To further reduce the risk of procyclical spending cuts, the central government should ensure that its transfers to autonomous communities do not fall during downturns. The rule should also entail a clear and applicable corrective arm in the event of non-compliance, enforced by the Ministry of Finance.

6. The paper makes the case for an expenditure target through both descriptive and econometric analysis. Section B discusses the basic principles of fiscal federalism and subnational fiscal rules, relating them to the Spanish context. It highlights the case of the GFC to stress the need to prevent procyclical spending and the importance of debt sustainability. Sections C and D apply econometric techniques to more formally assess the historical conduct of fiscal policy by autonomous communities over 2004–2024. The analysis finds that regional public spending was positively correlated with the business cycle—falling in downturns, particularly in the aftermath of the GFC—and that most regions failed to stabilize their debt dynamics over this period. Moreover, Spain's strong procyclicality of spending on health and education—the communities' main responsibilities—is at odds with the experience from peer euro area countries, where it is mostly acyclical, as warranted. Section E discusses Spain's current subnational fiscal rule, set out by the LOEPSF, examining regions' historical compliance and highlighting the inherent inconsistency between the yearly deficit and spending growth targets. Section F considers key issues in the design of an expenditure-based fiscal rule for Spain's regions, drawing also from two recent proposals by AIReF (2025) and Martínez-López and others (2026).

7. The finances of autonomous communities have been the subject of significant analysis, particularly after the GFC and the euro area crisis. For instance, Fernández-Llera (2011) and Pérez and Prieto (2015) present early analysis of regional debt, while Canuto and Liu (2013) place the Spanish case in the comparative context of other countries in the wake of the GFC. More

recently, Marín-González and Martínez-López (2024) provide an in-depth analysis of historical drivers of regional debt. Moreover, the yearly fiscal performance and budget execution of communities has been highly studied and tracked by academics and think tanks (e.g., see for instance de la Fuente, 2025). Several works point to the importance of examining regional finances in the broader context of national fiscal policy in Spain (Hernández de Cos and Pérez, 2013). Studies thus considered the limited coordination of fiscal effort (Lledó, 2015), spillovers from the fiscal stance of the central government (Molina-Parra and Martínez-López, 2018), the role of extraordinary liquidity funds that allow for soft budget constraints (Herrero-Alcalde and others, 2019; Calvo-López and Cadaval-Sampedro, 2022), and the spending responsibility of regions on essential services, which tend to be prioritized over debt reduction (Marín-González and Martínez-López, 2026).

8. Several studies have also examined the historical track record of compliance with the subnational fiscal rule and the implications for fiscal policy. Agrimón and Hernández de Cos (2012) examine an earlier version of the national fiscal rule, in place between 1992 and 1998, finding that it did not have significant effects on regional fiscal balances. Leal and López-Laborda (2015), Lago-Peñas and others (2016), and Delgado Téllez and others (2017) study econometrically the drivers of non-compliance with the objectives of the fiscal rule, finding that a variety of "hard" and "soft" factors matter. Among the former are the ambitiousness and volatility of the targets, exogenous growth shocks, and the persistence of non-compliance (i.e., a track record of low compliance decreases the likelihood of meeting current targets, all else equal). Among the latter are political-economy factors such as soft budget constraints, the degree of fiscal autonomy, and changes in the political affiliations of regional governments. Martínez-López (2020) points to the reduced efficacy particularly of the debt and spending rules of the LOEPSF, as well as the limited enforceability of the rule's corrective mechanisms. More recently, however, Herrero-Alcalde and others (2022) find that, despite partial compliance, the expenditure rule has to some extent helped contain growth in current and primary expenditure.

B. Principles of an Enhanced Subnational Rule in the Context of Spain's Spending Areas

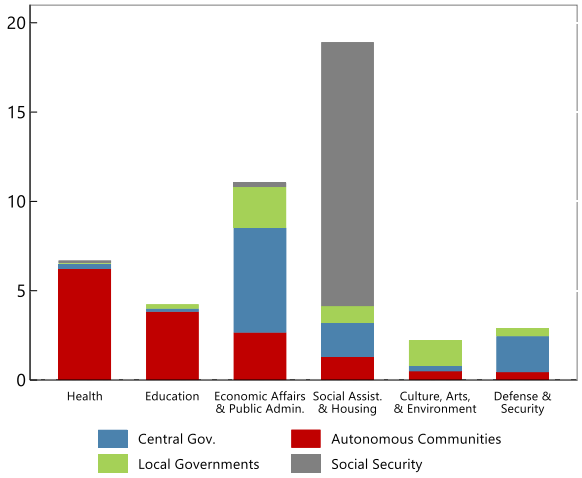
9. Autonomous communities account for the majority of public sector expenditure in health and education in Spain (Figure 2, left panel).[2] The central administration, on the other hand, concentrates its spending on economic development, public administration, and defense and security. Finally, the social security administration and local governments (i.e., municipalities) have more specialized functions such as pensions and local security, respectively, and, in the case of the latter, represent a smaller share of total spending. This distribution of responsibilities is well aligned with theories of optimal federal spending (Oates 1972, 1999), whereby central authorities are best placed to address macroeconomic stabilization and deliver country-level public goods like national defense, while territorial governments should focus on the provision of services that may require

[2] Long-term care (e.g., for elderly and disabled individuals) is also primarily a responsibility of regional governments. The functional classification of government expenditure (COFOG) distinguishes between nursing-oriented long-term care, which falls under health, and non-nursing care, which falls under social protection. The latter, outside of pensions, is a significantly smaller spending area compared to health.

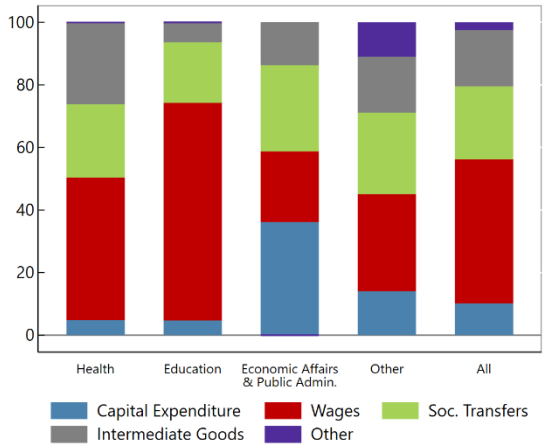
tailoring to the needs and preferences of their populations. Although spending in health and education is mostly comprised of wages and social transfers, autonomous communities also account for approximately half of all capital spending (amounting to 1.6 percent of GDP) concentrated under economic affairs and general public service programs (Figure 2, right panel).[3]

Figure 2. Public Spending by Functional Divisions

Spending by Level of Government
(Percent of GDP)



Economic Composition of Spending by Autonomous Communities
(Percent)



Sources: IGAE and IMF staff calculations.
Note: The left plot reports average spending as a share of GDP over 2022–2024. The right plot reports the average composition of spending by autonomous communities in different programs by its economic classification over 2022–2024.

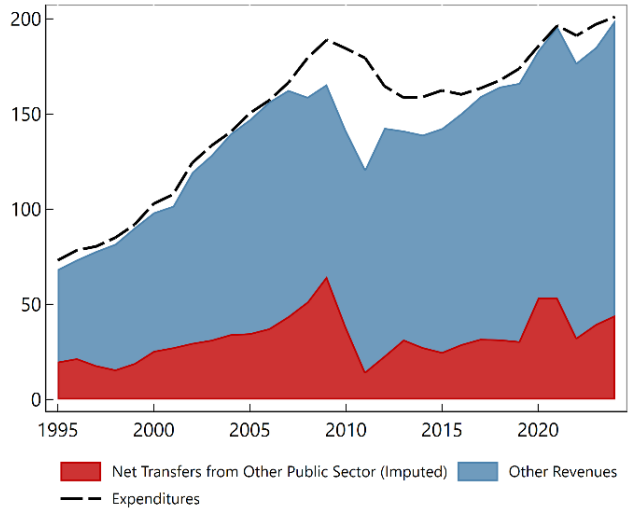
10. Autonomous communities' spending should not fluctuate significantly over the business cycle. Health and education are crucial for fostering long-term economic growth but do not have strong macroeconomic stabilization functions, as they generally have lower short-run multipliers (Atolia and others, 2017) and are mostly determined by inelastic demand for essential services. Hence, they do not lend themselves well to countercyclical spending. At the same time, procyclical spending in these areas should also be avoided, as health and education services provision should not be diminished or discontinued due to macroeconomic circumstances, and evidence shows that cuts in health and education during downturns can lengthen the duration of the recession—a phenomenon called hysteresis—and inflict long-lasting scars on human capital and potential output (Jackson and others, 2021). These spending programs should therefore remain

[3] The main results of Figure 2 are robust to considering the full period 1995-2023. While health expenditure has increased significantly since 1995, this area of spending and education have historically been assigned to autonomous communities. Moreover, the composition of spending within each area, portrayed in the right panel, is also broadly stable over time.

acyclical, while still contributing to debt sustainability and fiscal consolidation efforts by following predictable multi-year trajectories and through spending efficiency reviews.[4]

11. In turn, to maintain stable spending through the business cycle, autonomous communities require a combination of debt-issuance capacity and stability in revenue sources. Some access to debt markets, allows communities to maintain stable (acyclical) spending on essential services when revenues decline due to cyclical shocks. However, while autonomous communities can issue debt in the form of bonds and loans, their overall debt-carrying capacity is more limited than that of the national government.[5] Therefore, acyclical spending also requires that, during economic upswings, revenue surpluses be devoted to debt repayments rather than increased provision of services above initial plans. Moreover, the more stable revenues are, the less likely it is that communities need to issue debt to finance spending. In particular, transfers from the central government should remain stable and predictable, if not actively offsetting fluctuations in communities' own tax revenues, whose bases fluctuate with the business cycle.

Figure 3. Consolidated Revenues and Expenditures of Autonomous Communities
(Billions of Euros, Constant 2019 Prices)



Sources: IGAE, INE, and IMF staff calculations.
Note: Net transfers are computed as transfers (current and capital) from other public sector entities minus transfers to other public sector entities (current and capital) minus 50 percent of the central government's VAT revenues minus 58 percent of the central government's revenues of alcohol, tobacco, and hydrocarbons excise taxes, and minus 100 percent of the central government's revenues of electricity excise taxes.

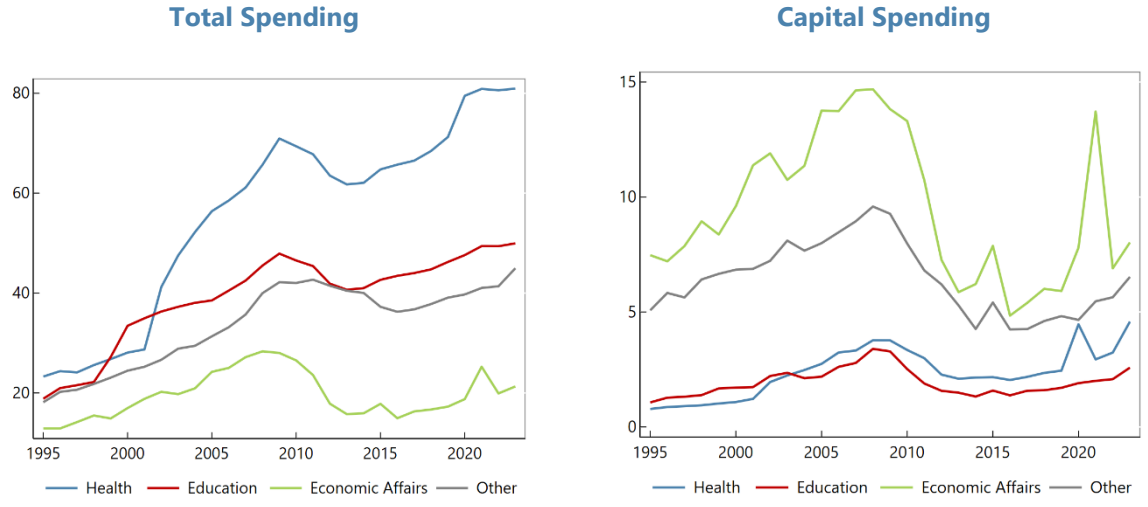
12. The experience of the Global Financial Crisis (GFC) and euro area crisis in Spain illustrates how limited debt issuance capacity and unstable revenues can result in procyclical spending by regions. The consolidated revenues of autonomous communities began to slow down in 2007, driven primarily by lower tax revenues, while net transfers from the central government remained stable at first and eventually rose (Figure 3). Spending continued to rise over 2007–2009, outgrowing revenues and leading to an initial rise in debt as seen in Figure 1. In 2010 and 2011, transfers from the central government, partly linked to the system of reconciliation of past tax

[4] As recommended in the 2025 Article IV, health and education are two areas in which AIReF could conduct comprehensive reviews, with cross-country benchmarking.

[5] The limited debt-carrying capacity of autonomous community governments is clearly reflected in Figure 5 and Annex Figure A.2, which are discussed later in the text. For instance, before 2008, most communities owed just between 5 and 10 percent of their GDP in debt but faced effective interest rates above 4 percent, comparable to those faced by the central government with a debt-to-GDP ratio of about 30 percent.

revenues (known as *liquidaciones*)—which had fallen due to the economic crisis, also contracted sharply and persistently. This led to a long-lasting slump in autonomous communities' revenues, which recovered their 2007 level in real terms only 10 years later. This slump was accommodated through both a steep rise in debt and eventually a durable reduction in spending. In 2008, and then more decisively in 2010, autonomous communities retrenched spending in all areas, including health and education (Figure 4, left panel).[6] The adjustment was mostly carried out via cuts to capital expenditure, which fell by more than 50 percent in real terms over 2009–2014 (Figure 4, right panel) and accounted for 54 percent (€16 billion) of the €30 billion contraction, in 2019 prices, in total spending by regional governments over the same period. The long-lasting reduction in spending was motivated by soaring debt servicing costs for most communities starting in 2009 until 2014, when the establishment of the *Fondos de Financiación Autonómica* reduced effective interest rates and allowed regions to regain fiscal space (Figure 5). In the following decade, despite the recovery in revenues and the lower borrowing costs, debt plateaued but did not decline to pre-GFC levels.

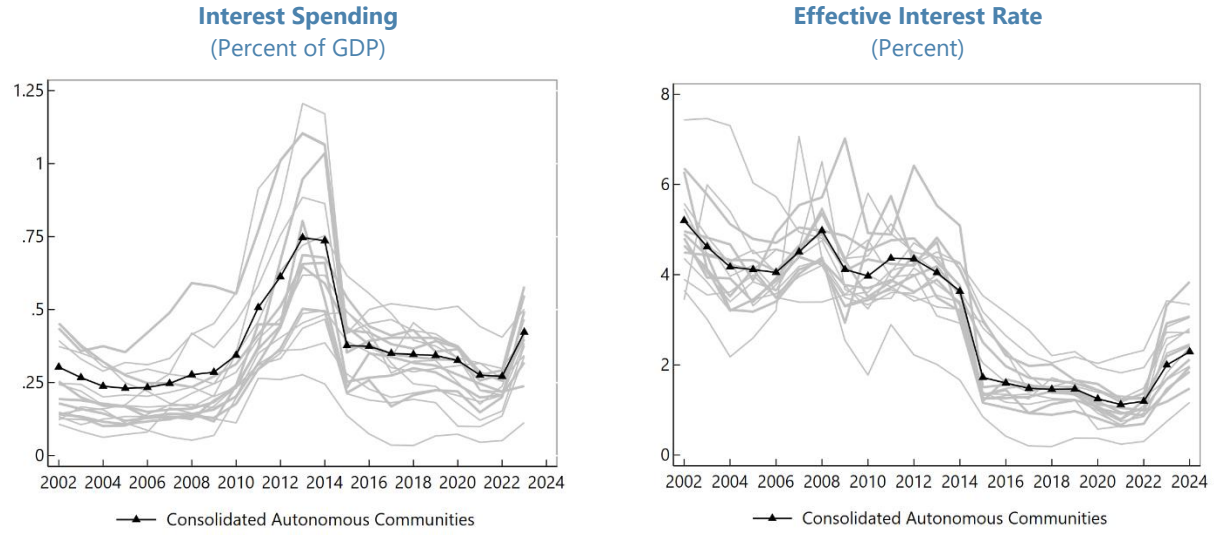
Figure 4. Spending by Autonomous Communities in Selected Functional Divisions
(Billions of Euros, constant 2019 Prices)



Sources: IGAE, INE, and IMF staff calculations.

[6] Figure 3 uses data on expenditures and revenues in national accounts terms, as published by IGAE. The data does not differentiate between different types of transfers from (to) the central government to (from) autonomous communities. In particular, it does not separate the central government's contribution to the regional financing system from transfers related to tax revenues that the central government collects on behalf of the autonomous communities (such as for the VAT). The figure therefore imputes net transfers as transfers (current and capital) from other public sector entities to the communities minus transfers from the communities to other public sector entities (current and capital) minus 50 percent of the central government's VAT revenues minus 58 percent of the central government's revenues of alcohol, tobacco, hydrocarbons excise taxes, and minus 100 percent of the central government's revenues of electricity excise taxes. The main dynamics of the figure are robust to using an alternative source of data on expenditures, revenues, and transfers: Annex Figure A.1 presents a version of the plot using data by the Ministry of Finance on the budget execution of autonomous communities reported on a cash accounting basis.

Figure 5. Debt Servicing Costs of Autonomous Communities



Sources: IGAE, INE, and IMF staff calculations.
Note: The grey lines report the interest spending in percent of GDP (left plot) and the effective interest rate on debt (right plot) of individual autonomous communities. The black lines represent the respective variables for the consolidated regional government sector.

13. The next two sections discuss the historical conduct of fiscal policy by autonomous communities more comprehensively and more formally. Specifically, Section C examines the cyclicality of spending of regional governments, as a collective and as individual entities. Section D studies the responsiveness of regions' deficits to debt levels and the implications for debt stability.

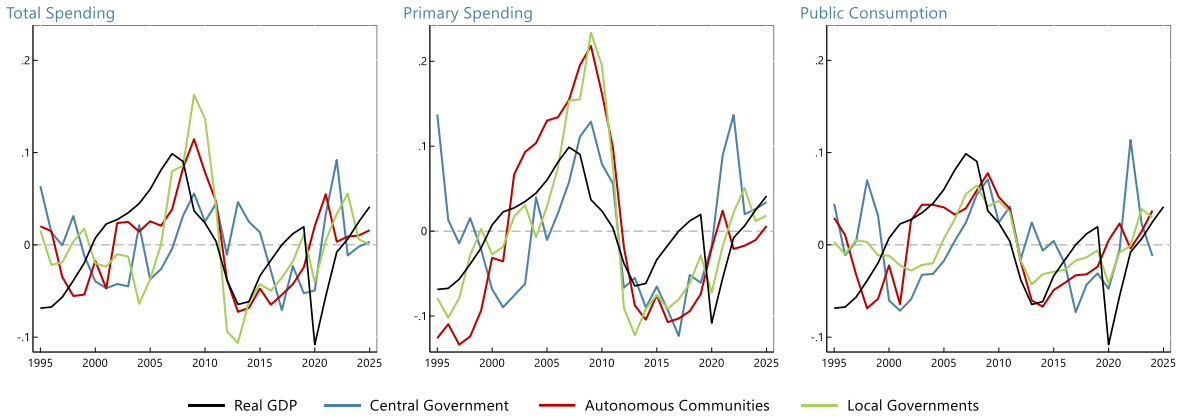
C. Cyclicality of Spending

14. Autonomous communities' spending has been strongly procyclical throughout the last three decades. Figure 6 plots the cyclical component of log real expenditure by level of government for different definitions of spending against the cyclical component of real GDP.[7] The three definitions considered are total spending, primary spending—which excludes interest costs—and public consumption—which excludes interest, investment, and transfers. In all cases, spending by autonomous communities appears more aligned with the business cycle (or its lag) and exhibits a larger amplitude of fluctuations than that of the central government. This procyclical behavior is similar in nature to spending by local governments, which, however, are significantly more constrained in accessing debt. Moreover, while the GFC boom-and-bust dynamics are most notable, the alignment with the business cycle is also visible in the upswing phase over 2013–2024, when the current fiscal rule was in place. The COVID-19 pandemic is the only exception to this pattern, as spending by autonomous communities rose markedly in response to the health emergency despite a sharp economic contraction. Primary expenditure appears to be the most procyclical definition of

[7] All reported values are chained at 2019 prices using the GDP deflator. The cyclical component is extracted by subtracting from the natural logarithm of the series the trend estimated with the Hodrick-Prescott filter using a smoothing parameter of 100, which is a common value for yearly data.

spending, as it excludes interest costs—which can be countercyclical (Figure 3)—but includes capital expenditure, which has historically borne a strong positive correlation with the cycle.

Figure 6. Cyclical Component of Real Spending Across Levels of Government and of Real GDP
(Deviations from HP-filtered trend of log series)



Note: The plots report the cyclical component of each type of spending by level of government and of real GDP. Cyclical components are computed by extracting a trend using the Hodrick-Prescott filter with a smoothing weight of 100 from the natural log of spending deflated to constant 2019 prices.
Sources: IGAE, INE, and IMF staff calculations.

15. Econometric analysis confirms the procyclicality of autonomous communities' spending. The specifications presented in this section examine regional spending in Spain as a consolidated level of government, that of individual regional governments, and through the areas of spending for which they are mostly responsible. Following a long-standing literature (e.g., Ilzetzki and Vegh, 2008; Frankel and others, 2013), the overall responsiveness of fiscal policy to the business cycle is studied by focusing on spending, rather than the balance or revenues, because governments have greater discretionary ability to adjust at least some spending items throughout the year, as observed economic conditions evolve. This allows for more reliable analysis of the discretionary response of fiscal policy to business cycle fluctuations. Moreover, the study of public consumption, rather than total or primary spending, further focuses the analysis on areas of expenditure that are in policymakers' control by excluding automatic stabilizers such as unemployment benefits and interest payments, which are strongly countercyclical.

16. Following the approach of the literature on cyclical fiscal policy, the starting point for the analysis is a regression of cyclical spending on the output gap. The baseline specification is as follows:

$$\text{Cycle}\,(\text{Log Expenditure}_t) = \alpha + \beta\,\text{Cycle}\,(\text{Log GDP}_t) + \gamma X_t + \epsilon_t \qquad (1)$$

where *Expenditure* and *GDP* are expressed in constant 2019 prices. For both series, the cyclical component is constructed by extracting the trend of the natural logarithm through a Hodrick-Prescott filter, using a smoothing weight of 100. The vector X_t represents possible control variables to be added (e.g., a binary variable for specific historical period, or the series on *liquidaciones* of previous tax revenues).

17. The coefficient of interest is β, which captures the general behavior of fiscal policy over the business cycle. A negative value would indicate countercyclical spending, which would likely reflect the use of fiscal policy predominantly for active macroeconomic stabilization. Meanwhile, a positive value would imply procyclical spending, which may be the result of different behaviors. First, it could reflect tight financing constraints, forcing the government to adjust expenditure in line with procyclical fluctuations in revenues, originating from a limited ability to issue debt. Alternatively, even when there is additional borrowing capacity, procyclicality could be suggestive of strict compliance with deficit-based fiscal rules, which would imply adjustments in spending in order to match fluctuations in revenues to achieve a given deficit target.[8] Whenever possible, instrumental variable methods are applied, as described below, to avoid two-way causality between the output gap and spending. In particular, higher (lower) spending could stimulate (tighten) the economy and thus lead to a higher (lower) output gap.[9] In this regard, the analysis of public consumption, which excludes automatic stabilizers like unemployment benefits, already partially reduces the risk of endogeneity.

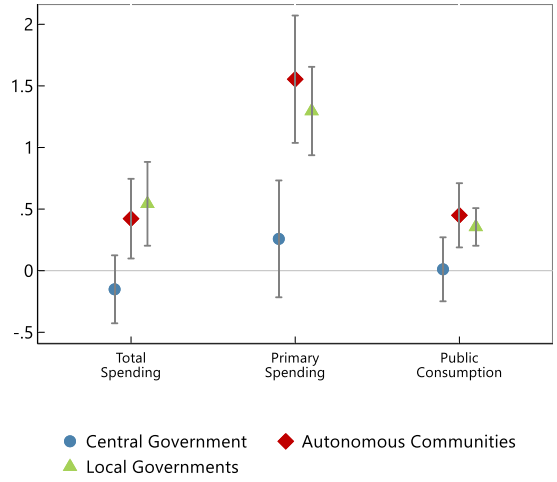
18. The above specification is adapted to three different aspects of fiscal policy procyclicality. First, it is used to compare the cyclicality of each level of government in Spain: central, autonomous, local, and where the latter two are studied as consolidated sectors. Second, it is applied to the panel of the 17 individual autonomous communities. Third, it is used to compare the cyclicality of spending on health and education in Spain relative to peer EU advanced economies. The first two specifications use data by the Spanish Ministry of Finance's internal control body (IGAE) on the yearly fiscal accounts of each consolidated level of government and for individual autonomous communities over 2004–2024. Real GDP is produced by the national statistical institute (INE). The third specification uses data by Eurostat over 1995–2023 on real GDP and public spending in health and education following the functional classification of spending (COFOG).

[8] In theory, as deficit-based rules impose limits rather than exact targets, the behavior of spending could be asymmetric with respect to fluctuations in revenues, whereby revenue falls are matched by contractions in spending to meet the deficit limit, while spending does not rise during positive revenue surprises to achieve an over-performance of the deficit. In practice, however, governments are unlikely to restrain spending during period of buoyant revenues, as they have incentives to compensate for past periods of fiscal restraint during downturns.

[9] In several specifications, the small sample size of the regression impedes the use of an instrumental variable. In those cases, robustness checks are conducted using lags of the output gap as the explanatory variable of interest.

19. The analysis shows that the fiscal policy of the consolidated regional government sector has historically been more procyclical than that of the central government. Figure 7 reports the coefficients of interest from specification (1) estimated individually for each consolidated level of government and definition of spending. The quantitative results confirm the visual results of Figure 6. The estimated elasticity coefficient for autonomous communities is in all cases positive, statistically different from zero, and larger than the coefficient for the central government. Regional government spending is in fact closer in behavior to that of municipalities. For total spending and public consumption, the estimated coefficient is close to 0.5, reflecting substantial procyclicality: a one percent increase in the output gap has historically been associated with a 0.5 percent increase in total spending and public consumption. Meanwhile, the coefficient for primary spending is about three times as large. This difference reflects the large fluctuations in capital spending, which is often the most discretionary in nature and, being related to long-term projects, may be more easily shifted across years. Meanwhile, the estimated coefficients for the central government are not statistically different from zero, thus suggesting acyclical fiscal policy overall (even though the coefficient for primary spending appears slightly more positive). Taken together, these results confirm the view that, despite having some ability to borrow to smooth consumption, and having increased their debt significantly over 2004-2024, autonomous communities have historically conducted fiscal policy more in line with that of local governments, which have almost no borrowing capacity, than that of the central government, which has significantly greater ability to issue debt.

Figure 7. Cyclicality of Spending by Level of Government
(Estimated regression coefficients)



Sources: IGAE, INE, and IMF staff calculations.
Note: The plot reports the estimated coefficients from 9 linear regressions of the cyclical component of each definition of public spending for each level of government on Spain's output gap, as described in the main text.

20. A panel regression of spending for individual autonomous communities confirms this procyclicality. A panel regression with community-specific fixed effects is run for all three types of spending separately. Following the approach of Ilzetzki and Vegh (2008), the cyclical component of real GDP of each community is instrumented using two variables which plausibly affect local output but are unlikely to be contemporaneously associated with local public spending. Specifically, these are: (i) the average output gap of bordering autonomous communities, and (ii) the export-weighted output gap of Spain's trading partners. All autonomous communities are weighted equally in the regression. Table 1 reports the estimated regression coefficient for each of the three definitions of spending. In all cases, although the estimated values are lower than for the consolidated regional government sector, with values in the range of 0.3-0.4, the coefficient is positive and statistically

significant. Once again, primary spending shows somewhat higher procyclicality, although differences are more moderate than they are for the consolidated regional government sector.

Table 1. Spain: Panel Regressions of Cyclicality of Spending in the Autonomous Communities

VARIABLES	(1) Total Expenditure	(2) Primary Expenditure	(3) Public Consumption
Regional GDP - Detrended	0.366***	0.437***	0.349***
	(0.055)	(0.057)	(0.025)
Constant	0.003***	0.003***	0.003***
	(0.000)	(0.000)	(0.000)
Observations	340	340	340
Number of CAs'	17	17	17
IV 1: Neighbors' GDP	YES	YES	YES
IV 2: Trading Partners GDP	YES	YES	YES
First-Stage F-stat	264	264	264
P-val	0.00	0.00	0.00
R2 - Between	0.32	0.31	0.39
R2 - Within	0.03	0.04	0.07

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Sources: Eurostat, IGAE, INE, and IMF staff calculations.

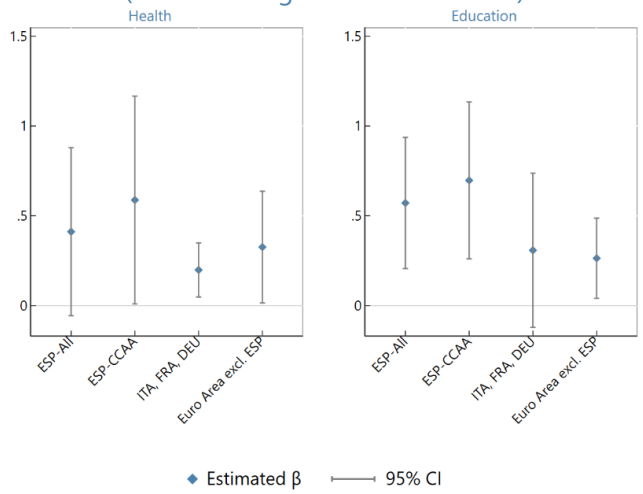
21. The panel regression results are robust to sensitivity analysis, presented in the Annex. First, Annex 1 Table 1 shows that the estimated coefficients do not vary substantially when (i) excluding Navarra and País Vasco, the two communities under the "foral regime" of financing (Columns 1, 5, 9), (ii) using one instrumental variable at a time (Columns 2–3, 6–7, 10–11), and (iii) controlling for *liquidaciones* of tax revenues from two years prior.[10] Second, given the large fluctuations related to the GFC seen in Figure 6, Annex 1. Table 2 examines whether the procyclicality of spending can be entirely ascribed to this episode or holds more broadly instead, by adding an interaction between the output gap and a dummy variable for the period 2009–2012. The results suggest that the GFC period—represented by the interacted coefficient—was characterized by very strong procyclicality (4 to 6 times the baseline value) but that the rest of the period of analysis is also marked by statistically significant procyclicality. Annex 1. Tables 3 and 4 examine alternative specifications. The former shows that a regression in first differences leads to smaller coefficients but that are still positive and statistically significant. The latter applies a System-GMM approach with Arellano-Bond instruments, as in Ilzetzki and Vegh (2008), to model potential

[10] *Liquidaciones* are netting transfers from the central government to regional governments related to the difference between the expected revenue and the actual outturn of taxes that the central government collects on behalf of the regions and transfers to the common funds that constitute the "system of autonomous financing". When revenues in year *t* exceed expectations, the central administration transfers the revenue surprise to the corresponding community in year *t*+2. In some cases, this sum can entail a substantial increase in resources available, which in a given year is in most part anticipated as it is related to past tax outturns. In the regression, *liquidaciones* of year *t* are included in the observation of year *t*+2 and are reported as a percent of GDP in year *t*+2.

autocorrelation in the dependent variable.[11] Spending has strong persistence, as the estimated coefficient on the lagged value *t*-1 is around 0.7 for all three expenditure definitions. Nevertheless, while the coefficient on the output gap is about half as large as in the main specification, it remains statistically significant.

22. Spending on health and education has historically been more procyclical in Spain compared to peer European economies. The regression specification (1) is adapted to separately examine the business cycle behavior of spending on health and education for (i) Spain's general government, (ii) Spain's autonomous communities, (iii) Germany, France, and Italy, and (iv) all EU countries excluding Spain. Figure 8 plots the estimated coefficients for each sample.[12] For both health and education, the estimated coefficient for Spain's total general government spending and for spending by regions is above that obtained for other European countries. In fact, unlike in Spain, the procyclicality of spending in these two areas is not the norm among these peer economies.

Figure 8. Cyclicality of Spending on Health and Education in Spain and the EU
(Estimated regression coefficients)



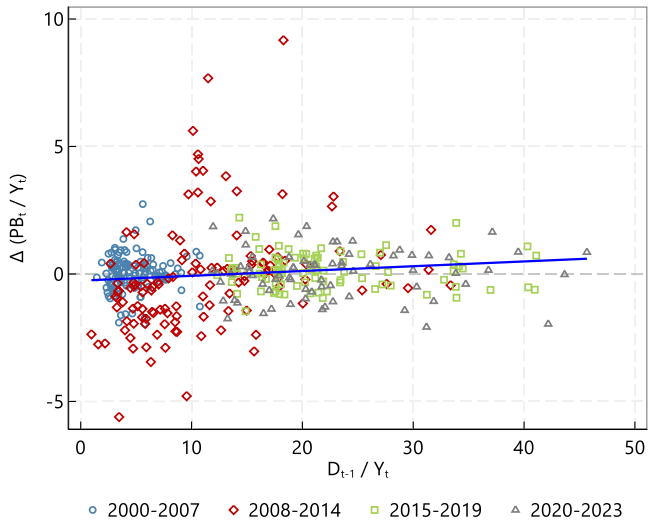
Sources: Eurostat, IGAE, INE, and IMF staff calculations.
Note: The plots report the estimated coefficients and 95 percent confidence intervals from linear regressions of the cyclical component of public spending on health and education on the output gap for (i) Spain, (ii) Spain's autonomous communities, (iii) Italy, France, and Germany, and (iv) the panel of Euro Area countries excluding Spain.

[11] The inclusion of a lagged dependent variable in a fixed-effects framework introduces correlation between the explanatory variables and the error term, which requires an instrumental variable approach for the lagged dependent variable, System GMM specifies the equation both in first differences and in level, with the lag of the dependent variable appearing in the right-hand sides of both equations. Past values of the level are used as Arellano-Bond instruments for the lagged first difference value, while lagged first differences serve as instruments of the lagged level. To reduce the number of instruments, the analysis uses only up to the tenth lag of the dependent variable with the "collapse" option to avoid overfitting. The output gap remains instrumented using the neighbor regions' and trading partners' GDP.

[12] The baseline specification uses the contemporaneous output gap. Results are robust to using the one-year or two-year lag of the output gap to avoid two-way causality.

D. Debt Stabilization

Figure 9. Debt-to-GDP ratio and Fiscal Impulse of Autonomous Communities



Sources: Bank of Spain, IGAE, INE, and IMF staff calculations.

23. On average, since 2000, autonomous communities' fiscal policy has not been strongly responsive to debt levels. Figure 9 plots communities' debt-to-GDP ratios against their fiscal impulse—measured as the yearly change in the primary balance.[13] The impulse shows little association with debt levels. A positive relationship would suggest a stronger response of fiscal policy to debt levels, aimed at reducing debt when it is high. However, the plotted historical values throughout the full period display a flat relationship. Only the interval 2008-2014, which spans the years from the pre-GFC cyclical peak to the establishment of the *Fondos de Financiación*, exhibits a positive association. The subsequent subperiods, however, show no relationship between the high debt levels in the wake of the GFC and a tightening of the fiscal stance. As a result, debt ratios remained generally high after 2010.

24. An econometric specification is applied to estimate the "fiscal reaction function" of autonomous communities. Following the seminal work of Bohn (1998), the fiscal reaction function quantitatively appraises the debt-stabilizing properties of fiscal policy. The relationship is estimated in three ways: (i) separately for individual communities, (ii) jointly for the panel of communities, and (iii) for a single time series of the consolidated regional government sector. For an individual community, the specification is as follows:

$$\mathrm{PB_t/GDP_t} = \alpha + \beta\ (\mathrm{D_{t-1}/GDP_t}) + \gamma\ \mathrm{Cycle}\ (\mathrm{Log\ GDP_t}) + \epsilon_t$$

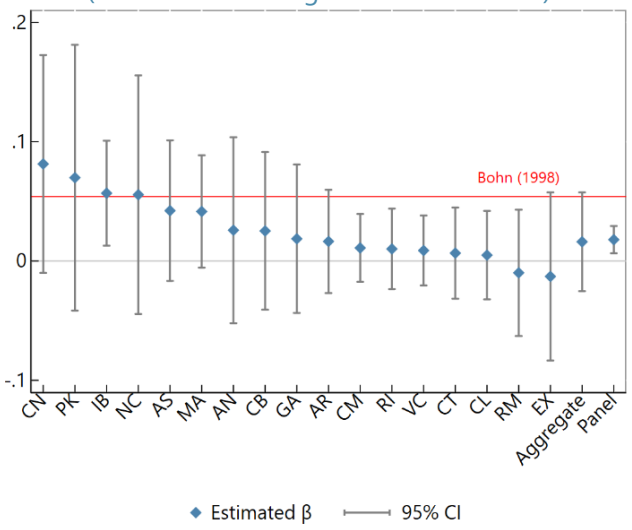
where the coefficient of interest is β. Higher values of β reflect a stronger reaction of the primary balance to the debt level and thus a larger weight put on debt stabilization in the conduct of fiscal policy. As discussed below, the estimated value of the coefficient also sheds light on whether the conduct of fiscal policy is consistent with stabilizing the debt ratio over the long term. The inclusion of the output gap on the right-hand side controls for the response of fiscal policy to the business cycle, which is a confounding factor.

[13] The debt-to-GDP ratio is computed as the beginning-of-period by using the debt level at the end of year *t*-1 and GDP in year *t*.

25. Estimated coefficients confirm that, for most communities, fiscal policy has been little responsive to debt levels historically. Figure 10 reports the coefficients for individual communities, as well as for the consolidated regional government sector and the panel of regional governments. The small sample size for each region leads to large confidence intervals and mostly statistically insignificant coefficients at the 5 percent level. A few communities show coefficients larger or similar in size to that estimated by Bohn (1998) for the United States in the second half of the 20th century (red line in Figure 10). However, in most cases, and for the panel of all regions, the coefficient is very close to 0. The value for the panel of communities is approximately 0.02, meaning that a 10-percentage point increase in debt is associated with a 0.2-percentage point improvement in the primary balance.

26. The estimated coefficients can also shed light on the stationarity of the debt ratio and its sensitivity to financing costs and growth shocks. Bohn (1998) shows that stationarity of the time series of debt requires that the condition $(1+\bar{r}-\bar{g})(1-\beta)<1$ be met, where $\bar{r}$ is the average real sovereign interest rate and $\bar{g}$ is the average real growth rate. For an estimated value of β, setting either $\bar{r}$ or $\bar{g}$ to historical values allows deriving the size of the growth decline or the worsening of financing costs, respectively, that would result in non-stationary debt dynamics.

Figure 10. Bohn Rule Coefficient by Autonomous Community
(Estimated from regression coefficients)



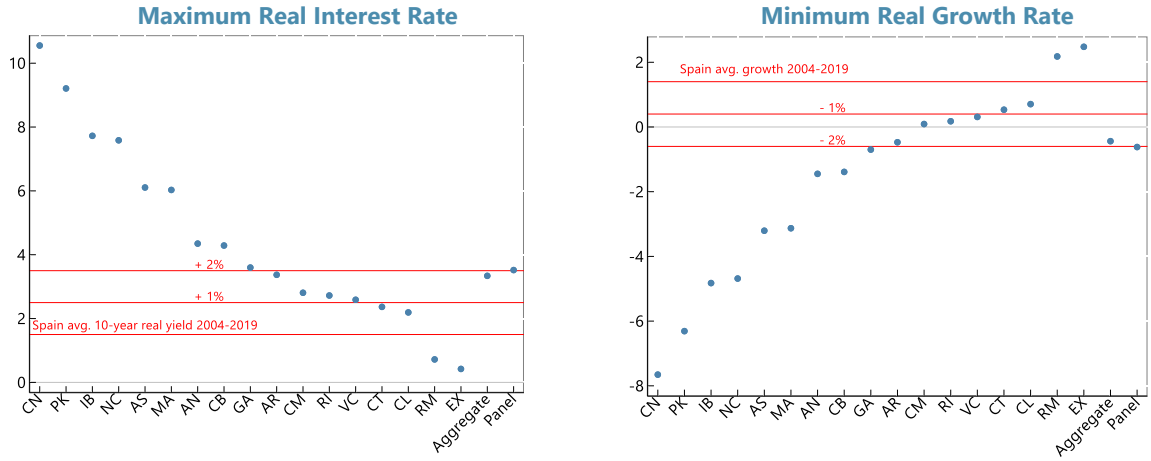
Sources: Bank of Spain, IGAE, INE, and IMF staff calculations.
Note: The plot reports the estimated coefficients from a linear regression of the primary balance on the debt-to-GDP ratio of individual autonomous communities, as described in the main text. The red line reports for reference the value estimated by Bohn (1998) for the US in the second half of the 20th century.

27. Based on historical relationships, debt dynamics in several autonomous communities would become non-stationary in the event of higher interest rates. The left panel of Figure 11 shows the maximum interest rate which would ensure stationarity when setting average growth $\bar{g}$ equal to 1.7 percent, in line with staff's medium-term projection for Spain. For most communities, real borrowing rates in line with those faced by Spain's central government prior to the pandemic would imply stationarity. However, the debt dynamics of 6 communities would become non-stationary with an increase in financing costs of 2 percentage points, which is close to the rates faced by most regions prior to the introduction of the *Fondos de Financiación Autonómica*. Meanwhile, the right panel of Figure 11 fixes the long-run real borrowing cost $\bar{r}$ to 1.2 and plots the minimum growth rate that ensures stationarity.[14] Once again, stationarity holds for most

[14] This value approximates the average real cost of funding between 2000 and the GFC, when Spain's 10-year bond yields averaged 4.4 percent and inflation averaged 3.2 percent.

communities with growth rates in line with the pre-COVID average. A reduction in growth of 2 percentage points would result in non-stationary debt dynamics for 6 regions. Compared to financing costs, however, it is unlikely that real growth could fall durably by this amount, entering negative territory.

Figure 11. Maximum Interest Rate and Minimum Growth Rate for Stationary Debt Dynamics
(Percent)



Sources: Bank of Spain, IGAE, INE, and IMF staff calculations.
Note: The left plot reports the maximum real interest rate at which debt dynamics for each community remain stationary based on the estimated regression coefficients from a linear regression of the primary balance on the debt-to-GDP ratio of individual autonomous communities, as described in the main text. Similarly, the right plot reports the minimum real GDP growth at which debt dynamics for each community remain stationary.

E. Historical Compliance with the Subnational Fiscal Rule

28. Spain's subnational fiscal rule is currently defined by the LOEPSF (Organic Law 2/2012), but deficit-based subnational targets had already been in place in previous decades. Starting in 1992, regional governments agreed on yearly fiscal deficit targets with the central administration. Under the 2001 Budget Stability Law (Law 18/2001 and Organic Law 5/2001), starting in 2002 regions had to achieve either balanced budgets or a surplus. The 2006 Budget Stability Law (Organic Law 3/2006), which came into force in 2007, aimed at harmonizing the national framework with the European Union's Stability and Growth Pact; it set fiscal deficit limits in percent of regional GDP that could vary depending on the cyclical position and the implementation of productive investments. More developed corrective and coercive mechanisms were also introduced by the same law (Delgado Tellez and others, 2017).

29. Introduced in 2013, the LOEPSF articulates objectives based on three fiscal measures and differentiated by level of government. In particular, the LOEPSF envisions three types of limits:

- *Structural deficit.* All administrations should achieve a structural balance, although adjustments are made based on cyclical considerations, emergencies, natural disasters, or growth-enhancing investments. In practice, a deficit limit is set by the Ministry of Finance for the consolidated general government and broken down into

separate targets for the central, regional, and local governments, as well as for the social security administration. With the exception of 2013, all autonomous communities have always been subject to the same deficit target since the LOEPSF has been in place.[15]

- *Spending growth*. A spending growth limit, computed based on Spain's nominal medium-term potential growth rate, is set homogenously for the central, regional, and local governments. The Ministry of Finance is responsible for computing the reference rate.

- *Debt*. A debt limit, compatible with the EU's Excessive Deficit Procedure target of 60 percent of GDP, is split into specific debt limits for each territorial level: 44 percent for the central government, 13 percent for the autonomous communities, and 3 percent for municipalities. When the debt-to-GDP ratio is above these limits, the respective entities must publish a multi-year debt reduction plan resulting in yearly debt targets, which must also be compatible with the deficit and spending growth targets.

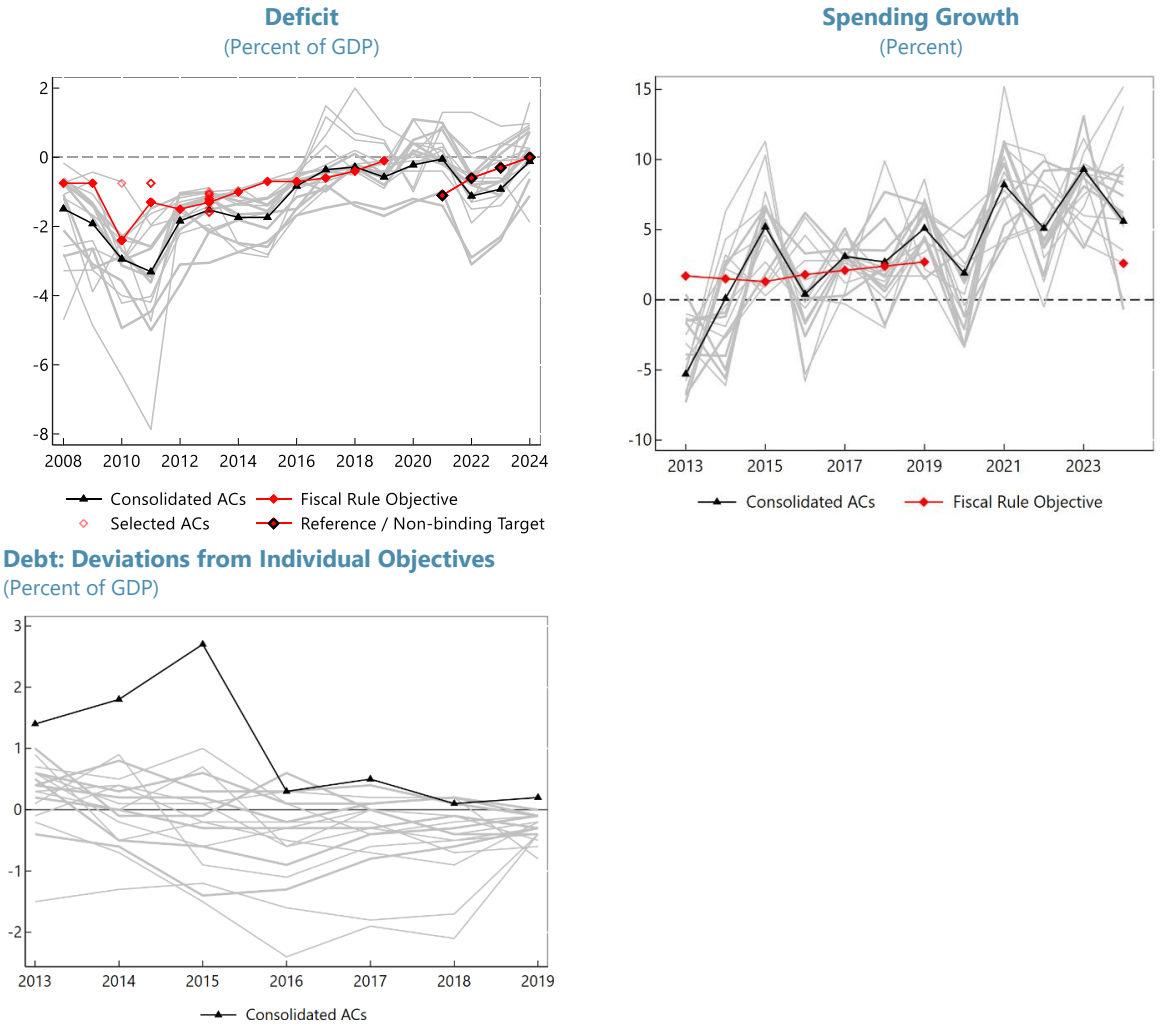
30. Historical compliance with fiscal targets has been mixed. Recent analysis by AIReF (2025) on the fulfillment of fiscal targets finds that over 2013–2019 a substantial share of communities in each year did not comply with either the deficit or expenditure target, or both. At the consolidated regional sector level, there were years in which either the deficit target (2017, 2018) or the expenditure target (2013, 2014, 2016) were met, but the two were never met at the same time. The debt target, on the other hand, exhibited a higher compliance rate by individual communities (often above 80 percent), and for the regional sector as a whole it was collectively met each year except for 2015. However, simultaneous compliance with all three objectives was rare at the individual level and never occurred at the consolidated level.

31. Figure 12 visually corroborates this assessment. In the top left panel, the deficit rule had limited compliance in the version in force between 2008–2012, when it was the sole fiscal target for autonomous communities. In some years, no community reached the deficit limit. These years coincided with the GFC, when, as discussed above, the communities faced a significant contraction in revenues. Under the LOEPSF, compliance then progressively improved. The consolidated deficit fell below the limit in 2017 and 2018 and was not far from it in 2016 and 2019. The average distance from the target for non-compliant regions also decreased over time. Over the COVID-19 pandemic, when the fiscal rule was paused, indicative non-binding targets were set over 2021–2024. Communities achieved deficits gradually closer to the target as the post-pandemic recovery

[15] The targets for the consolidated government sectors require parliamentary approval to come into force. Meanwhile, community-specific objectives, even in the case of a homogeneous limit, need to be approved by the Council of Fiscal and Financial Policy of the Autonomous Communities (CPFF) before becoming legally binding. In 2024 and 2025, although a limit for the consolidated regional sector was prepared and approved by the Council of Ministers as part of the Government's budgetary stability objectives, these and the individual limits for communities were not approved by Congress and by the CPFF. Hence, while the national rule was in place, it was not operationally binding.

progressed. Meanwhile, compliance with the expenditure limit (top right panel) was more irregular over 2013–2019. The time series of expenditure growth for the consolidated sector and for individual regions appears generally more volatile than the deficit. In 2024, when the expenditure rule was the only legally binding limit, a large majority of communities exceeded it, with an average growth rate about twice as high as the target. Compliance with the yearly debt target at the consolidated level and for individual regions improved starting in 2016 (bottom panel). However, over this period the debt-to-GDP ratio for most individual communities and for the consolidated regional sector remained substantially above the debt anchor of 13 percent under the LOEPSF (see Annex 1. Figure 2).

Figure 12. Fiscal Rule Targets and Outcomes of Autonomous Communities

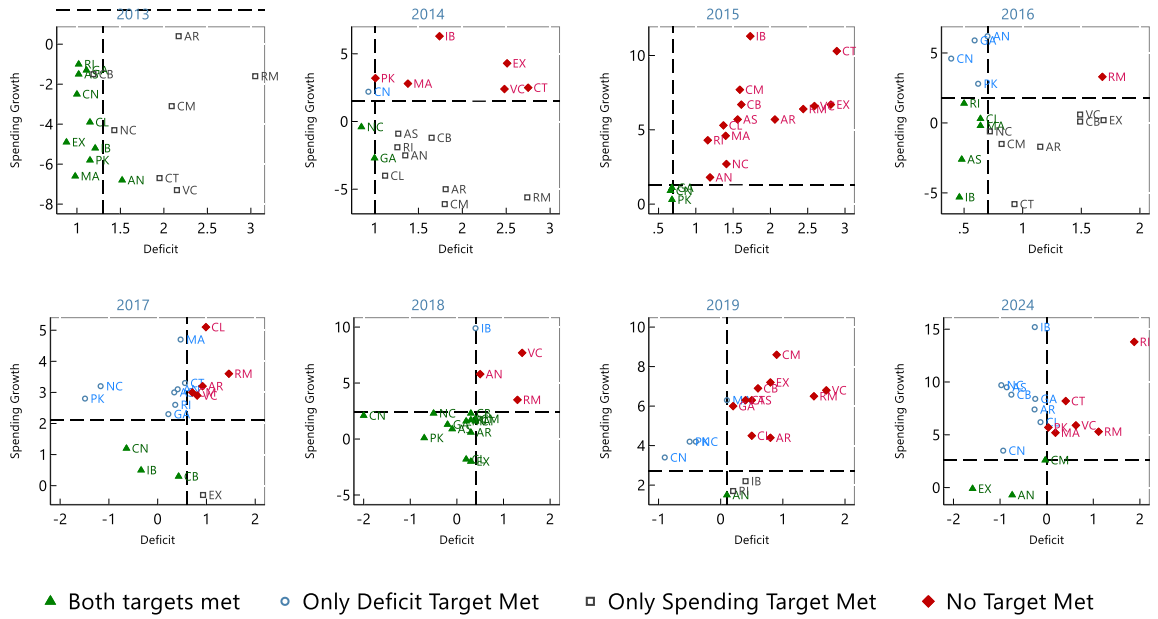


Sources: Ministry of Finance and IMF staff calculations.

Note: In the first two plots, red lines report the fiscal rule objectives for the consolidated sector of autonomous communities. In the first plot, red empty diamonds report the deficit targets for individual communities whenever these differ from those of the consolidated regional sector. Black-red diamonds report indicative or not legally binding targets (see main text for details). For the expenditure growth rule, the consolidated sector target always applies also to individual communities. For the debt rule, the third plot reports the deviation of individual communities' debt from their specific targets. A value above zero implies that debt was above the community-specific target or, in the case of the black line, the consolidated sector target.

32. Inconsistencies implied by the multiplicity of yearly targets partly underlie the low historical compliance. Depending on individual communities' own revenues and macroeconomic growth, a given deficit target may imply significantly different expenditure growth targets, and *vice versa*. Figure 13 shows this point graphically. In a given year, several regions fall into one of the plot quadrants in which only one target is met, while other communities with the same level of the complied-with target fulfill both. This is, for instance, clearly visible in 2016, when Extremadura, Cantabria, and Comunidad Valenciana fulfilled the expenditure limit with a growth rate close to 0 but had deficits around 1.5 percent of GDP, well above the 0.7 limit. Meanwhile, Castilla y León and Comunidad de Madrid had the same expenditure growth but also complied with the deficit rule. Finally, País Vasco, Andalucía, and Galicia had comparable deficits to the latter two but with expenditure growth substantially above the limit.

Figure 13. Deficit and Spending Growth Targets of Autonomous Communities by Year
(Percent of GDP, Percent)



Sources: Ministry of Finance and IMF staff calculations.
Note: The deficit target is met to the left of the vertical dash line, while the expenditure growth target is met below the horizontal dash line. For 2024, the figure uses the non-binding deficit target.

F. Considerations for Reforming the National Fiscal Rule

33. Given the case for acyclical spending and autonomous communities' limited debt issuance capacity, a rule focused on spending growth would be preferable. A deficit rule could be overly procyclical, as was the case for the EU rule in the past (e.g., among many others, Arnold and others, 2022; and Constâncio, 2020). A spending rule, possibly based on a multi-year framework, would ensure stable and predictable spending on health, social care, and education, independent of

surprises in the business cycle. This would apply to both downward and upward surprises. For example, if revenues were to underperform due to an unpredicted downturn, the expenditure rule, unlike the deficit rule, would prevent expenditure from falling in tandem.

34. Within the scope of an expenditure rule, multiple alternative frameworks are possible, each entailing important tradeoffs. Key choices relate to: (i) whether to set community-specific targets or a common target for all communities, (ii) the methodology to set the target(s), (iii) the time horizon of the target(s), and (iv) additional features such as stricter adjustments for high-debt communities and escape clauses. Choices regarding each of these elements of a fiscal rule should be grounded not just in economic principles but also in the broader context of the budget cycle, the political economy of fiscal policy, and technical feasibility. A brief discussion of each of these points is provided below:

- *Individual vs common targets.* Establishing individual expenditure targets would take into account community-specific structural and conjunctural factors and, as a result, would in principle be more likely to achieve debt sustainability. For example, communities with higher projected revenue growth, higher initial levels of revenues relative to spending, or lower debt could be granted looser (i.e., higher) spending growth targets. Differentiation, however, poses several practical and political challenges. First, depending on the methodology, the data required to derive the target (such as potential growth, the output gap, or structural revenues) may be difficult to produce precisely and timely for individual communities. Second, individual targets derived from the criteria listed above would not necessarily be compatible with an aggregate target for the consolidated regional government or at the national level. In particular, compliance with the path of the EU rule may require some adjustment to the regional targets, or some other level of government—essentially the central government—to adjust its spending, to achieve the national target. Third, individual targets may run against political-economy constraints if they result in substantial differences across communities and are perceived as untransparent or unfair. A common target would be less attuned to each autonomous community's individual fiscal situation, but it would address or at least ease some of these challenges. It would not require community-specific macroeconomic data. Moreover, it could more easily be made ex-ante consistent with the EU fiscal rule target if set as part of a top-down exercise in which the aggregate target was broken down into objectives for each level of government. Finally, some differentiation across communities could still be achieved via additional features, such as stronger adjustments for those whose debt is above a certain threshold or escape clauses for large negative shocks.

- *Methodology for setting the target.* The choice of methodology is dictated by data availability, political economy constraints, and transparency considerations, with an overarching trade-off between granularity and feasibility. Community-specific targets may require more parsimonious approaches due to the difficulty of measuring potential growth and projecting health and education costs based on demographic dynamics for individual regions. For instance, medium-term spending growth limits could be set by statistically estimating trend growth in revenues, which requires only historical fiscal data. While in principle transparent, such an approach may

be difficult to implement politically, however, as communities may oppose a solely technical method that does not directly consider structural differences in demographic trends, costs of service delivery, or exposure to climate change, for example. Moreover, by extrapolating trends from past data, it would not incorporate the impact of planned revenue measures. Aggregate targets may instead apply more advanced methodologies if based on national-level data. For instance, a common target for all communities can be set based on the projected spending on health, long-term care, and education, and on estimates of the communities' ability to raise additional revenues through their tax toolkit.

- *Time horizon.* Targets are generally set either year-on-year—as is the case with the current subnational fiscal rule—or over a multi-year horizon, entailing both cumulative objectives and yearly targets—as under the current EU fiscal rule. In principle, both approaches can be compatible with the multi-year framework of the EU rule. The former may provide more flexibility in case of changes in macroeconomic circumstances but may also result in more volatile spending paths if the target-setting methodology is very sensitive to cyclical factors. Longer horizons, on the other hand, provide stronger commitment to stable spending, protecting it from cuts during downturns and assigning revenue surprises to debt reductions during booms. Some flexibility, when justified by external shocks, may still be provided through escape clauses. Moreover, a longer time horizon before resetting objectives allows for better assessments of whether revenue surprises that may have taken place in previous years were temporary or structural in nature, informing whether and how the targets should be reset.

- *Additional features.* Escape clauses provide flexibility to adjust targets, or lift them altogether, in the event of large exogenous shocks, such as natural disasters or deep recessions. Conversely, rules can also be made more stringent if required to preserve debt sustainability, for instance in case debt is above a chosen threshold. Escape clauses and debt limits are already embedded in both the LOEPSF and the EU fiscal rule.

35. Two recent proposals for reforming the regional fiscal framework by AIReF (2025) and Martínez-López and others (2026) are also centered on expenditure-based limits, but their differences are illustrative of the aforementioned trade-offs. AIReF (2025) outlines an approach whereby Spain's Medium-Term Fiscal Structural Plan (MTFSP) path under the EU rule would represent the starting point to ensure consistency between national and EU targets. Specifically, in a given year, Spain's target for primary spending growth net of revenue measures under the MTFSP would be translated into differentiated targets across levels of government. This step effectively also entails a policy decision over which areas of spending would carry out the efforts of fiscal adjustment. As such, multiple decision-making processes and methodologies could be employed to set the spending growth limits. The resulting net primary spending growth objective for the collective of autonomous communities would then be applied to each individual regional government, possibly with a stronger adjustment required for entities with high debt. Martínez-López and others (2026) propose an alternative that would involve computing community-specific expenditure limits based on an econometric approach. Specifically, for each community, they suggest estimating the trend of revenues based on a (Holt-Winters) filter for *h* years ahead. Starting

from the community's current expenditure level at time *t*, yearly growth rates until *t+h* would be set such that by *t+h* the community is in structural balance—that is, expenditures equal trend revenues. This method implies that communities for which trend revenues are currently higher than expenditure or where revenues are expected to rise faster will face looser expenditure growth limits. By contrast, communities where expenditures currently exceed trend revenues or where revenues are projected to grow slowly will face stricter expenditure growth limits.

36. Additional considerations are important for an expenditure-based fiscal rule to be successful for Spain's autonomous communities. First, given regions' limited debt-carrying capacity, acyclical spending requires revenues to also be acyclical to the extent possible. As some of the taxes assigned to the communities, like the VAT and the PIT, are strongly procyclical, it is essential that other components of their revenues remain at a minimum acyclical. This applies also to transfers from the central government which, if necessary, could also be explicitly countercyclical in case of shocks that disproportionately affect regional spending—as was the case, for instance, during the COVID-19 pandemic. Second, given the high degree of uncertainty related to demographic dynamics and aging-related pressures, it is important for the fiscal framework of autonomous communities to have the capacity to adjust over time to evolving spending needs. For example, should demographic aging slow down via higher migration inflows, it would be important to use methodologies that can reflect these developments into the revised spending and revenue projections without excessive lags.

37. An effective rule also requires a clear and enforceable set of preemptive, corrective, and coercive mechanisms to ensure compliance. Martínez-López (2020) notes how the LOEPSF is on paper one of the strictest subnational rules across the EU, according to metrics published by the European Commission. However, its potential strictness is not matched by a strong compliance track record, as discussed above. The author identifies multiple elements weakening its compliance incentives. For instance, several of the coercive measures to be taken by supervisory entities are specified as optional rather than mandatory. With regard to the spending growth rule, non-compliance does not preclude access to the borrowing instruments of the *Fondos de Financiación* that entail lower conditionality, while non-compliance of the deficit rule does. Moreover, the absence of correction for past deviations in the setting of yearly limits provides an indirect incentive for non-compliance, as future spending growth targets are computed based on the previous year's realized spending rather than the (lower) maximum allowed spending. Finally, due to their misaligned timing with respect to the regular budget cycle, the economic and financial plans (PEFs) that communities must present in case of non-compliance often lack the information necessary for the Ministry of Finance to decide on potential coercive actions (Martínez-López, 2020). Corrective and coercive mechanisms should therefore also be revisited to be made compatible with the reformed targets and their time frame, with an emphasis on graduality and political feasibility in their enactment so that the provisions that exist on paper can be strictly enforced in practice.

38. The design of the revised fiscal rule should go hand in hand with other reforms of the regional fiscal framework. For instance, multi-year targets under the revised rule could more easily be set if revenues were predictable over several years ahead. Meanwhile, the establishment of the

rule may help reduce the moral hazard risk from the proposed one-time debt absorption of regional debt by constraining regions' ability to use the entirety of the gained fiscal space for new spending. Additionally, in case the rule maintained a debt limit clause (such as the current threshold of 13 percent of GDP or a revised one), the exact way in which the debt reduction operation is carried out would determine whether high-debt autonomous communities would still have to implement strict adjustments in the first few years under the revised rule (e.g., if the amount of relief received were not large enough for some communities' total debt level to fall below the debt threshold of the revised rule). Finally, it will be important for the design of the rule to recognize and address the loss of central government fiscal space that would result from the proposed debt reduction and revision to the "common regime" framework. For instance, throughout the adjustment period of the MTFSP, different formulations of the rule would shift the shares of the envisioned aggregate consolidation that are borne by the central government and the autonomous communities.

39. An enhanced subnational fiscal rule should foster ownership and political commitment by both the regional and central governments. The effectiveness of a reformed rule will critically depend not only on its technical design but also on the acceptability of the process through which it is developed and enforced. Together with other aspects of the fiscal system of autonomous communities, the fiscal rule also reflects a societal choice regarding the degree of redistribution and risk-sharing across regions (e.g., in the choice between region-specific or common targets), as well as preferences on the prioritization of spending on services provided by different public entities. Dialogue among all stakeholders, in particular between the central and regional governments—who likely hold diverse positions on such issues—is essential to reach politically viable compromises. A predominantly top-down framework, even if economically well grounded, would risk limited buy-in from autonomous communities, ultimately undermining compliance and credibility. A collaborative approach would be especially important to ensure acceptability, and ultimately strong enforcement, in the case of a rule specifying differentiated targets across autonomous communities.

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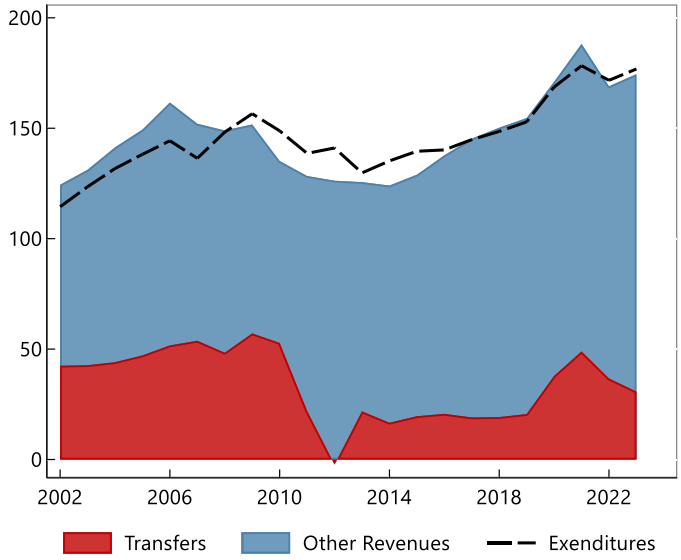
Annex I. Additional Figures and Tables

Annex I. Figure 1. Consolidated Revenues and Expenditures of Autonomous Communities from Budget Execution Data

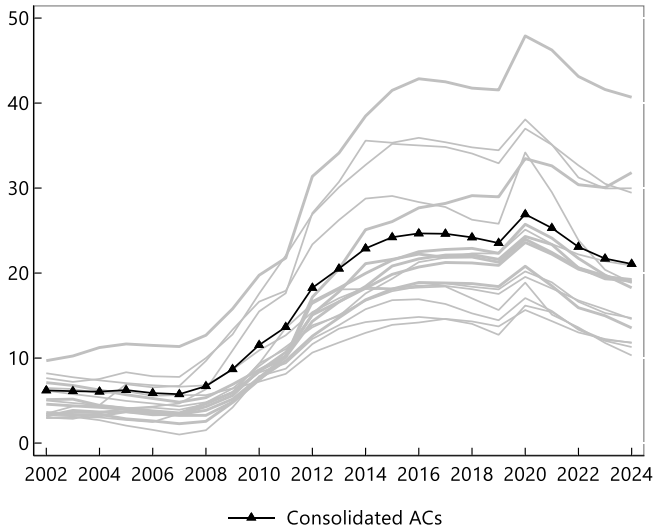
(Eur. Bil., Constant 2019 Prices)



Sources: Ministry of Finance and IMF staff calculations.
Note: Series from budget execution data published by the Ministry of Finance with cash-based accounting.

Annex I. Figure 2. Debt-to-GDP Ratios of Individual Autonomous Communities

(Percent of GDP)



Sources: Bank of Spain and IMF staff calculations.

Annex I. Table 1. Spain: Robustness Checks of Panel Regression of Expenditure on the Cyclical Component of Real GDP

	Total Expenditure				Primary Expenditure				Public Consumption			
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(7)	(8)	(9)	(10)
Regional GDP - Detrended	0.362***	0.395***	0.087**	0.345***	0.434***	0.470***	0.108***	0.439***	0.348***	0.372***	0.124***	0.345***
	(0.059)	(0.057)	(0.039)	(0.023)	(0.061)	(0.059)	(0.039)	(0.057)	(0.027)	(0.026)	(0.018)	(0.023)
Constant	0.004***	0.003***	-0.000***	-0.001	0.004***	0.003***	0.000	0.002	0.003***	0.003***	0.000***	-0.001
	(0.000)	(0.000)	(0.000)	(0.004)	(0.000)	(0.000)	(0.000)	(0.004)	(0.000)	(0.000)	(0.000)	(0.004)
Liquidaciones				0.007				0.002				0.007
				(0.007)				(0.008)				(0.007)
Observations	300	340	357		300	340	357		300	340	357	
Number of CAs'	15	17	17		15	17	17		15	17	17	
IV 1: Neighbors' GDP	YES	YES	-	YES	YES	YES	-	YES	YES	YES	-	YES
IV 2: Trading Partners GDP	YES	-	YES	YES	YES	-	YES	YES	YES	-	YES	YES
Foral Communities	NO	YES	YES	YES	NO	YES	YES	YES	NO	YES	YES	YES
First-Stage F-stat	225.1	423.8	318.6	264	225.1	423.8	318.6	264	225.1	423.8	318.6	264
P-val	0.00	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0.00	0	0.00
R Sq. - Between	0.247	0.322	0.0141	0.0497	0.239	0.310	0.0230	0.0461	0.329	0.390	0.0474	0.00240
R Sq. - Within	0.0250	0.0257	0.0241	0.0289	0.0319	0.0330	0.0298	0.0359	0.0657	0.0654	0.0590	0.0736

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Sources: IGAE, INE, and IMF staff calculations.

Annex I. Table 2. Spain: Panel Regression of Expenditure on the Cyclical Component of Real GDP with an Interaction Term for the GFC

VARIABLES	(1) Total Expenditure	(2) Primary Expenditure	(3) Public Consumption
Regional GDP	0.238***	0.295***	0.284***
	(0.049)	(0.052)	(0.024)
GFC * Regional GDP	2.694***	2.984***	1.413***
	(0.320)	(0.322)	(0.209)
Constant	0.004***	0.004***	0.003***
	(0.000)	(0.000)	(0.000)
Observations	340	340	340
Number of id	17	17	17
IV 1: Neighbors' GDP	YES	YES	YES
IV 2: Trading Partners GDP	YES	YES	YES
First-Stage F-stat	264	264	264
P-Val.	0.00	0.00	0.00
R Sq. - Between	0.109	0.110	0.0816
R Sq. - Within	0.158	0.175	0.133

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Sources: IGAE, INE, and IMF staff calculations.

Annex I. Table 3. Spain: Regression Expenditure on Real GDP in Log First Differences

VARIABLES	(1) Total Expenditure	(2) Primary Expenditure	(3) Public Consumption
D% Regional GDP	0.152*	0.176*	0.151**
	(0.091)	(0.099)	(0.062)
Constant	0.016***	0.015***	0.020***
	(0.003)	(0.004)	(0.002)
Observations	340	340	340
Number of CAs'	17	17	17
IV 1: Neighbors' GDP	YES	YES	YES
IV 2: Trading Partners GDP	YES	YES	YES
First-Stage F-stat	169.9	169.9	169.9
R Sq.	0.009	0.011	0.024

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Sources: IGAE, INE, and IMF staff calculations.

Annex I. Table.4. Spain: System-GMM Specification with Arellano-Bond Instruments of Expenditure for the Panel Regression of Expenditure on the Cyclical Component of Real GDP

VARIABLES	(1) Total Expenditure	(2) Primary Expenditure	(3) Public Consumption
Regional GDP - Detrended	0.149***	0.173***	0.200***
	(0.047)	(0.050)	(0.025)
Total Expenditure t-1	0.701***		
	(0.016)		
Primary Expenditure t-1		0.681***	
		(0.015)	
Public Consumption t-1			0.756***
			(0.021)
Constant	0.004***	0.004***	0.004***
	(0.000)	(0.000)	(0.000)
Observations	340	340	340
Number of CAs'	17	17	17
P-val of AB Test for AR-1	0.00	0.00	0.00
P-val of AB Test for AR-2	0.14	0.33	0.27
P-val Hansen J test	0.09	0.09	0.13

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

System GMM specification with both fist-differences and level equation; moment conditions for the lag dependent variables include lags 2 to 10. Instruments for regional GDP growth include growth of neighboring regions and Spain's trading partner growth.

Sources: IGAE, INE, and IMF staff calculations.

THE CASE FOR BORROWER-BASED MACROPRUDENTIAL MEASURES IN SPAIN[1]

House prices in Spain have grown rapidly since the COVID-19 pandemic, and while household leverage remains low by euro area standards, the share of risky mortgage loans at issuance has risen. Against this backdrop, this paper provides analytical inputs to inform the potential design and calibration of borrower-based measures (BBMs)—currently not activated as part of the Bank of Spain's toolkit—should such measures be considered. It combines a review of international experience with two complementary empirical analyses using Spanish data: a loan-level analysis assessing how lending standards at issuance affect the subsequent probability of mortgage default, and a scenario-based stress analysis quantifying how alternative BBM calibrations would affect bank mortgage portfolio losses under adverse macroeconomic conditions. Both approaches point in the same direction: a collateral-based measure, such as a loan-to-value (LTV) cap, would be associated with the largest reduction in default probabilities at origination and in portfolio losses under stress, with further gains if complemented by an income-based cap. The evidence also suggests that BBMs and existing capital-based measures—such as the ongoing phasing-in of the counter-cyclical buffer—could act as complementary instruments, addressing risk ex ante at origination and ex post through banks' loss-absorption capacity.

A. Introduction

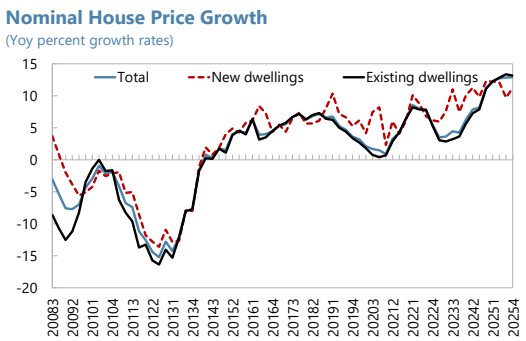
1. House prices in Spain have been rising over the past decade, with a sharp increase since the COVID-19 pandemic. After the major correction that followed the global financial crisis (GFC), the housing market stabilized and gradually recovered, but prices have accelerated markedly since 2020—including amid the unprecedented ECB monetary policy tightening episode (Figure 1). The post-pandemic rebound has been broad-based, with especially large price gains in large urban areas and touristic regions where supply is more rigid. While the current buoyancy does not pose immediate macro-financial risks, affordability pressures are mounting (2025 Spain Article IV Consultation), and financial vulnerabilities could build over time.

2. Notwithstanding subdued growth in household mortgage credit, the share of risky loans at issuance has been steadily increasing over the past few years. Households have continued to deleverage, extending a decade-long trend, and the stock of mortgage credit has only recently begun to rise modestly. Spain's overall household debt-to-income ratio is now well below the euro area average, reflecting healthy household balance sheets on the back of a strong labor market and prudent lending standards. Yet these aggregate indicators can mask shifts in the composition of new lending: the share of loans with loan-to-value ratios above 80 percent has risen

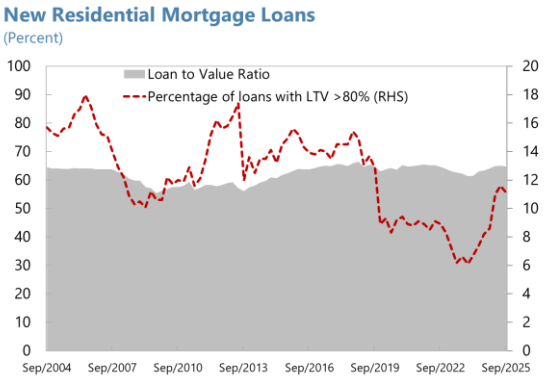
[1] Prepared by Nina Biljanovska (EUR) and Laura Valderrama (MCM), with technical inputs from Gabriel Jiménez, Jorge Galán, and Raquel Vegas (all Banco de España) on the loan-level analysis using data from the European DataWarehouse.

steadily since 2023 (Figure 1), suggesting some deterioration in the risk profile of recent originations even as average leverage remained contained.

Figure 1. House Price Growth and New Mortgage Issuance



Sources: Bank of Spain and IMF staff calculations.



Source: Bank of Spain and IMF staff calculations.

3. Despite relatively low household leverage, persistently strong house price growth and emerging signs of easing in lending standards raise the question of whether pre-emptive borrower-based measures (BBMs) are warranted, and if so, how they should be calibrated. Sustained increases in valuations may, over time, create pressure to ease bank lending standards or encourage riskier lending behavior, as historical evidence suggests (Martín and others, 2021; Duca and others, 2011; Justiniano and others, 2019). Over and above the role of micro-prudential supervision, one option to pre-empt such accumulation of vulnerabilities would be to introduce BBMs, an increasingly popular macro-prudential tool. Implementing such measures before they become strongly binding could also minimize their economic, social, and political costs, as they are unlikely to constrain credit materially and would face less public resistance if introduced early on. To date, BBMs have not been activated as part of the Bank of Spain's macroprudential toolkit, while they are in place in most other euro area countries.

4. This Selected Issues paper provides analytical inputs to inform the potential design and calibration of BBMs should such measures be considered. It draws on three complementary building blocks. First, it reviews international experience with BBMs—their objectives, benefits and costs, design features, and calibration practices across euro area peers. Second, it uses loan-level data to assess how loan-to-value (LTV), loan-to-income (LTI), and loan-service-to-income (LSTI) ratios at origination affect the probability of mortgage default in Spain, and how these effects interact with lenders' capitalization. Third, it employs a scenario-based stress analysis of the Spanish mortgage portfolio to quantify how alternative BBM calibrations could lower bank losses under an adverse macroeconomic scenario.

B. Overview of BBMs and Complementary Macroprudential Measures

5. BBMs are regulatory limits on loan underwriting criteria. They are most often applied to residential real estate lending, directly constraining borrowers' capacity to borrow, containing the build-up of vulnerabilities, and thereby supporting the resilience of banks and the broader financial system (ECB 2025). BBMs that have been most widely used across countries, and which empirical evidence suggests have been the most effective at containing housing-related systemic risks, include:

- **LTV ratios**, which cap the loan amount at a fixed share of the property's value at origination, requiring borrowers to fund the remainder through a downpayment. The borrower's equity then acts as a first-loss buffer in the event of a house price correction, lowering banks' loss given default.

- **LSTI or LTI ratios** restrict borrowers' total debt service or debt stock relative to gross income. These lower the probability of default by strengthening households' ability to withstand interest rate or income shocks.

6. While not BBMs, loan maturity caps and amortization requirements are frequently applied alongside them to strengthen their effectiveness (Valderrama 2023). By limiting loan terms and ensuring steady debt repayment, they prevent circumvention of debt-service limits and promote faster equity build-up. More specifically:

- **Loan maturity limits** cap the tenor of loans (e.g., 30 years for mortgages). They prevent risk build-up from excessively long loans, which lower initial payments but raise total debt and could also otherwise be used to circumvent LSTI limits (2025 France FSSA). Shorter maturities accelerate amortization and reduce default risk, all else equal.

- **Amortization requirements and interest-only restrictions** impose a repayment structure. Regulators may limit interest-only mortgages or request that high-LTV loans amortize more quickly. Such measures set amortization schedules to reduce default risks.

Table 1. Spain: Key Policies to Address Vulnerabilities in the Residential Real Estate Market

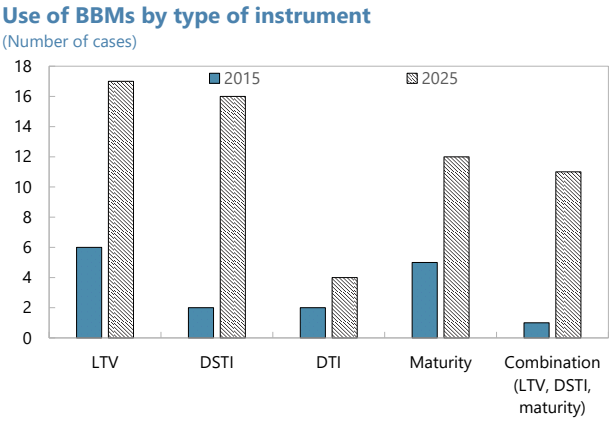
	Policies to Contain Build-Up of Vulnerabilities	Policies to Strengthen Banks Resilience
Objective	Keep borrowing at sustainable levels	Build bank buffers to absorb losses
Tools	Borrower-based limits: - LTV, LSTI, LTI Amortization requirements: - Amortization rate, max loan maturity	Capital-based requirements: - Broad/sectoral CCyB or sectoral SyRB - Risk-weight measures Regulatory provisions
Channel	Direct: Credit demand Indirect: House prices	Direct: Higher capital in good times Indirect: Credit supply; house prices
Impact	Direct: Decrease the size/number of loans Indirect: Increase resilience of borrowers; save regulatory capital	Direct: Increase capital requirement in good times Indirect: Decrease build-up of vulnerabilities (if pass-through effect); increase regulatory capital

Sources: Valderrama (2023).

7. Another important complementarity to be considered is with prevailing capital-based measures. In Spain, two key measures are currently in place: the countercyclical capital buffer (CCyB), which has been set at 1 percent, effective October 2026, and the capital buffers for systemically important institutions (G-SII and O-SII), with rates ranging from 0.25 to 1.25 percent (2025 Bank of Spain). Other macroprudential tools in the capital-based toolkit—such as the Systemic Risk Buffer (SyRB) and the Sectoral CCyB—are part of the framework but not currently activated (2025 ESRB). By limiting leverage and ensuring debt serviceability at issuance, BBMs can strengthen households' balance sheets and improve banks' asset quality ex ante, complementing capital-based measures that act on the outstanding stock of exposures and improve resilience ex post.

8. Nearly all Euro-area countries have adopted BBMs in some form over the last decade (Figure 2). As of 2025, 18 out of 21 banking union countries have at least one active measure (ECB 2025), and use of combined collateral-, income- and maturity-based limits has risen markedly (Table 2). This broad adoption reflects the growing consensus on the effectiveness of BBMs in safeguarding financial stability, even though less is known about their overall welfare effects. Evidence from both advanced and emerging economies shows that these tools have helped curb the build-up of risky mortgage

Figure 2. Activation of BBMs in Euro Area Countries, 2015–25



Sources: June 2025 ECB Macroprudential Bulletin 29.

lending by limiting high-LTV and high-LSTI loans, thereby strengthening household and bank resilience (e.g., Ahuja and Nabar, 2011; Kuttner and Shim, 2016; Valderrama, 2023). Recent monetary tightening episodes also suggest that countries with established borrower-based frameworks experience milder housing corrections and smaller increases in default rates (2024 IMF WEO).

9. BBMs are primarily designed for residential real estate lending, though some countries extend them to other types of credit. A few EU countries—including Romania and Slovakia—apply BBMs to consumer credit as well. Commercial real estate lending, by contrast, generally falls outside the borrower-based framework and is addressed through capital-based tools instead. The analysis in this paper focuses on BBMs for residential mortgage lending.

C. Design and Calibration Considerations

10. Designing BBMs requires balancing their financial-stability benefits against potential costs in terms of reduced credit access for affected households and economic activity. Well-calibrated BBMs strengthen household and bank resilience by limiting excessive leverage and debt burdens, but if introduced too late or set too tightly, they can restrict credit unnecessarily and contribute to or amplify an economic downturn. Insofar as they are more binding for lower-income households, they may also entail unwanted distributive consequences in terms of access to home ownership. Effective design therefore hinges on when and how these tools are deployed, how tightly they are calibrated, what exemptions if any might be introduced, and how flexibly they adapt to evolving market conditions. The following principles—on timing, calibration, complementarity, flexibility, implementation, and coordination—capture key lessons from international experience on how to strike this balance.

11. First, timing matters: BBMs are most effective when introduced early in the financial cycle, before systemic risks accumulate. Deployed at this stage, BBMs act as a structural safeguard: imposing prudent lending standards ex ante while avoiding immediately binding constraints on credit. This logic is consistent with both theory (Bianchi, 2011) and empirical evidence (Valderrama, 2023; Biljanovska and others, 2023), which imply that preemptive activation is less distortionary and more effective than waiting until vulnerabilities are already entrenched. Introducing BBMs only after lending standards have already loosened can amplify procyclicality, as late tightening may trigger a correction in credit and housing markets.

12. Second, calibration should be data-driven and grounded in country-specific risk analysis. Common benchmarks have emerged, but with wide variation across countries. LTV limits across countries are typically set between 80 and 100 percent for first-time buyers purchasing a primary residence, and somewhat tighter for repeat buyers (70-90 percent). Income-based limits usually complement these collateral constraints, with LSTI caps ranging from 30 to 80 percent of the borrower's monthly income across countries.

13. While international benchmarks provide useful reference points, effective limits should be tailored to domestic factors. These factors include household indebtedness, income distribution, housing market dynamics, and typical underwriting standards, as well as how these may

affect household and bank resilience in the future versus credit today. To this end, authorities should rely on granular, loan-level data to analyze the distributions of borrower leverage and debt-service burdens and identify thresholds where default risk rises sharply. Model-based stress testing and scenario analysis—such as those developed by Gornicka and Valderrama (2020) and applied recently to Austria and Switzerland, for example—can further help quantify how much alternative LTV or LSTI limits would strengthen households' capacity to service their debt and banks' ability to withstand potential losses under various stress scenarios.

14. Third, a multi-pronged approach can be more effective than relying on a single instrument. In particular, LTV and LSTI caps address different dimensions of risk—loss given default and likelihood of default, respectively—and are thereby mutually reinforcing. Complementary constraints, such as maturity caps or amortization requirements, can help prevent circumvention (e.g., stretching maturities to pass a LSTI test) and further reduce borrower vulnerabilities (ESRB, 2016).

Table 2. Spain: BBMs, Maturity Caps, and Capital-Based Measures across EU Banking Union Countries

	LTV		LTV exemption		DSTI/LSTI		DSTI/LSTI exemption		DTI/LTI		DTI/LTI exemption		Maturity		Maturity exemption		CCyB
	FTB	SSB	FTB	SSB	FTB	SSB	FTB	SSB	FTB	SSB	FTB	SSB	FTB	SSB	FTB	SSB	
Austria	90		20%		40		20%						35y		20%		0
Belgium	90		35%	20%	50		5%		9y		5%						1%
Bulgaria	85		5%		50		5%						30y		5%		2%
Cyprus	80				80												1% (1.5% from Jan 2026)
Germany																	0.75%
Estonia	85		15%		50		15%	15%					30y		15%		1.5%
Spain																	0.5% (1% from Oct. 2026)
Finland	95	90			60		15%						30y		10%		0%
France					35		20%						25y		20%		1%
Greece	90	80	10%		50	40	10%	20%									0.25%
Croatia	90		20%		45		20%						30y				1.5% (2% from Jan 2026)
Ireland	90		15%						4y	3.5y	15%						1.5%
Italy																	0%
Lithuania	85	70			40		5%						30y				1%
Luxembourg	90		15%														0.50%
Latvia	90		10%		40		10%		6y		10%		30y		10%		1%
Malta	90	75	10%	20%	40								40y	25y			0%
Netherlands	100				30								30y				2%
Portuga	90		20%		50		10%	5%					40y				0% (1% in 2026)
Slovenia	80	70			50		3%								15%		1%
Slovakia	80		20%		60		5%		3-8y		5%		30y		10%		1.5%

Sources: June 2025 ECB Macroprudential Bulletin 29 and national authorities' announcements.
Notes: Only housing loans are considered. Austria: loan-to-collateral (LTC) limits are considered instead of LTV. Belgium: LTV exemption rates refer to first-time buyers (FTB) and second and subsequent buyers (SSB). DSTI and DTI measures are computed as follows: 5% of DSTI>50% x LTV>90% and DTI>9 x LTV>90%. Bulgaria: the 5% exemption applies to all three limits (LTV, DSTI and maturity) simultaneously. Ireland: the LTV and loan-to-income (LTI) exemption rates refer to FTB/SSB and buy-to-let (BTL) loans. The LTV limit for BTL loans is 70%, with an exemption of up to 10%. Finland: the LTC limit is considered instead of LTV. Luxembourg: LTV for other residential real estate loans, including BTL loans, is 80%, with no exemption. Latvia: LTV limit for BTL loans is 70%. Malta: a distinction is made between category I and category II borrowers for the LTV exemption. An exemption rate of 10% applies to category I borrowers and a 20% exemption rate applies to category II borrowers. Portugal: for the DSTI exemption, 10% of loans can be granted to borrowers with a DSTI of up to 60%, while 5% of total loans can be granted to borrowers with a DSTI above 60%. Slovakia: for the LTV exemption, the LTV ratio may be up to 90% for up to 20% of new loans. Slovenia: up to 15% of consumer loans may have a maturity of up to 120 months if compliant with the DSTI cap.

15. Fourth, flexibility enhances implementation feasibility. Many countries have incorporated exemption quotas, so called *speed limits*, that allow a small share of new loans—typically 5-20 percent—to exceed caps (Table 2). This preserves banks' discretion to lend to creditworthy borrowers with atypical profiles, while keeping systemic risk contained. Others

differentiate by borrower type, offering somewhat looser terms for first-time home buyers or stricter rules for investor loans (ECB 2025). These design features have helped maintain political and social support for BBMs while ensuring they remain binding in aggregate.

16. Fifth, BBMs can also be tailored to the distribution of risks—across regions or borrower income—to target vulnerabilities more precisely. In countries where housing risks are concentrated in specific local markets, geographic differentiation has helped contain local imbalances without over-tightening credit elsewhere. For example:

- Norway applied a stricter LTV limit and a lower speed limit in Oslo for mortgages secured by secondary dwellings from 2017 through end-2022.[2] Since January 2023, a uniform national LTV limit applies, with Oslo retaining a tighter speed limit (8 percent of new lending per quarter) than the rest of the country (10 percent).

- New Zealand introduced tighter LTV limits and lower speed limits for Auckland investment properties in November 2015, and further tightened investor LTV restrictions nationwide in October 2016.[3] LTV restrictions have remained in force since (with adjustments and a temporary removal during COVID-19), and from July 2024 have been complemented by LTI restrictions.

- Denmark introduced its *Growth Area Guidelines* for Copenhagen and Aarhus in 2016, with additional restrictions added in 2018 for borrowers with LTI above 4 and LTV above 60 percent. These borrowers face limits on the type of mortgage they can take—interest-only loans are permitted only with a 30-year fixed interest rate, and floating-rate loans must have their rate locked in for at least five years.

Other countries have differentiated BBMs across income groups, setting LSTIs in line with borrowers' repayment capacity:

- Hungary differentiates LSTI limits by income level, with a higher cap applying above a monthly net income threshold (about EUR 2,000). Limits also vary by the loan's interest-rate fixation period, with longer fixation periods (which reduce borrowers' exposure to rate resets) qualifying for looser (i.e. higher) LSTI caps.

- Slovenia introduced income-tiered LSTI caps in 2018, setting a 50 percent limit for borrowers earning up to twice the gross minimum wage and 67 percent for the portion of income above that threshold. Since July 2023, however, it has applied a uniform 50 percent LSTI cap irrespective of income.

[2] A secondary dwelling is defined as a dwelling at an address other than the owner's registered residence. The LTV cap for such loans in Oslo was 60 percent, compared with 85 percent for primary residences nationwide.

[3] The 2015 measure capped the LTV for Auckland investor lending at 70 percent, with a 5 percent speed limit, against an 80 percent LTV (with a 10 percent speed limit) for investor lending in the rest of the country. From October 2016, investor LTVs were tightened nationwide to a 60 percent cap.

Such targeted calibration differs from broad flexibility mechanisms like speed limits: rather than allowing discretionary exceptions by lenders within a national framework, it adjusts the framework itself to reflect heterogeneity in risk exposure across markets and borrower types.

17. Sixth, implementation should be gradual and well-communicated. Transparent communication that BBMs are permanent structural safeguards—not temporary interventions—helps anchor expectations and avoids procyclical dynamics. Countries such as Austria and Ireland introduced BBMs with transition periods or initially as supervisory guidance (soft limits) before moving to binding limits, giving banks time to adjust their lending practices and underwriting processes. In Portugal, on the other hand, the authorities have maintained the supervisory guidance initially introduced in 2018. Where BBMs are introduced as supervisory guidance, it is important to communicate clearly that the limits are intended as ceilings rather than targets, to avoid the perverse incentive for banks with currently conservative lending standards to loosen them up to the new regulatory threshold.

D. Impact of Lending Standards on Mortgage Defaults in Spain

18. This section assesses how loan-level lending standards—LTV, LTI, and LSTI ratios—affect the probability of mortgage default in Spain. The analysis relies on loan-level data from the European DataWarehouse (EDW), a pan-European repository of securitized loans, restricted here to residential mortgages originated in Spain between 1999 and 2021. For each loan, the EDW reports the LTV at origination, together with a rich set of loan, borrower, and collateral characteristics, as well as performance indicators over the life of the loan. These loan-level records are then merged with two additional sources: bank-level capital ratios from Banco de España, matched to each mortgage through the identity of the originating lender; and province-level data for the 50 Spanish provinces (excluding Ceuta and Melilla), including GDP and real house prices (deflated by province-level CPI) from Sociedad de Tasación. One potential caveat is that the EDW only captures securitized loans rather than the universe of Spanish mortgage originations, which might entail a representativeness bias. However, Galán and Lamas (2025) show that securitized Spanish mortgages are broadly representative of the overall market along their key risk dimensions for the period they analyze, supporting the external validity of the results.

19. The empirical strategy follows a standard reduced-form linear probability model widely used in the loan-level mortgage default literature.[4] The baseline specification relates an indicator of default—equal to one if the borrower misses at least three consecutive monthly payments—to dummies for loans with risky lending standards at origination, a rich set of loan, borrower, and collateral controls, and high-dimensional fixed effects:

$$Default_{irbt} = \alpha + \beta^{i} LS^{1}_{irbt} + \beta^{2} LS^{j}_{irbt} + \beta^{3}\left(LS^{1}_{irbt} \times LS^{j}_{irbt}\right) + \gamma X_{irbt} + \delta Y_{irbt} + \theta Z_{irbt} + \lambda_{tb} + \mu_{rt} + \epsilon_{it},$$

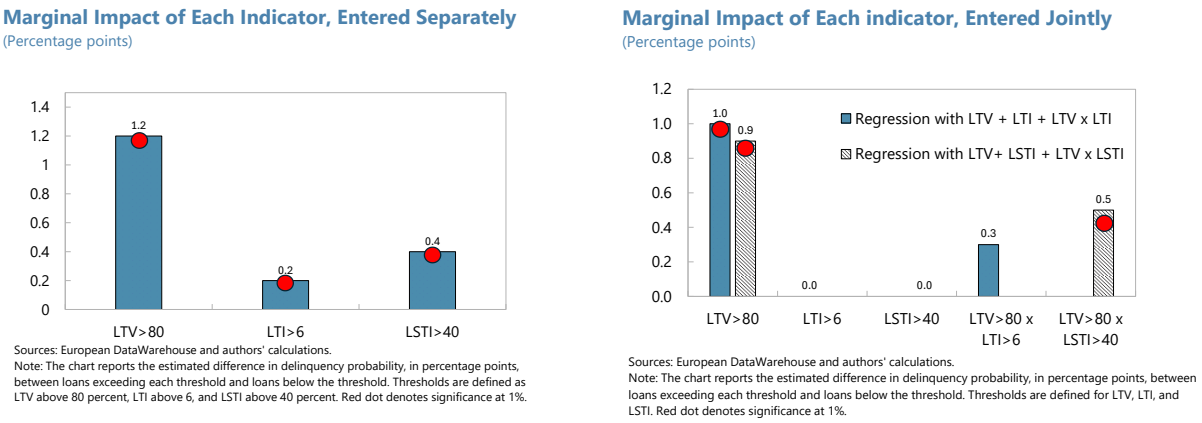
where i, r, b, t index loans, provinces, banks, and origination quarters. LS^{1} is a dummy that takes the value one for loans with LTV above 80 percent, while LS^{j} is an income-based lending-standard

[4] See for example Demyanyk and Van Hemert (2011) and Jiménez and others (2012).

dummy (LTI>6 or LSTI>40 percent) used on its own or to form combinations with the collateral-based LTV dummy.[5] The controls include borrower characteristics (X: log income, job status, nationality, multiple loans), loan terms (Y: maturity, fixed versus variable rate, loan purpose, interest rate), and collateral features (Z: property type and recourse). Bank-by-origination-quarter fixed effects (λ_{tb}) absorb time-varying lender heterogeneity—such as changes in screening technology or risk appetite—while province-by-origination-quarter fixed effects (μ_{tr}) absorb local macroeconomic and housing-market conditions at the time of origination. The model is estimated in three nested forms: (i) a *single-measure* specification entering each lending-standard dummy on its own; (ii) a *joint* specification entering LTV together with either LTI or LSTI; and (iii) a specification augmented with the interaction between the LTV dummy and the income-based (LTI or LSTI) dummy, which isolates the marginal risk of loans that simultaneously breach collateral- and income-based thresholds.

20. In a second step, the baseline model is augmented with an interaction between each lending-standard dummy and the originating bank's capital ratio at the time of issuance. This extension assesses whether lender capitalization affects the default risk associated with riskier loans, and sheds light on how borrower-based and capital-based tools interact at the point of origination—an important consideration to inform whether and how to balance the two sets of instruments in the policy mix.

Figure 3. Marginal Impact of High-Risk Loans at Issuance on the Default Probability



Sources: European DataWarehouse and authors' calculations.
Note: The chart reports the estimated difference in delinquency probability, in percentage points, between loans exceeding each threshold and loans below the threshold. Thresholds are defined as LTV above 80 percent, LTI above 6, and LSTI above 40 percent. Red dot denotes significance at 1%.

Sources: European DataWarehouse and authors' calculations.
Note: The chart reports the estimated difference in delinquency probability, in percentage points, between loans exceeding each threshold and loans below the threshold. Thresholds are defined for LTV, LTI, and LSTI. Red dot denotes significance at 1%.

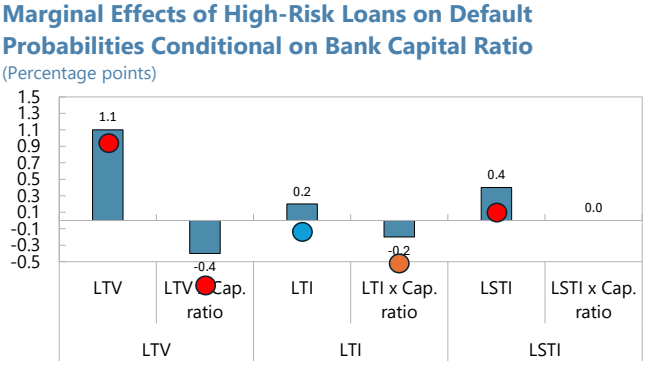
21. Loans originated with looser lending standards are significantly more likely to default, with a high-LTV ratio emerging as the dominant risk factor. In the single-measure specification, loans with LTV above 80 percent exhibit a default probability 1.2 percentage points higher than otherwise comparable loans, compared with a 0.2-0.4 percentage points higher default probability for loans with LTI above 6 or LSTI above 40 percent (Figure 3). When LTV enters jointly with either

[5] The time subscript *t* denotes the date of loan issuance. Loan characteristics are measured at origination, while default is recorded based on the loan's subsequent performance over the observed horizon.

LTI or LSTI, the LTV effect remains essentially unchanged (about 1.2 percentage points and significant at the 1 percent level), while the LTI coefficient becomes statistically insignificant and the LSTI coefficient gets smaller, although it remains significant (results not shown). Once the LTV×LSTI interaction is included, the standalone LSTI coefficient loses its significance, while the interaction term with high LTV is positive, economically meaningful (about 0.5 percentage points), and statistically significant (Figure 3). These results point to an ordering of risk: collateral-based looseness is the primary driver of default, while income-based looseness matters mainly through its interaction with high-LTV lending. Finally, among income-based measures, LSTI appears to matter more than LTI.

22. Stronger lender capitalization partially mitigates—but does not eliminate—the default risk associated with high-risk mortgages. When the baseline specification is augmented with interactions between the lending-standard dummies and the originating bank's capital ratio (measured at the time of the loan issuance), high-LTV loans continue to be linked to a significantly higher default probability (about 1.1 percentage points), but the interaction term is negative and significant at the 1 percent level (around -0.4 percentage points), indicating that loans originated by better-capitalized lenders carry lower default risk, all else equal (Figure 4). A qualitatively similar, though weaker, attenuation effect is found for high-LTI loans, but not high-LSTI ones. These findings are consistent with a growing literature suggesting that better-capitalized banks screen and monitor borrowers more carefully—leading to lower default even for given financials—and have greater capacity to work out troubled loans, reducing realized defaults even within the high-risk segment. Two caveats are worth noting, however. First, the estimates capture the average relationship and therefore mask heterogeneity across banks. Therefore, for lenders with capital ratios below average, the mitigating effect of capital on default would be much smaller; hence riskier loan characteristics are less fully offset by capital buffers. Second, and more importantly, the attenuation effect is partial: even among well-capitalized lenders, high-LTV loans retain an economically and statistically significant default premium.

Figure 4. Interaction of BBMs with Capital-Based Measures



Sources: European DataWarehouse and authors' calculations.
Note: The chart shows, for each LTV/LTI, LSTI threshold, the estimated difference in delinquency probability between loans that surpass the given threshold and those that do not; and how this difference changes with the lender's capital ratio at issuance. Red denotes significance at 1 percent, orange at 5 percent, and blue at 10 percent. Red dot denotes significance at 1%; orange at 5%; blue at 10%.

E. Scenario-Based Calibration of Borrower-Based Measures in Spain

23. This section complements the analysis by developing a scenario-based framework to help inform the calibration of BBMs for Spain's residential mortgage market. The analysis uses

confidential credit registry data on the issuance of mortgages by origination cohort (vintage) and risk bucket from the Central Risk Information Office of the Bank of Spain (CIRBE), covering Spain's €505.7 billion mortgage portfolio as of 2025Q2, representing 99.5 percent of outstanding mortgages. The resilience of this portfolio to an adverse macroeconomic scenario with versus without BBMs is assessed to evaluate the potential effectiveness of alternative tools, including LTV, DSTI, LSTI, LTI as well as a combination of them, in mitigating portfolio risk. The analysis employs a structural model of mortgage default, building on the framework developed by Górnicka and Valderrama (2020) and adapted to the characteristics of the Spanish mortgage and housing markets.

24. The portfolio is segmented into 660 loan vintage-risk buckets. There are 55 loan vintages (quarterly from 1990Q1 to 2025Q2, with pre-2012Q1 loans grouped together) crossed with 12 LTV categories. Each bucket is characterized by risk metrics (LTI and DSTI ratios),[6] the loans' repricing schedule (including six repricing buckets), and their average effective maturity. Borrower liquid financial assets—estimated at 1.15 percent of average property value based on the 2023 Household Finance and Consumption Survey (HFCS)—are incorporated into the default trigger to assess whether financially distressed borrowers can avoid default by drawing down savings. Macroeconomic variables for the baseline scenario (unemployment, household income, GDP) are drawn from the January 2026 WEO. Paths for the adverse scenario, defined as deviations from baseline, as well as baseline projections for house prices follow the 2025 EU-wide stress test assumptions.

25. The mortgage portfolio comprises a significant share of loans originated during the run-up to the GFC as well as the post-pandemic period since 2020. This distribution reflects Spain's housing market cycles, with the earlier cohort representing legacy exposures from the pre-crisis boom (20 percent of outstanding loans were originated between 2004-2008) and the more recent vintages capturing the acceleration in lending activity following COVID-19 (about half of outstanding loans were issued after 2020). Mortgages are predominantly issued at floating rates, though the share of fixed-rate loans has increased following the 2022 ECB monetary hiking cycle.[7]

26. Borrower leverage and debt service burdens in new originations have risen in recent years (Figure 5). Although households have deleveraged on average since the pandemic—with the *average* LTI ratio for mortgage loans peaking at 4.9 in 2020Q2 and declining to 4.2 by 2025Q2—the fraction of high-risk new mortgages has risen. The share of loans with LTI ratios above 4 fell from 58.6 percent in 2021Q4 to 43.7 percent in 2024Q1 but has since increased to over 50 percent in 2025Q2. In 2025Q2—the latest available quarter for this paper, one-third of new issuances had a ratio above 5—high by international standards, where a common LTI cap is 4.5. Likewise, the DSTI of

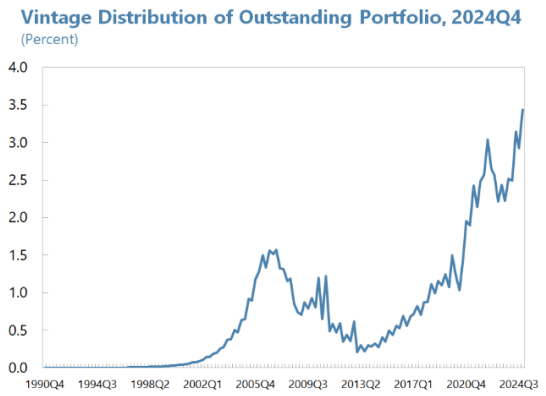
[6] The DSTI ratio measures a borrower's total debt repayments—including the new mortgage as well as existing obligations such as car loans and credit card debt—as a share of disposable income. Because DSTI data are available only for a short period (2018 and 2024–25), the analysis combines DSTI data with LSTI information, which is available since 2012. The LSTI captures the servicing costs of the new mortgage relative to income, rather than total debt payments. Using econometric techniques, we estimate a long time series of DSTI by LTV bucket (starting in 2012) based on its historical relationship with LSTI in the available data.

[7] Before the 2021 hiking cycle, over 70 percent of mortgages had repricing schedules of less than one year, while this share has fallen to around half for the most recent issuances.

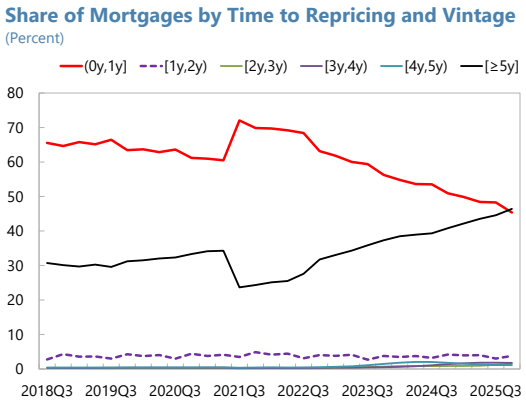
high-risk mortgages (those with an LTV ratio above 80 percent) rose from 32.2 to 34.7 percent between 2018 and 2025Q2, and average DSTI ratios across all mortgages also rose from 30 to 33 percent over the same period. LTV ratios had declined steadily over the previous decade up to 2023. The average LTV ratio fell from about 80 percent in 2012 to 64 percent in 2023, and the share of high-LTV originations (above 80 percent) declined from over 40 percent to just 9 percent. However, this trend has reversed during the past two years: By 2025Q2, the average LTV ratio had risen to 68 percent, and high-LTV originations had increased to 16 percent.

Figure 5. Characteristics of Spanish Mortgage Portfolio by Vintage

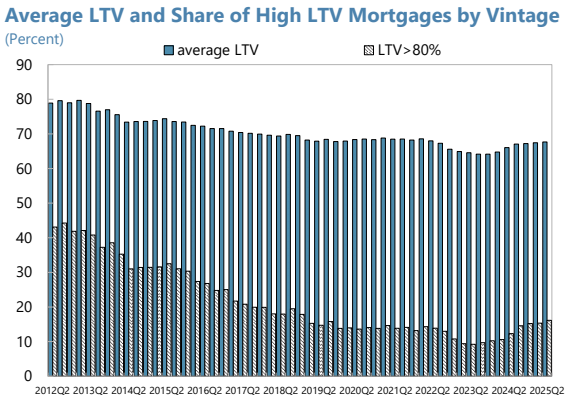
Legacy exposures remain significant, with a material portion of outstanding loans that were originated during the 2005–06 housing boom.



Mortgages have historically been predominantly issued at floating rates, although the share of fixed-rate loans has increased following the 2022 ECB hiking cycle.



High-risk lending has risen, with recent increases in both high-LTV…



…and high-LTI mortgage segments.

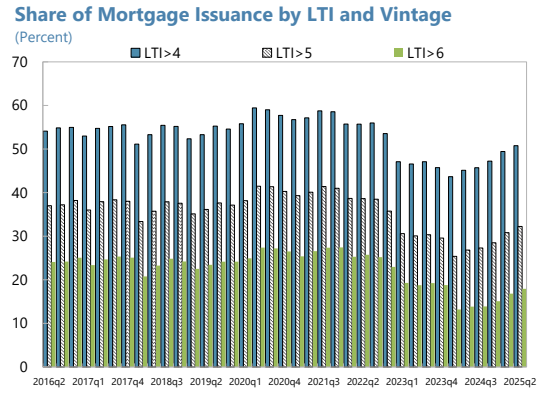
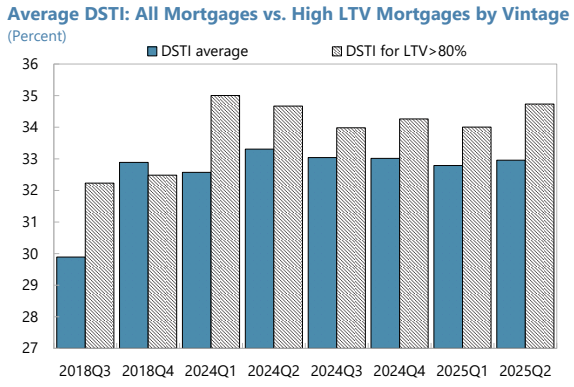
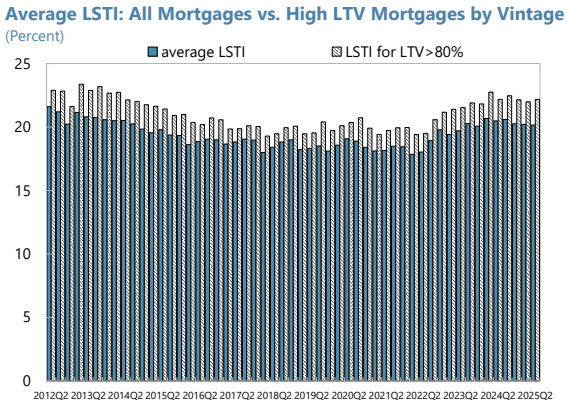


Figure 5. Characteristics of Spanish Mortgage Portfolio by Vintage (Concluded)

Borrowers' repayment capacity has weakened since 2018…



… and this deterioration is evident even among high-LTV borrowers.



Sources: Bank of Spain and IMF staff calculations.

27. The deterioration in lending standards over the past two years may heighten financial stability risks. For a similar mortgage contract, recent vintages are more likely to exhibit pockets of vulnerability, as borrowers originating loans in recent years have repaid less principal and accumulated smaller housing equity buffers. As a result, they are more vulnerable to rising interest rates and declining house prices than earlier cohorts.

28. The model uses a "double trigger" approach to default in estimating a loss event. Mortgage default is assumed to occur when a borrower experiences both (i) *financial distress*, i.e. an inability to service a loan (a liquidity shock), and (ii) *economic default*, which happens when they hold negative home equity (i.e., the mortgage is "underwater," with the property value below the outstanding loan value). In this situation, the borrower is unable to meet mortgage payments and cannot sell the property to avoid foreclosure, triggering default.[8]

29. Debt servicing costs and income shocks increase financial distress. Equation (1) determines the *probability of financial distress*—defined as an event in which borrowers in a given vintage-risk bucket are unable to service the loan on time due to liquidity constraints. Financial distress is modeled as a function of affordability risk ($DSTI$ ratio and its change), labor market conditions (unemployment level and change), and demographic factors (D):

[8] The model does not consider "strategic defaults," whereby a borrower who remains able to service the mortgage nevertheless chooses to default because the property is underwater. Such behavior is unlikely given the prevalence of full-recourse loans in Spain.

$$\Pr\left(FD_{i,t}\right) = \Phi\left(DSTI_{i,t}\right) \cdot D_i + \beta_1 \cdot \Delta DSTI_{i,t}{}^{\gamma} + \Phi\left(DSTI_{i,t}\right) \cdot \left(\beta_2 \cdot U_t + \beta_3 \cdot \Delta U_t^{\alpha}\right) \quad (1)$$

where i, t identify the vintage-risk buckets, $\Phi(\cdot)$ is a non-linear function, sharply increasing in $DSTI_{i,t}$; $D_i, \alpha, \beta_1, \beta_2, \beta_3, \gamma$ are parameters set to match the probability of financial distress observed in the data. U_t denotes the national-level unemployment rate. Mitigating actions—such as loan restructuring, borrowing from family members, or reductions in non-essential consumption—are implicitly captured in the calibration of the parameters of this financial distress equation.

30. If there is financial distress and the value of the collateral net of disposable costs is less than the value of the loan, the borrower is considered to default. Equation (2) defines the *probability of economic default*—which occurs when the house sale price net of transaction costs cannot cover the loans' net present value in a given vintage-risk bucket, which includes the outstanding balance plus prepayment penalties for fixed-rate mortgages:

$$ED_{i,t} = \begin{cases} 1 & if \ \widetilde{P_{\iota,t}} - C + FinWealth_{\iota,t} < \widetilde{NPV\left(L_{\iota,t}, r_t^{type,M}, r_t^f, T_{t,s} \middle| FD_{\iota,t}\right)} \\ 0 & Otherwise \end{cases} \quad (2)$$

where $P_{i,t}$ is the market property value, C is the transaction cost of selling the property, assumed to be constant, $FinWealth_{i,t}$ is the liquid financial assets—estimated from the 2023 HFCS as 1.15 percent of average property value.[9] The net present value of the loan, NPV, consists of two elements: (i) the outstanding loan amount $L_{i,t}$, and (ii) the penalty for early prepayment which is estimated as the discounted value of foregone interest payments[10], which increase with the mortgage rate locked-in at the time of default $r_t^{type,M}$ (which depends on the type of mortgage and the resetting price schedule of the loan), and its remaining maturity $(T_{t,s} - s)$ for a loan issued at time s.[11] The average mortgage rate as of 2025Q2 r_t^f is used to discount the amount of future interest payments. If the borrower can afford to service the loan, default will not occur even if there is negative home equity. If the borrower cannot service the loan but the house is worth more than the loan value, default is not assumed to occur either, as the borrower will refinance the loan posting additional collateral, or sell the house to repay the loan to avoid foreclosure.

31. The model is calibrated using historical crisis episodes and validated by its ability to replicate observed default rates in Spain. Parameters calibration follows Harrison and Mathew (2008), drawing on the Spanish 2013-14 real estate crisis to capture unemployment and interest rate sensitivities in the financial distress equation, the 1990s UK real estate crisis to estimate the

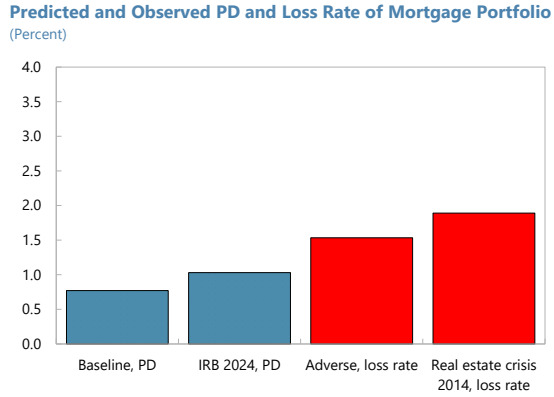
[9] As the ratio of liquid financial assets to house value varies across LTV and LTI buckets, we rely on the average value as a simplifying assumption.

[10] According to the mortgage law, early prepayment penalties in Spain are capped, varying by mortgage type and time elapsed since signing.

[11] The penalty for early prepayment decreases with the current value of interest rates. The model uses the conservative assumption that the bank charges a positive penalty for early re-payment even if market rates rise, calculated as the net present value of foregone interest rate payments for a specified number of months.

sensitivity of financial distress to the initial DSTI ratio, and the Spanish internal-rating based (IRB) banks' 2024Q4 reported default rates for demographic factors.[12] Calibrated on this basis, the model successfully replicates Spanish IRB banks' reported default risk under both baseline conditions and the adverse environment observed during the 2014 real estate crisis (Figure 6).

Figure 6. Model Validation



Note: The average PD over the 3-year baseline scenario is compared against the PD reported by IRB Spanish banks in 2024Q4 (1-year ahead PD). The average loss rate over the 3-year adverse scenario is compared against the peak loss rate observed during the 2014 Spanish real estate crisis.

32. Before conducting stress-test scenario analysis, risk characteristics for each vintage-risk bucket are updated from origination to point-in-time up to 2025Q2. For each bucket, the model calculates: (i) the outstanding loan amount after amortization; (ii) the current property value using the average cumulative house price growth in Spain; (iii) borrower income updated with cumulative wage growth proxied by the average household disposable income; and (iv) the current interest rate reflecting the bucket's repricing schedule and mortgage type composition.[13] These inputs generate point-in-time LTV, LTI, and LSTI ratios for each bucket. The stress scenario is then applied to these point-in-time estimates, ensuring that the analysis reflects the portfolio's actual risk profile as of 2025Q2.

33. The model simulations assume a baseline and an adverse scenario. The baseline scenario follows the IMF's January 2026 WEO projections. To assess banking sector resilience to a house price correction, we construct a three-year adverse scenario (2027Q2-2030Q2) combining an inflationary shock[14] with a domestic recession, based on the 2025 EU-wide stress test exercise for Spain. Key assumptions include: house prices falling 17.2 percent cumulatively (with stochastic variation allowing fluctuations of ±15 percent to capture idiosyncratic property-level risk); unemployment

[12] The model parameters are calibrated using historical crisis episodes. Following Harrison and Mathew (2008), α is set to 1. The sensitivity parameters $(\beta_1, \beta_2, \beta_3, \gamma)$ are calibrated using the Spanish 2013-14 crisis which provide information on how unemployment and interest rate changes affect financial distress. The demographic parameters (β_2, D) are jointly calibrated to match Spanish IRB banks' reported default rates in 2024Q4. See Annex II. Table 1 and Table 2 for detailed parameter values.

[13] While greater granularity—for example, house price growth at the level of Spanish autonomous communities or income growth by quantile—would be desirable, we use average values because the mortgage portfolio is aggregated across provinces and the income distribution.

[14] Given that mortgage loans in Spain have been extended most commonly at variable rates, typically reset every 6 to 12 months and linked to an official reference index (most commonly the 12-month Euribor), an inflationary scenario is more conservative than a deflationary one.

rising 5.6 percentage points; mortgage rates widening by an average of 160 basis points (varying by mortgage type and repricing schedule); and household disposable income remaining broadly flat in nominal terms.

Table 3. Spain: Stress Test Scenario (2028-2030): Key Macrofinancial Variables

Variable	Baseline	Adverse
Household disposable income	YoY growth = 12.9%	YoY growth = 0%
Real estate price	N [0, standard deviation = 15%]	N [-17.2%, standard deviation = 15%]
Unemployment	-0.1 ppts	5.6 ppts
Benchmark rate	0.19 ppts	1.62 ppts

Note: The scenario produces annual projections of key macro-financial variables over a three-year horizon (2028–2030). The table reports cumulative shocks. During the two preceding years (2026–2027), the economy follows the WEO baseline projections as of January 2026. The adverse projections are based on the inflationary-recession scenario used in the EU-wide stress test exercise for Spain conducted in 2025, with deviations from baseline applied to the IMF WEO forecasts.

34. To calculate the probability of default (PD) and loss given default (LGD) under each scenario (baseline and adverse), we conduct Monte Carlo simulations over the 660 vintage-risk buckets (12 LTV categories crossed with 55 quarterly vintages). The simulation proceeds in three steps for each bucket:

- First, we compute the probability of financial distress for each bucket using equation (1), which yields a value between 0 and 1, representing the share of borrowers in that bucket who are in financial distress under the scenario's macroeconomic conditions.

- Second, conditional on financial distress, we simulate economic default outcomes for that bucket. All loan characteristics in equation (2)—outstanding loan amount, interest rate, remaining maturity, transaction costs, and liquid financial assets—are LTI-LTV bucket-level averages. To account for loan level heterogeneity, we draw N=10,000 house prices for each LTV-vintage bucket from a distribution centered on the scenario's house price path to capture property-level variation. For each draw, equation (2) produces a binary outcome: 1 if that house price results in economic default (sale proceeds cannot cover the loan), 0 otherwise.

- Third, we calculate the bucket's PD using these N binary outcomes:

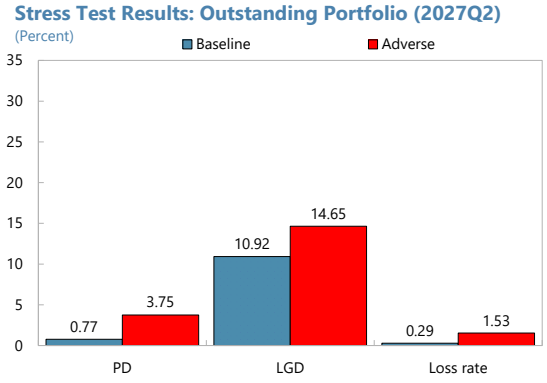
$$PD_{i,t} = \frac{\sum_{n=1}^{N} ED_{i,t}}{N} \times \Pr\left(FD_{i,t}\right) \tag{3}$$

where the numerator of the first term is an indicator function equal to 1 if equation (2) equals 1 and $\Pr\left(FD_{i,t}\right)$ is the (scalar, continuous) probability of financial distress (from equation 1), $PD_{i,t}$ is then the bucket's probability of default. The bucket-specific LGD is computed as the average of LGDs

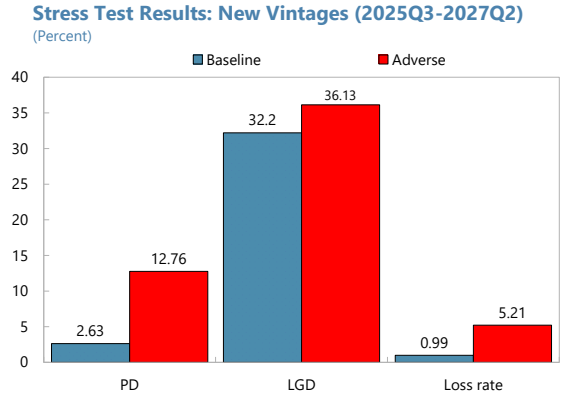
among defaulted loans shown in equation (4). To ensure stability of the simulation results, this process is repeated 1,000 times for each LTV-vintage bucket.[15]

Figure 7. Stress Test Results

Annualized loss rates in the outstanding portfolio could rise from about 30 bps under the baseline to 150 bps in the adverse scenario…



….with the most recent vintages appearing particularly vulnerable—loss rates for these cohorts could surge to around 520 bps.



Note: Credit risk projections are Point-in-Time. Therefore, they reflect cyclical conditions and affect bank capital through loan loss provisions.

35. Loss given default (LGD) is then calculated as the difference between the defaulting loan's net present value and the discounted recovery value from selling the repossessed property:

$$LGD_{i,t} = NPV\left(L_{i,t}, r_t^{type,M}, r_t^f, T_{t,s}\right) - (1-\delta) \times \frac{\widetilde{P_{i,t+n}}}{\left(1 + r_t^f + spread\right)^n} \quad (4)$$

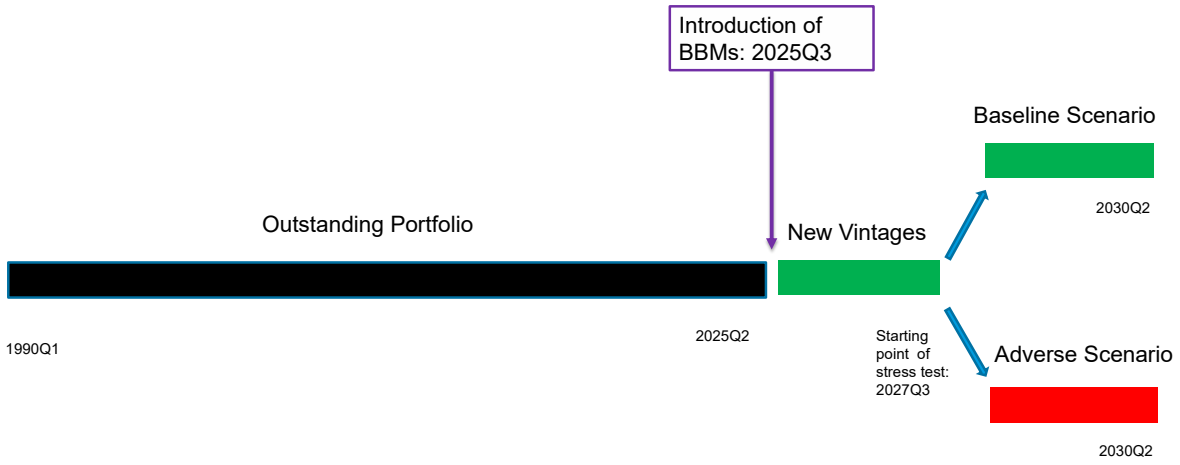
where the first term denotes the outstanding debt and the second term the recovery value; δ denotes the foreclosure discount at which the bank sells the property at time $t+n$, where n is the average time needed to sell off the collateral (6.17 years in Spain, based on estimates from the Bank of Spain for 2022-2024[16]), and *spread* is the risk-adjusted spread used to discount the value of the risky asset. The portfolio-wide PD, LGD, and loss rates are calculated by aggregating bucket-specific results weighted by each bucket's outstanding share of the total portfolio in 2025Q2.

[15] Monte Carlo simulations draw values for the house price index by LTV bucket to account for loan heterogeneity within the bucket. As the error of a Monte Carlo simulation decreases in proportion to $1/\sqrt{N}$ where *N* is the sample size, increasing iterations reduces random variability and improves precision.

[16] These estimates are based on calculations of the Forward-Looking Exercise on Spanish Banks (FLESB) model which is a macroprudential stress testing model developed by the Bank of Spain.

36. While Spanish banks appear broadly resilient to severe macroeconomic shocks, a pronounced real estate downturn could pose material risks to macrofinancial stability. Under the adverse scenario, annualized mortgage loss rates for the overall portfolio rise from 30 basis points in the baseline to 150 basis points, resulting in cumulative losses of roughly 4.6 percent of the total mortgage portfolio—about €23 billion over the three-year horizon (Figure 7).

Figure 8. Assumed Timeline of Macroprudential Policy Interventions

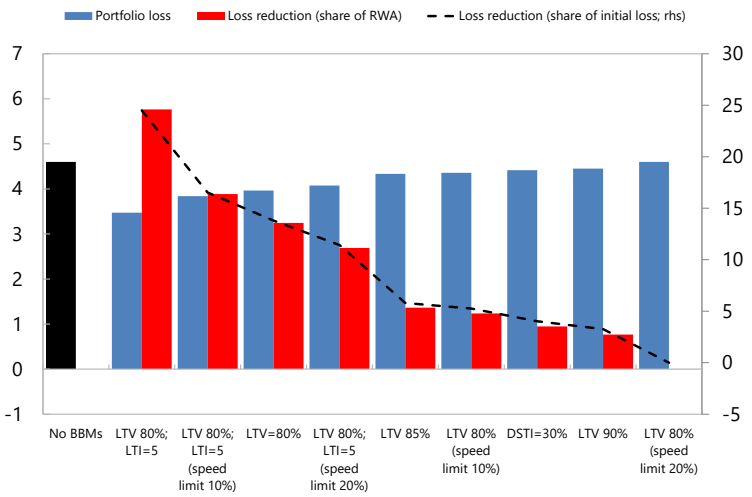


Note: Regulatory limits on new vintage flows are assumed to be introduced 8 quarters before the 3-year stress materializes. The model delivers stress test results for the outstanding portfolio and new vintages with and without regulatory policy interventions. Regulatory limits may include LTV, DSTI, and a combination of LTV and LTI caps, with and without 'speed limits.'

37. Losses are heavily concentrated in recent vintages, underscoring the importance of acting pre-emptively—before lending standards further loosen significantly—to mitigate risks to the mortgage portfolio. Mortgages originated during 2025Q3-2027Q2 would face loss rates of 520 basis points—nearly 3.5 times the portfolio average—as these borrowers have accumulated smaller equity buffers and remain highly exposed to rising interest rates and falling house prices. At the same time, under stress, banks' credit losses are primarily concentrated in non-collateralized retail and corporate loans rather than residential mortgages. As a result, the 1 percent countercyclical capital buffer (CCyB), scheduled for October 2026 and estimated at around EUR 16 billion, would mainly help absorb non-mortgage losses. Against this backdrop, the projected EUR 23 billion in gross mortgage losses (i.e. before netting out credit provisions) is significant—particularly if losses were to be unevenly distributed across banks. In such a scenario, affected banks would likely curtail lending, amplifying stress through negative feedback loops.

38. Introducing borrower-based measures—particularly collateral-based ones—targeting new loan originations could materially reduce these risks. The analysis shows that well-calibrated borrower-based measures could reduce portfolio losses under severe stress by up to 25 percent after two years of implementation—equivalent to roughly €6 billion (Figure 9). An LTV cap of 80 percent—either as a hard limit or combined with an LTI limit of 5 under a *speed-limit* framework[17]—is found to be most effective, while DSTI caps calibrated at standard ratios (30 or 40 percent) yield minimal benefits as system-wide average DSTI ratios already fall well below tested thresholds.[18] Looser LTV thresholds also deliver substantially smaller gains: an 85 percent cap would reduce adverse-scenario losses by only about 6 percent relative to the no-BBM baseline, reflecting the fact that new mortgages originated with LTVs at or above 85 percent have averaged only around 7.7 percent of issuance over the past three years, and a 90 percent cap would be almost non-binding.

Figure 9. Impact of BBM limits in the Adverse Scenario



Note: Regulatory limits on new vintage flows are introduced 8 quarters before the 3-year stress test horizon materializes. The model delivers stress test results for the outstanding portfolio with and without regulatory policy interventions. Regulatory limits include LTV (with and without speed limits), DSTI, and a combination of LTV and LTI caps (with and without speed limits).

39. The estimated gain from BBMs should be interpreted as a lower bound. First, the benefits from collateral-based measures are based on LTV ratios rather than loan-to-price (LTP) ratios. Calibration using LTP ratios—which capture the actual purchase price rather than the appraised value—would likely yield larger resilience gains for a given level of the chosen ratio (e.g., 80 percent). Second, the CIRBE data used in this analysis cover only mortgages secured on households' main residences. Extending the analysis to second homes and buy-to-let mortgages, where risks are typically higher, could further strengthen the estimated benefits of borrower-based measures.

[17] We assume that new lending exhibits "bunching" just below the regulatory limits. In particular, to comply with these limits, the relative share of loans with LTV, LTI, or DSTI ratios just below the thresholds increases. This occurs because some borrowers who would otherwise obtain loans with LTVs, LTIs, or DSTIs above the limits instead agree to loans at the maximum allowable ratios. When "speed limits" are applied, the share of loans exceeding the limits is adjusted proportionally to the initial distribution of originations in the absence of BBMs.

[18] A caveat is that we use a long time series of the LSTI ratio to estimate DSTIs as the latter are only available in 2018 and from 2024Q1 onwards.

F. Conclusion

40. The analyses in this paper provide data-driven inputs for the design and calibration of potential BBMs in Spain. Spain's mortgage market does not currently display acute imbalances, average household leverage remains low, and bank balance sheets are solid. At the same time, banks' mortgage portfolio displays a gradual accumulation of risk in recent vintages—rising high-LTV shares, higher LTI ratios, and smaller equity buffers among post-2020 borrowers—that would translate into material portfolio losses under a severe housing correction, particularly among the most recent cohorts.

41. If BBMs were to be introduced, the evidence supports anchoring the framework on a collateral-based cap (such as LTV or LTP), possibly complemented by an LSTI cap. The loan-level analysis identifies collateral-based looseness as the primary driver of mortgage default in Spain, while income-based looseness matters essentially through its interaction with high-LTV lending. The scenario-based analysis points in the same direction: an LTV cap of around 80 percent—whether as a hard limit or combined with an LTI limit under a speed-limit framework—is found to deliver the largest reduction in adverse-scenario losses, while a standalone LSTI cap calibrated at standard international thresholds would add little given that average LSTI ratios in Spain already fall well below those levels. From a calibration standpoint, this supports anchoring the BBM framework on a collateral-based cap, with a LSTI limit acting as a complement that targets the particularly risky segment of loans that are simultaneously highly leveraged and exhibit stretched debt-service burdens.

42. Three further considerations would shape implementation. First, BBMs and capital-based measures should be viewed as complements rather than alternatives: both impose economic costs, so the relevant question is how to balance these costs to achieve a given level of banking system resilience. The Spanish evidence that stronger lender capitalization only partially offsets the default risk embedded in high-LTV loans suggests that capital buffers alone cannot substitute for addressing risk at origination. Second, introducing BBMs pre-emptively—before they become binding—would minimize their economic and social cost, as they would not materially constrain current credit conditions while helping prevent a possible deterioration, and would likely face less public resistance compared to introducing them in more binding form after a further loosening in lending standards. Third, and importantly to ease the trade-off between strengthening banking system resilience and maintaining home ownership access inherent to BBMs, flexibility features such as speed limits and differentiation by borrower type could help mitigate distributive concerns, while a gradual, well-communicated implementation path would further ease the transition.

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Annex I. Full Regression Results for the Loan-Level Analysis

Annex I. Table 1. Spain: Effects of High-Risk Loans on Mortgage Defaults

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
LTV>80%	0.0117***			0.0116***	0.0115***	0.0100***	0.0093***
	(0.0019)			(0.0019)	(0.0020)	(0.0016)	(0.0017)
LTI>6		0.0025***		0.0012		0.0000	
		(0.0009)		(0.0008)		(0.0010)	
LSTI>40%			0.0037***		0.0026**		0.0003
			(0.0010)		(0.0010)		(0.0010)
LTV>80% # LTI>6						0.0030	
						(0.0019)	
LTV>80% # LSTI>40%							0.0054***
							(0.0020)
Observations	1015509	1030201	1012602	1015509	993698	1015509	993698
R-squared	0.0453	0.0448	0.0435	0.0454	0.0441	0.0454	0.0441
Time-Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time-Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is mortgage delinquency. Lending standards are included as indicator variables equal to one when the loan exceeds the following thresholds: LTV > 80% , LTI > 6 and LSTI>40. All specifications control for loan, borrower risk and property characteristics. Regressions include bank-by-time and province-by-time fixed effects. Robust standard errors are reported in parentheses. ***, **, * denotes coefficient statistically distinct from 0 at 1%, 5% and 10% levels, respectively. Columns (1)-(3) refer show the coefficients from a single-measure specification entering each lending-standard dummy on its own; columns (4)-(5) show the coefficients from a joint specification entering LTV together with either LTI or LSTI; and columns (6)-(7) show the coefficients from a specification augmented with the interaction between the LTV dummy and the income-based dummy.

Annex I. Table 2. Spain: Effects of High-Risk Loans on Mortgage Defaults Contingent on Lenders' Capital Ratio

	(1)	(2)	(3)
LTV>80%	0.0106***		
	(0.0018)		
LTI>6		0.0023*	
		(0.0013)	
LSTI>40%			0.0042***
			(0.0014)
LTV>80% # RWA Capital Ratio	-0.0039***		
	(0.0012)		
LTI>6 # RWA Capital Ratio		-0.0018**	
		(0.0007)	
LSTI>40% # RWA Capital Ratio			0.0004
			(0.0011)
LTV>80% # LTI>6			
LTV>80% # LSTI>40%			
Observations	463933	470862	462178
R-squared	0.0451	0.0445	0.0433
Time-Bank FE	Yes	Yes	Yes
Time-Province FE	Yes	Yes	Yes

Notes: The dependent variable is mortgage delinquency. Lending standards are included as indicator variables equal to one when the loan exceeds the following thresholds: LTV > 80%, LTI > 6 and LSTI>40. The risk weighted assets (RWA) capital ratio is winsorized at the 1st and 99th percentiles and standardized. Regressions include bank-by-time and province-by-time fixed effects. Robust standard errors are reported in parentheses. ***, **, * denotes coefficients statistically different from 0 at 1%, 5% and 10% levels, respectively.

Annex II. Scenario-Based Default Model Calibration

Annex II. Table 1. Spain: Key Parameters of the Mortgage Model

Parameter	Value
Calibrate sensitivity of FD to shifts in DSTI	$\beta_1 = 0.0016 \qquad \gamma = 2.5$
Calibrate sensitivity of FD to initial DSTI by bucket	$\phi(DSTI) = \begin{cases} \left(\frac{DSTI - 15\%}{30\% - 15\%}\right) & 15\% < DSTI < 30\% \\ 1 & otherwise \end{cases}$
Calibrate sensitivity of FD to unemployment	$\beta_2 = 0.06 \qquad \beta_3 = 0.727 \qquad \alpha = 1$
Allocate financial distress to shocks during the Spanish real estate crisis 2013-14	$\xi_{FD,u} = \frac{\partial FD}{\partial u} = 17.6\% \qquad \xi_{FD,i} = \frac{\partial FD}{\partial i} = 14.8\%$
Estimate sensitivity to demographic factors	$D = 0.02$
Estimate foreclosure transaction costs	$C = 3.65\%$
Estimate liquid financial assets as a share of average residential real estate price	$1.15\% \cdot \tilde{P}$

Source: Bank of Spain and IMF staff calculations. Note: The calibration and parameterization of the model is based on the loan loss experience of the burst of the real estate bubble in Spain in 2012-2014. The risk characteristics of vintages are adjusted to reflect current conditions as of 2025Q2.

Annex II. Table 2. Spain: Other Parameters of the Mortgage Model

Parameter	Value
Foreclosure discount	27.26%
Time to sell collateral after foreclosure	6.17 year
Discount rate of real estate collateral	2.7%
Spread on discount rate on foreclosed collateral	1.0%

Source: Bank of Spain and IMF staff calculations. Note: The calibration and parameterization of the model is based on the loan loss experience of the burst of the real estate bubble in Spain in 2012-2014.

Annex III. Macrofinancial Variables Path Assumptions

Annex III. Table 1 reports the time paths of the key macrofinancial variables used in the scenario-based analysis—unemployment, interest rates (weighted average of fixed/floating mortgages across all maturities whose counterparty is a household), income growth (year-on-year), and house prices (nominal year-on-year growth)—under both the baseline and the adverse scenario. The baseline paths are drawn from the January 2026 WEO (except the house price projections), while the house price projections and the adverse paths follow the European Banking Authority's (EBA) 2025 EU-wide stress test exercise. The shocks embedded in the 2025 EU-wide stress scenario are applied to the January 2026 WEO baseline forecasts to project the adverse paths in levels. These trajectories feed into the model simulations underlying the mortgage portfolio loss estimates—with and without BBMs—reported in Section E.

Annex III. Table 1. Spain: Baseline and Adverse Scenario

Baseline	2025	2026	2027	2028	2029	2030
January 2026 WEO						
Unemployment	10.8	10.7	10.7	10.7	10.7	10.7
Interest rates	2.6	2.5	2.5	2.5	2.5	2.5
Income growth	6.0	5.1	4.2	4.4	4.0	4.0
EBA 2025 stress test						
House prices	8.5	7.6	6.7	4.9	4.9	4.9
Adverse						
EBA 2025 stress test						
Unemployment	10.8	10.7	10.7	14.0	17.2	16.4
Interest rates	2.6	2.5	2.5	5.1	4.5	4.1
Income growth	6.0	5.1	4.2	4.4	4.0	4.0
House prices	8.5	7.6	6.7	-4.3	-11.0	-5.6

Note: The adverse paths are generated by applying deviations from the baseline assumed in the EBA 2026 EU-wide stress test scenario to the January 2026 WEO projections.

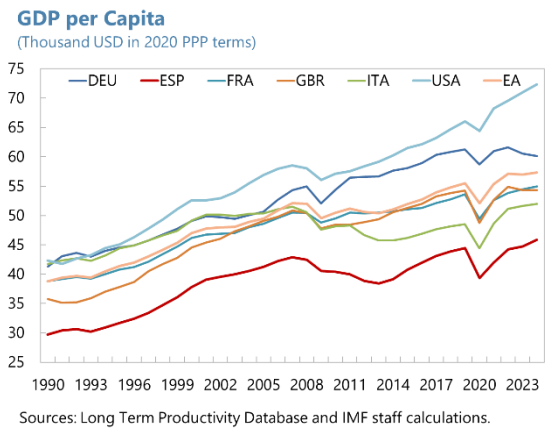
FIRM-LEVEL INNOVATION IN SPAIN: PATTERNS, DRIVERS, AND POLICY IMPLICATIONS[1]

While Spain's productivity growth has picked up in recent years, a sizable gap with other high-income countries remains. One contributing factor, which is the focus of this paper, is a large innovation gap vis-à-vis peer countries. Firm-level evidence shows that this gap is particularly pronounced among young firms and widens further for higher-quality patents. Innovation by Spanish firms is found to be held back by several factors, including size-dependent regulations, financial constraints, and regulatory burdens. These frictions not only reduce the likelihood of innovation but also its payoff in terms of post-innovation firm growth. Another obstacle is the complexity of the R&D tax credit, which is relatively generous on paper compared to other countries yet has a low take-up rate in practice. Simulations of an endogenous growth model with firm-level innovation and creative destruction suggest that easing these frictions, together with streamlining the R&D tax credit, could raise Spain's long-term total factor productivity growth by over a quarter of a percentage point.

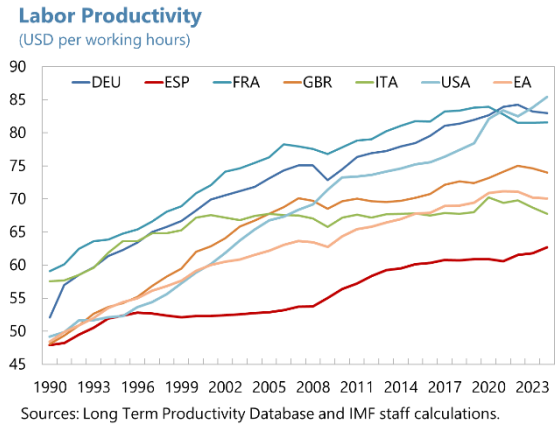
A. Introduction

1. Notwithstanding its recent improvement, Spain's productivity growth performance has been weak over the past two decades and a large gap remains with respect to other high-income countries. Figure 1 plots Spain's GDP per capita and labor productivity alongside other high-income countries. Despite some recent catchup, productivity levels remain below the euro area average and are even further behind those of the US. In particular, Spain's labor productivity was roughly comparable to that of the US in 1990, but the gap has widened over time, with Spain's productivity now at about 74 percent of the US level.

Figure 1. GDP per Capita and Labor Productivity of Spain and Other High-Income Countries



Sources: Long Term Productivity Database and IMF staff calculations.



Sources: Long Term Productivity Database and IMF staff calculations.

[1] Prepared by Younghun Shim, Isabel Figueiras (EUR summer intern), and Carlo Pizzinelli.

2. This paper focuses on innovation as a driver of productivity growth. Productivity is determined by various factors, including innovation, foreign technology adoption, technology diffusion across firms, allocative efficiency, and human capital. Among these, this paper focuses on innovation, which is one of the main drivers of long-run productivity growth in high-income countries (Acemoglu and others, 2006). Specifically, it examines the magnitude of the innovation gap, how it varies across firm characteristics such as size and age, and the frictions that hinder innovation in Spain.

3. To study the drivers of, and obstacles to innovation by Spanish firms, empirical analysis is carried out using a firm-level patent dataset. Analyzing innovation requires output-based measures at the micro level; in this paper, patent data are used, as commonly used in the literature. Patent data provide measures of both the quantity and quality of innovation. They are obtained from PATSTAT and merged with firm-level ORBIS data using firm names. Using this dataset, stylized facts are documented on firm-level innovation in Spain relative to other high-income countries. Specifically, the results indicate that Spanish firms innovate less than French and Swedish firms, particularly among young firms. This is consequential for growth, as we also find that younger firms tend to produce higher-quality innovations. In addition, we examine the role of various frictions—including size-dependent regulations, financial frictions, and regulatory burdens—on both the likelihood of innovation and post-innovation firm growth. All three frictions are negatively associated with both the probability of innovation and its quality. Moreover, conditional on innovating, firms grow less when they face frictions.

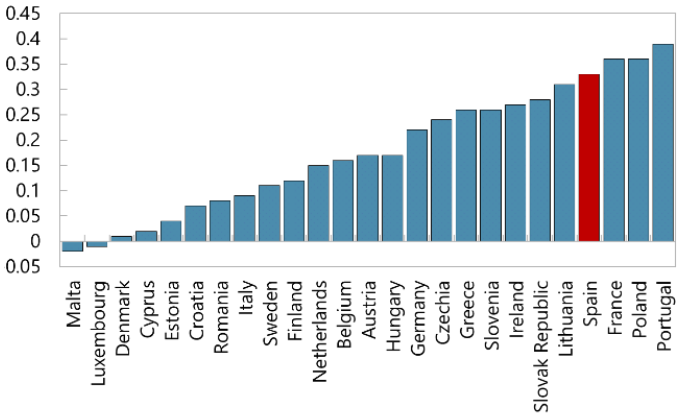
4. To quantify the implications of removing some of the key innovation obstacles for aggregate productivity growth, an endogenous growth model is developed. Building on Klette and Kortum (2004), a general equilibrium framework is constructed in which productivity growth is driven by innovation. In the model, firms invest in R&D to innovate, which raises productivity and expands firm size. We extend the standard framework by incorporating frictions that reduce firms' innovation incentives and, in turn, aggregate growth. The model is calibrated to match the observed micro-level patterns of innovation and firm size in Spain, including those derived from the empirical results.

5. Policy counterfactuals based on the calibrated model point to sizable productivity growth gains from easing the frictions that are holding back innovation and streamlining the R&D tax credit. The counterfactual analysis suggests that addressing all three frictions mentioned above could increase the long-run TFP growth rate by 0.18 percentage points. As for Spain's R&D tax credit, whose complexity lowers take-up, a reform that would streamline the tax credit to raise the take-up rate and thereby the effective subsidy rate could yield an extra productivity growth gain. Specifically, streamlining the program and better targeting it toward young firms could increase the TFP growth rate by a further 0.1 percentage point.

B. Spain's Innovation Policies

6. Spain's R&D tax credit is generous in terms of statutory rates, but its complexity and administrative burden substantially limit actual take-up. R&D expenditure in Spain is eligible for a 25 percent tax credit up to the average expenditure level of the previous two years, and for a higher rate of 42 percent on additional expenditure above that level. OECD data (Figure 2) show that Spain's implied tax subsidy rates on R&D exceed those in most other EU countries. However, AIReF (2020) finds that the actual take-up rate of the R&D tax credit is only around 30 percent. One important contributing factor—highlighted by AIReF—is real and perceived legal and regulatory uncertainty: tax authorities may reject applications after ex-post evaluation if the reported activities are not deemed to qualify as "R&D." Firms, particularly smaller ones, perceive this rejection risk as high. In addition, small and young firms often lack sufficient taxable profits against which to apply the credit, which substantially reduces its effective value since the credit cannot function as a negative tax (AIReF, 2020). Although the Spanish government has introduced a monetization mechanism that allows firms to cash out unused credits in the absence of tax liabilities, this option comes at a cost: the credit is discounted, and firms must satisfy strict continuity of activity and employment requirements. In addition, because this support is received with a lag, it may do little to ease the short-term credit constraints that hold back firms' R&D investment. Finally, the administrative burden associated with documentation, certification, and compliance is widely perceived to be large, further discouraging participation. Together, these features imply that Spain's R&D tax credit is generous on paper but much less accessible in practice, particularly for small and young firms.

Figure 2. Implied Tax Subsidy Rates on R&D Expenditures
(Implied subsidy in $ per $1 of R&D)



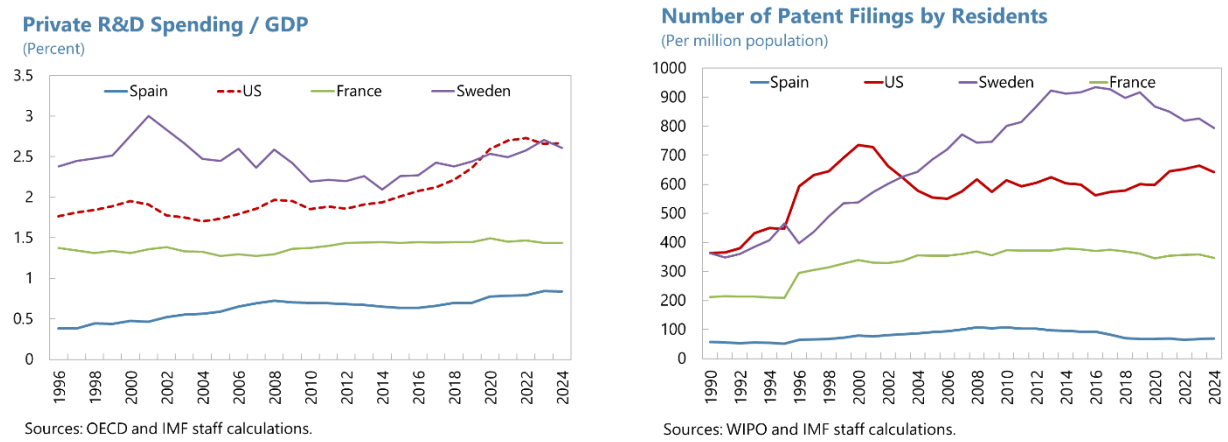
Sources: OECD Innotax

C. Data and Stylized Facts

7. Spain has been lagging behind other advanced economies on both input and output measures of innovation. The left panel of Figure 3 shows that R&D intensity has stagnated since the late 2000s and the gap relative to other advanced economies has remained persistent. The right panel presents an output measure of innovation—the number of patents filed by residents per million population. Spain has been recording substantially fewer patents than other countries, and this gap is even larger than that observed for R&D intensity. Together, these patterns suggest that Spanish firms not only invest less in R&D, but also exhibit lower innovation productivity—since the

patenting gap significantly exceeds the R&D spending gap—compared with firms in other advanced economies.

Figure 3. Innovation in Spain Compared to Other Advanced Economies



8. Spain's patenting gap vis-à-vis the US is broad-based across sectors and does not mainly reflect Spain's sectoral specialization. The gap is mostly driven by the within-sector margin rather than by differences in sectoral composition, as the results from the following decomposition show:

$$\Delta P = \sum_j (\alpha_j^{US} - \alpha_j^{ES}) P_j^{ES} + \sum_j \alpha_j^{US} (P_j^{US} - P_j^{ES}).$$

where P_j is patents per worker and α_j is the employment share of industry j (2-digit NACE). The first term captures the across-sector (composition) margin, reflecting differences in patenting that arise from variation in industry shares across countries (for example, the higher sectoral share of the tech sector, in which firms have a high propensity to innovate, in the United States compared to Spain). The second term captures the within-sector margin, reflecting differences in patent intensity within given industries. The within-sector margin is found to account for about 70 percent of the total patenting gap between Spain and the US, while the remaining 30 percent is explained by differences in sectoral composition. This implies that Spain's innovation shortfall is driven mainly by weaker innovative performance of firms within the same industries, rather than by a concentration in less innovative sectors.

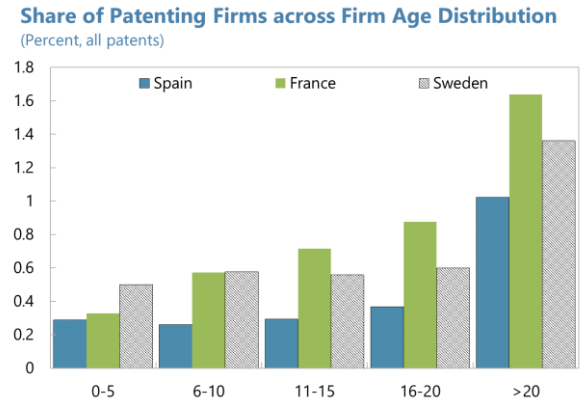
9. In this paper, Orbis data are merged with PATSTAT data to examine firm-level innovation. Firm-level data are obtained from Orbis, which provides data on sales, employment, fixed assets, industry, and location.[2] The analysis focuses on Spain, France, and Sweden, all of which have good coverage in Orbis. These are merged with PATSTAT data, which contains comprehensive patent information from several patent offices, including the European Patent Office, as well as the Spanish, US, and Japanese patent offices. Firm names and locations are used to merge the two

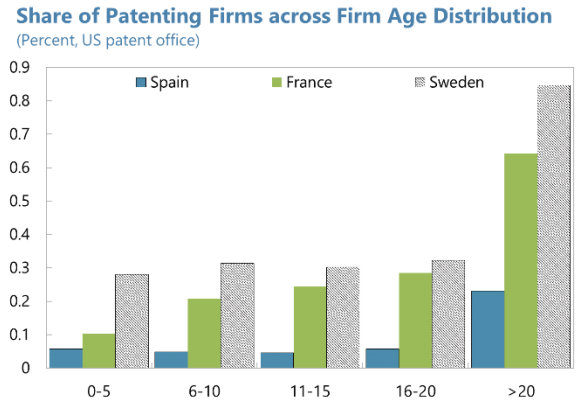
[2] We followed the data cleaning procedure by Díez and others (2021) and Kalemli-Özcan and others (2024).

datasets, following the standardization process of EUIPO (2025). The matching rate for Spanish firms is 87 percent, meaning that 87 percent of all patent applications filed by firms located in Spain are assigned to a harmonized firm ID from Orbis, and thus appear in our final merged sample. The corresponding matching rates for France and Sweden are 78 percent and 85 percent, respectively. These rates are comparable to those in the literature. Details on the data can be found in Annex I.

10. Spanish firms are less likely than French and Swedish firms to file patents, with the gap being larger for younger firms and even more pronounced for high-quality patents. Using the merged Orbis–PATSTAT dataset, firms' innovation probabilities are examined across age groups and countries. Two measures are employed. First, a firm is defined as a patenting firm if it files at least one patent in any patent office (for example, the Spanish Patent Office). Second, to capture higher-quality innovation, we restrict attention to patents filed at the US Patent and Trademark Office (USPTO), which are widely regarded in the literature as a proxy for higher-quality patents. Figure 4 plots the share of patenting firms by firm age, with the left panel showing all patents and the right panel showing only USPTO patents.[3] Across all age groups, Spanish firms exhibit lower patenting rates than their French and Swedish counterparts, and this gap is particularly pronounced for younger firms and for high-quality patents.

Figure 4. Share of Firms that File Patents across Firm Age Distribution





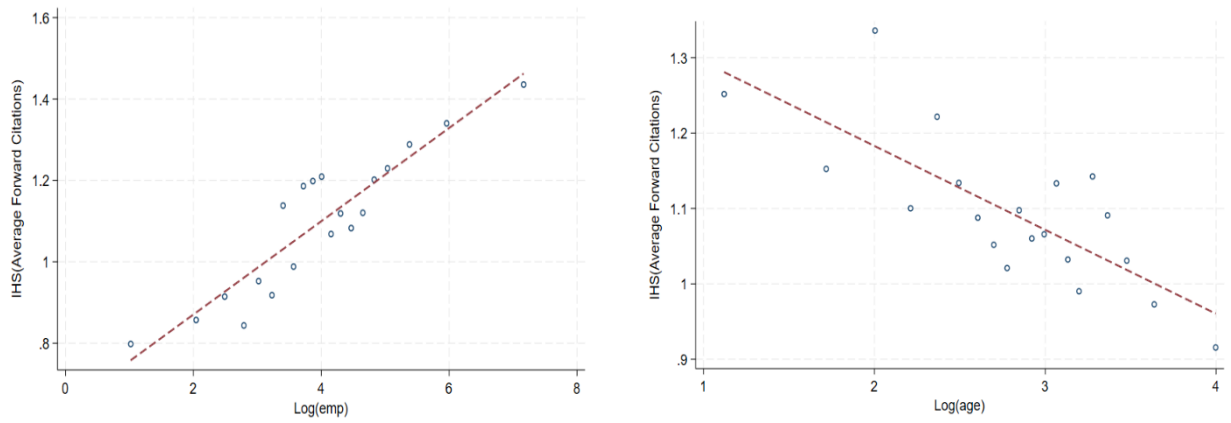
11. The average quality of patents increases with firm size but decreases with firm age, highlighting the importance of large and young firms in driving breakthrough innovation. Following the literature, we measure innovation quality using forward citations—the number of times a patent is cited by subsequent patents—and exclude self-citations in which firms cite their own patents. Firm size is proxied by employment. Figure 5 presents binscatter plots of the inverse hyperbolic sine transformation of forward citations against log employment and log firm age.[4] In

[3] We restrict the sample to the manufacturing sector to improve comparability across the three countries.

[4] The inverse hyperbolic sine (IHS) transformation is defined as $\text{asinh}(x) = \ln\left(x + \sqrt{x^2 + 1}\right)$. It behaves similarly to the natural logarithm for large values of x, while remaining well-defined at zero and for small values.

each specification, we control for the other firm characteristics (age or size), as well as industry and year fixed effects. The left panel shows that, conditional on firm age, smaller firms tend to produce lower-quality innovations. In contrast, the right panel indicates that younger firms are more likely to generate higher-quality innovations. The latter result suggests that policies supporting young firms may be particularly important when designing R&D subsidy programs.

Figure 5. Average Forward Citations across Firm Size and Age



Source: Orbis, PATSTAT, and IMF staff calculations.

12. There is substantial and persistent polarization in innovation outcomes across Spanish firms, with only a small fraction showing the ability to innovate. Only 0.17 percent of firms file a patent when they are young (defined as age five or below). Among firms that innovate when young, 36 percent also innovate at older ages. In contrast, among firms that do not innovate when young, only 0.3 percent file a patent later in life.[5] These patterns point to pronounced heterogeneity in firms' innovative capabilities: most startups appear to be non-innovative, subsistence-type firms, while a small subset exhibits persistent innovative activity (Hurst and Pugsley, 2011; Guntin and Kochen, 2025).

D. Empirical Analysis

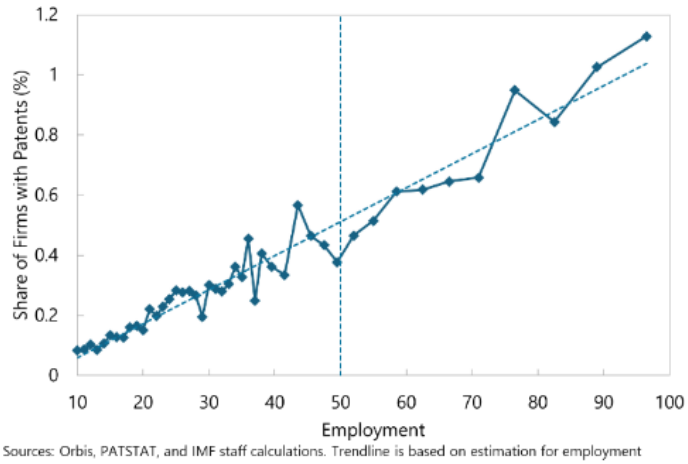
13. Firm-level analysis is carried out to assess the impact of frictions on firm-level innovation. Specifically, three types of frictions are examined: size-dependent labor regulations, financial constraints, and regulatory burdens stemming from regional and sectoral regulations. For each of them, two questions are addressed. First, is firm-level innovation negatively associated with the presence of the friction considered? Second, conditional on a firm innovating, does the friction hinder firm growth following the innovation? To this end, we proceed in two steps. We first regress a patenting indicator on the relevant friction measure to assess whether the friction is negatively correlated with innovation. Second, we regress firm employment growth on the interaction between

[5] Firms in France and Sweden also show similar level of polarization.

the patenting indicator and the friction measure to examine whether firm growth after innovation is dampened by the presence of the friction.

14. The share of patenting Spanish firms significantly declines near the key size-dependent regulation threshold of 50 employees. Spanish firms face significantly more stringent labor regulations once they exceed 50 employees (Almunia and others, 2024).[6] These include, among others, higher layoff costs and the requirement to establish a works council. The literature has found that size-dependent regulations of this type can discourage firm growth, often inducing firms to remain just below the threshold (Garicano and others, 2016). Most directly related to the present paper, Aghion and others (2023) document that similar size-dependent regulations in France reduce firms' incentives to innovate below the size threshold. Figure 6 plots the share of Spanish firms that file any patents by employment size. While the share generally increases with firm size, it also exhibits a noticeable decline around the size-dependent threshold of 50 employees. To assess whether this decline is statistically significant, we estimate the following regression:

Figure 6. Share of Patenting Firms by Employment Level



Sources: Orbis, PATSTAT, and IMF staff calculations. Trendline is based on estimation for employment between 10 to 100.

$$\boldsymbol{Y_{it}} = \boldsymbol{\beta} \cdot \mathbb{1}(\mathbf{45} \leq \boldsymbol{l} \leq \mathbf{49}) + \gamma \cdot \boldsymbol{log}(\boldsymbol{emp_{it}}) + \boldsymbol{\Gamma} \cdot \boldsymbol{X_{it}} + \boldsymbol{\epsilon_{it}}.$$

Three alternative dependent variables $\boldsymbol{Y_{it}}$ are used: i) a dummy variable indicating whether a firm files any patent; ii) the number of patents filed at the Spanish, European, and US patent offices, which captures higher-quality patents since patents filed at multiple offices—particularly those of the US and European patent offices—have typically been considered to be of higher quality in the literature; iii) the inverse hyperbolic sine transformation of the average number of forward citations, which have been used as another typical indicator of higher-quality patents. The vector $\boldsymbol{X_{it}}$ includes control variables such as (4-digit NACE) sector and year fixed effects. Table 1 reports the regression results. The coefficients on the dummy variable for firms with employment levels between 45 and 49 workers are negative across all dependent variables, suggesting that firm-level innovation is negatively correlated with size-dependent regulations.

[6] Almunia and others (2024) point out that another important threshold arises in Spain when a firm's operating revenue exceeds €6 million. On the innovation side, however, we do not find a statistically significant effect associated with this revenue-based threshold.

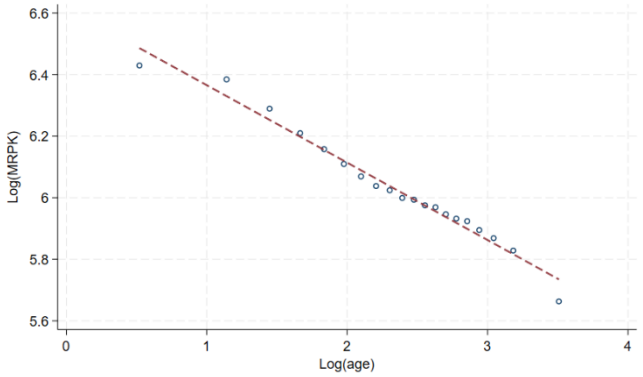
Table 1. Spain: 50-Employee Threshold and Innovation: Firm-Level Regression Results

	Any Patents	Patents filed in ES, EU, US	Average Citations
log(emp)	0.181***	0.039***	0.086***
	(0.001)	(0.001)	(0.008)
45≤ Emp < 50	-0.141***	-0.073***	-0.163*
	(0.019)	(0.008)	(0.089)
Observations	5,049,483	5,049,483	6,496
Mean of dep. var.	0.130	0.022	1.099

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

15. The share of patenting firms also significantly decreases with the magnitude of the financial constraints they face.

Figure 7. Log (MRPK) and Firm Age



Following Hsieh and Klenow (2009), we use marginal revenue product of capital (MRPK) as a proxy for the severity of financial constraints. Assuming a Cobb-Douglas production function, MRPK is calculated as below:

$$y_i = a_i l_i^{\alpha} k_i^{1-\alpha},$$

$$MRPK_i = (1-\alpha)\frac{p_i y_i}{k_i}.$$

Here, firm i's output, y_i, is produced using labor, l_i, and capital, k_i, where a_i denotes firm-specific productivity and α is the output elasticity of labor. The marginal revenue product of capital, $MRPK_i$, is given by revenue per unit of capital, where p_i is the firm-specific output price and $p_i y_i$is the firm's revenue. This measure of MRPK can be directly retrieved from firm balance sheet data. We classify firms as financially constrained if their MRPK exceeds the median within a given sector–year. The underlying intuition is that a higher MRPK signals a large incentive for the firm to expand capital investment which, since not fulfilled, suggests the presence of greater financial constraints compared to other firms. Figure 7 shows a negative correlation between log(MRPK) and log(firm age), conditional on firm sales and sector–year fixed effects, indicating that younger firms are more likely to be financially constrained. Next, for each of the three alternative indicators of firm patenting, the following regression is estimated:

$$Y_{it} = \beta \cdot \mathbb{1}(Constrained) + \gamma \cdot log(emp_{it}) + \Gamma \cdot X_{it} + \epsilon_{it},$$

where, $\boldsymbol{X_{it}}$ includes sector and year fixed effects. Table 2 shows the results. Innovation outcomes—both the probability of patenting and patent quality—are negatively associated with financial constraints.

Table 2. Spain: Innovation with Financial Frictions

	Any Patents	Patents filed in ES, EU, US	Average Citations
log(emp)	0.180***	0.039***	0.084***
	(0.001)	(0.001)	(0.008)
Constrained	-0.087***	-0.021***	-0.144***
	(0.003)	(0.001)	(0.030)
Observations	5,049,483	5,049,483	6,496
Mean of dep. var.	0.130	0.022	1.099

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

16. The probability of filing patents decreases with the intensity of regulatory burdens. Various types of regulatory burdens can hinder firm innovation. Here, we capture the intensity of some region-sector regulations using the number of newly introduced regulations at the region–sector–year level from Mora-Sanguinetti and others (2022, 2024). Specifically, we estimate the following regression:

$$Y_{it} = \beta \cdot \Delta\text{Log (\# of regulations)} + \gamma \cdot log(emp_{it}) + \Gamma \cdot X_{it} + \epsilon_{it},$$

where X_{it} includes sector, year, and region (two-digit NUTS) fixed effects. The regression results reported in Table 3 confirm that increases in the number of regulations are negatively associated with firm-level innovation activity. Although the coefficient on average citations is also negative, it is not statistically significant.

Table 3. Spain: Innovation with Regulatory Burdens

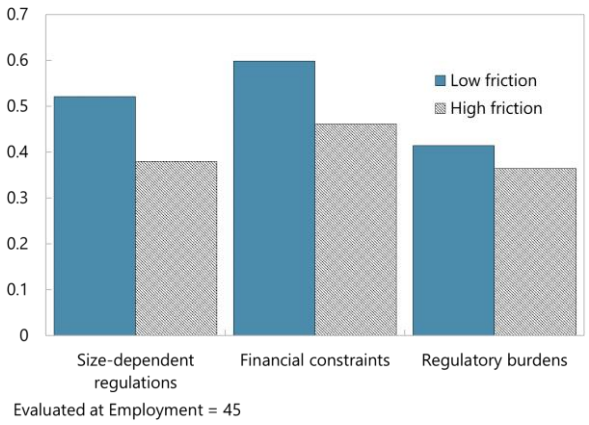
	Any Patents	Patents filed in ES, EU, US	Average Citations
log(emp)	0.130***	0.028***	0.077***
	(0.001)	(0.001)	(0.010)
Δ Log # of regulations	-0.022***	-0.006*	-0.027
	(0.008)	(0.003)	(0.078)
Observations	4,227,020	4,227,020	3,935
Mean of dep. var.	0.094	0.016	1.102

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

17. While caution should be exerted in interpreting non-causal empirical estimates, the analysis points to material impacts of the three frictions on innovation. For each of the three frictions, Figure 8 illustrates the innovation differential by plotting the innovation probability for firms facing low versus high frictions. More constrained firms correspond to those in the top decile of the friction measure considered, while less constrained firms correspond to those in the bottom

decile. For size-dependent regulations, we compare firms with employment between 45 and 49 workers to all other firms. Taken at face value, these implied probabilities suggest that these constraints together might account for about 88 percent of the innovation gap relative to Swedish firms at employment 45 (33 out of 37 percentage points).

Figure 8. Implied Firm-Level Innovation Probabilities for High Versus Low Frictions



18. Conditional on innovating, firms grow less when they face frictions. To examine this hypothesis, we estimate the following regression:

$$\log \mathrm{l}_{\mathrm{i,t+5}} - \log \mathrm{l}_{\mathrm{i,t}} = \beta_1 \mathbb{1}(\mathrm{Innovate}) + \beta_2 \mathbb{1}(\mathrm{Friction}) + \beta_3 \mathbb{1}(\mathrm{Innovate}) \times \mathbb{1}(\mathrm{Friction}) + \beta_4 \log \mathrm{l}_{\mathrm{i,t}} + \epsilon_{i,t}.$$

Here, $\mathrm{l}_{\mathrm{j,t}}$ is the number of employees of firm i at year t, $\mathbb{1}(\mathrm{Innovate})$ is a dummy variable that firms file a patent, and $\mathbb{1}(\mathrm{Friction})$ is a dummy variable if firms' friction measure is above the median. In case of employment threshold, it is a dummy variable where employment is between 45 and 50. Our main coefficient of interest is β_3. $\beta_3 < 0$ implies that, conditional on innovating, firms grow less when they face larger frictions. Table 4 reports the results for all three friction measures. For the regulatory burden friction (third column), the variable "Regulated" is a dummy equal to one if the cumulative number of regulations exceeds the within-year median. In all three cases, the coefficient on the interaction term is negative and statistically significant, indicating that post-innovation firm growth is negatively associated with each of the three friction measures.

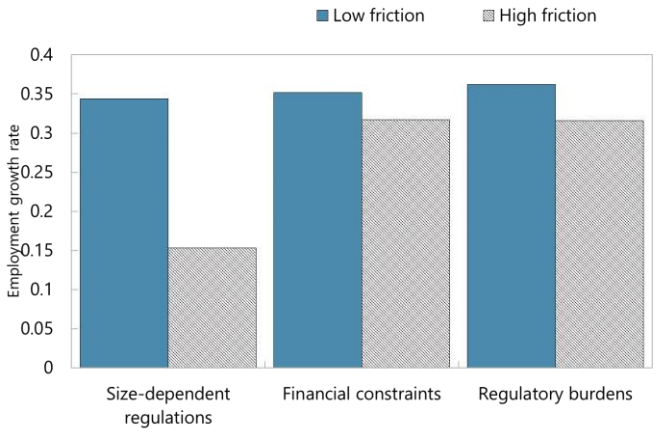
19. The 50-employee regulatory threshold appears to be quantitatively most strongly associated with reduced post-innovation firm growth. Figure 9 plots the employment growth rate differential between firms facing low versus high frictions. The size-dependent regulation captured by the 50-employee threshold appears to be more consequential economically, compared to the other two frictions.

Table 4. Spain: Employment Growth after Patenting and Frictions

	Emp growth	Emp growth	Emp growth
Innovation	0.344***	0.352***	0.362***
	(0.008)	(0.010)	(0.014)
Innovation x 45≤ Emp < 50	-0.191***		
	(0.052)		
Innovation x Constrained		-0.035**	
		(0.017)	
Innovation x Regulated			-0.046**
			(0.022)
Observations	4,705,084	4,705,084	3,940,540

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 9. Implied Post-Innovation Firm Growth for high versus low Frictions



E. Model

20. To quantify the aggregate growth impact of key frictions and the R&D subsidy program, an endogenous growth model is constructed. The starting point is the framework of Klette and Kortum (2004), who present a continuous-time general equilibrium model of endogenous growth. In this model, firm dynamics are driven by innovation and creative destruction. Firms consist of multiple product lines and invest in R&D to generate innovations that improve product-level productivity by a fixed step. R&D costs, featuring a Poisson arrival rate for innovation x_i, have the following functional form:

$$\boldsymbol{C(x_i; n_i)} = x_i^{\eta} n_i^{1-\eta} Y/\alpha,$$

where n_i is the number of product lines, α is the cost shifter, and Y is the final good in the economy. A successful innovation allows the firm to replace the incumbent producer of a product, increase the productivity of that product line, and add it to its portfolio, while incumbent firms lose existing product lines when rivals innovate. New firms enter the economy by innovating and acquiring an initial product line, and firms exit when all their product lines are displaced. Firm size is therefore determined by the number of product lines operated, generating a stationary firm size distribution, ongoing entry and exit, and aggregate productivity growth driven by firm-level innovation. The production function is linear in labor with heterogeneous productivity, and labor is inelastically supplied by households.

21. We extend the workhorse model by including size-dependent regulations, financial frictions, and regulatory burdens, together with heterogeneous innovation ability across firms. We incorporate size-dependent regulations by assuming that firms incur a fixed cost, $\phi > 0$, when their employment exceeds 50. Next, we extend the R&D cost function to incorporate financial costs and R&D subsidies. Financial frictions are modeled as an additional cost of R&D, $\tau(n_i)$, which decreases with firm-level employment. This can be microfounded if the firms have to borrow to finance R&D and the borrowing cost is larger when the firm is small, in line with empirical evidence. In sum, the R&D cost function with a Poisson arrival rate of innovation, x_i, in our model is

$$\boldsymbol{C}(\boldsymbol{x_i}; \boldsymbol{n_i}) = \left((\mathbf{1} - \boldsymbol{s})\big(1 + \tau(n_i)\big)x_i^{\eta}\, n_i^{(1-\eta)}Y\right)/\alpha,$$

where s is the R&D subsidy rate. Regulatory burdens are incorporated in the entry cost. Specifically, there is a unit mass of potential entrants who choose a Poisson arrival rate of innovation, $\tilde{x}$, with the same R&D cost function. Conditional on a successful innovation, the entrants pay a fixed cost $\delta > 0$ and replace a product line of an incumbent, while improving productivity. Lastly, we assume the step size of innovation—the magnitude of the productivity gain from innovation—can take two values $\lambda \in \{\lambda^H, \lambda^L\}$, where $\lambda^H > \lambda^L$. Following Acemoglu and others (2018), we assume that all firms start with λ^H, and that it transitions to λ^L with Poisson arrival rate κ. Annex II details the full model.

22. In the model, frictions reduce the net return to innovation, thereby suppressing innovation and productivity growth. Firms optimally choose their innovation rate by equating marginal costs and marginal gains from innovation. Accordingly, any factor that lowers the returns to innovation or raises its costs reduces the innovation rate. First, size-dependent regulations lower the return to innovation when firms approach the employment threshold, as expanding through innovation then entails an additional fixed cost. Because the model is dynamic, even smaller firms anticipate the possibility of crossing the threshold in the future and are therefore affected. Next, financial frictions increase the cost of investing in R&D, reducing innovation rates. In particular, smaller firms face tighter financial constraints, leading them to innovate less, all else equal. Regulatory burdens increase entry costs, which disincentivizes potential entrants to innovate. Lastly, high-type firms have larger innovation step sizes and therefore stronger incentives to innovate than low-type ones. However, the wedge between private and social returns increases with step size. This is because social welfare rises linearly with step size through its direct effect on the growth rate, whereas private returns rise concavely as firms' expected profits are discounted by Schumpeterian

forces, with the effective discount rate increasing in step size. Consequently, the optimal R&D subsidy rate is higher for high-type firms (Aghion and Howitt, 1992; Choi and Shim, 2024).

F. Quantitative Exercise

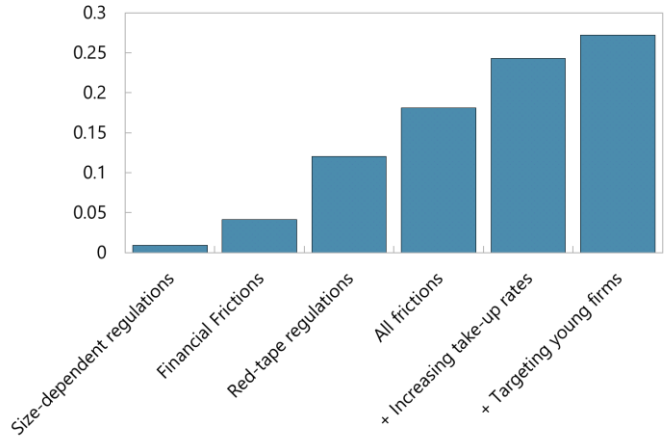
Table 5. Spain: Calibration Results

Parameter	Description	Main target	Model	Data
L	labor supply	Share of firm with emp>50	0.015	0.017
α	Innovation cost shifter	R&D / GDP	0.158	0.149
λ^L	Baseline step size	TFP growth rate	0.71	0.67
ϕ	Size-dependent regulation	Patenting decline at 45<emp<50	-0.44	-0.41
τ	Slope of financial friction	Slope of log(MRPK) over log(emp)	-0.08	-0.08
δ	Regulatory burdens	Entry rate	0.05	0.047
κ	Pr (Low type | High type)	Young vs Old patent quality difference	0.225	0.22
S	R&D subsidy rate	Effective subsidy rate x take up rate	0.1	0.1
η	Convexity of R&D cost	Acemoglu and others (2018)	2	NA

23. The model is calibrated to match key macro and micro moments of the data. We first calibrate a group of parameters by targeting macro moments, following the conventional procedure in the literature. First, α, the innovation cost shifter, is calibrated to match the ratio of R&D to GDP in Spain (1.49 percent). λ^L is calibrated to match the average TFP growth rate between 2015 and 2025 (0.67 percent) and λ^H is assumed to be twice as high as λ^L. Labor supply L is assumed to be fixed and calibrated to match the share of firms with more than 50 employees. Then, micro moments are used to calibrate parameters related to frictions. The cost of size-dependent regulation, ϕ, is calibrated to match the marginal decline in the probability of patenting as firm size increases from 45 to 50 employees obtained in the empirical analysis above. $\tau(n)$ is set to be $-\tau \log(n)$, and τ is calibrated to match the slope of log MRPK with respect to log employment estimated above. δ, the magnitude of regulatory burdens, is calibrated to match the firm entry rate in Spain (4.66 percent). The probability of transition from high to low type is set to match the patent quality difference between young and old firms. The R&D subsidy rate in the baseline is calibrated to be 10 percent, which multiplies the effective subsidy rate (33 percent) with the overall take-up rate (30 percent) estimated by AIReF (2020). Lastly, the R&D cost convexity, η, is set to be 2, following Acemoglu and others (2018). Table 5 summarizes calibration targets and the corresponding model-implied moments, alongside their empirical counterparts.

24. Model simulations of policy counterfactuals suggest that addressing frictions could increase annual productivity growth by about 0.2 percentage points. We conduct several counterfactual exercises and compare outcomes across different steady states. First, we reduce the cost parameters associated with each friction by half, one at a time—size-dependent regulations, financial frictions, and regulatory burdens. Figure 10 reports the long-term productivity growth gains from each counterfactual. The productivity growth increase from addressing size-dependent regulations alone is relatively small because the share of firms close to the employment threshold—and thus directly affected by the regulation—is rather small in the Spanish economy. By contrast, cutting financial frictions and regulatory burdens affects a broader set of firms and therefore generates larger productivity gains. Overall, reducing all three frictions is found to increase the long-term productivity growth rate by 0.18 percentage points.

Figure 10. Long-term TFP Growth Rate Gains from Various Innovation-Enhancing Reforms (Percentage Points)



25. Furthermore, streamlining the R&D tax credit and better targeting it to young firms could increase the productivity growth rate by an additional 0.1 percentage point. An economy is simulated in which the government streamlines the R&D tax credit program, increasing the take-up rate from 30 percent to 60 percent. In the model, this raises the effective R&D subsidy rate from 10 to 20 percent and increases the TFP growth rate by an additional 0.06 percentage points on top of the gains from cutting the three frictions. Finally, we consider a policy that targets young firms rather than all firms. Specifically, the take-up rate is assumed to increase only for firms younger than five years. In this counterfactual, we keep government spending as a share of GDP constant. Relative to the case in which the take-up rate increases for all firms, this targeting rule raises the growth rate by an additional 0.03 percentage points, for a total gain of 0.09 percentage points. This reflects the fact that young firms are more likely to be high-type firms, increasing the returns to R&D subsidies when targeted to these firms. Taken together, all reforms considered in the counterfactual analysis are found to raise the long-term productivity growth rate by 0.27 percentage points.

G. Conclusion and Policy Considerations

26. Addressing key frictions is key to boosting Spain's innovation and long-term productivity growth. On regulatory burdens, the ongoing "Regime 20" initiative—a common

regulatory framework aimed at reducing administrative barriers to doing business across regions—is an important policy initiative that should be pursued and amplified. This top-down approach could be complemented by bottom-up efforts, including broader adoption of open-market laws by individual autonomous communities, which could deliver immediate benefits to participating regions while creating economic and reputational incentives for others to follow. EU-level reforms, such as the EU 28th Regime initiative, could further ease regulatory burdens, thereby incentivizing firms to scale up and innovate. On financial frictions, progress toward the EU's Savings and Investment Union would greatly benefit comparatively more financially-constrained Spanish firms. The new public investment fund *España Crece* could also be helpful if it were to focus on stimulating innovation and were designed to target young and innovative firms rather than smaller, older, less innovative firms. Lastly, size-dependent regulations could be streamlined by smoothing existing regulatory thresholds—particularly the 50-employee threshold, which concentrates multiple regulations, thereby reducing the discontinuities they create.

27. The R&D tax credit could be made more effective by strengthening legal certainty and simplifying access to the refund option, which remains complex and costly to use in practice. AIReF (2020) identifies the costly application process and limited legal certainty as key obstacles to take-up. In particular, if the tax authorities later determine that an expenditure does not qualify as R&D-related, firms may be required to repay the tax benefit they previously claimed. To mitigate this risk, the Ministry of Science issues *ex ante* a Binding Motivated Report (*Informe Motivado Vinculante*, IMV), which is a certification process for firms that submit R&D projects. However, the tax authorities still review the underlying expenditures *ex post,* following which they may downsize the tax benefit. Greater coordination between the Ministry of Science and the tax authorities could strengthen the legal certainty provided by the IMV. Another obstacle, especially for smaller firms, is that many do not yet generate sufficient profits to benefit from a tax deduction. For these firms, a refund option is available, allowing them to receive cash instead of a tax offset. In practice, however, this option is less attractive because of several restrictions that should be eased. Refunds are currently subject to a 20 percent discount, firms must wait at least one year after the expenditure is incurred, and they must maintain at least the same number of R&D workers after receiving the refund. Although these conditions likely help limit abuse, they also weaken innovation; streamlining them could increase take-up, particularly among young and innovative firms.

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Annex I. Data

1. In this paper, we merge ORBIS data with PATSTAT data. Our main sample period spans 2000 to 2019. ORBIS provides firm-level information on sales, employment, fixed assets, industry, and location. The data cover not only large firms but also small and medium-sized enterprises. Kalemli-Ozcan and others (2024) show that Spain has good coverage in ORBIS, accounting for, on average, 82 percent of gross output in the manufacturing sector. To compare Spain with other advanced European countries, we also include France and Sweden, which exhibit similarly high coverage rates of 87 percent and 77 percent, respectively. We follow the data cleaning procedures in Kalemli-Ozcan and others (2024) and Díez and others (2021).

2. PATSTAT contains comprehensive patent information from several patent offices, including the European Patent Office, as well as the Spanish, US, and Japanese patent offices. For each patent, it provides information on assignee names, regions, and citations. Citation data are used to construct forward citations (citations received) as a proxy for patent quality. PATSTAT also reports patent family identifiers for patents that are registered in multiple patent offices.

3. We merge PATSTAT with ORBIS using firm names, following the procedure in EUIPO (2025). A common challenge is that firm names in patent records often contain abbreviations or misspellings, so the same firm may appear under different assignee identifiers. For example, Telefónica may be recorded as "Telefonica" or "Telefonica S.A.". We therefore first standardize firm names in both PATSTAT and ORBIS and then conduct exact matching. The merge is performed at the subsidiary level: Airbus France and Airbus Spain are treated as distinct firms.

4. The matching rate for Spanish firms is 87 percent, meaning that 87 percent of all patents applied for by firms located in Spain appear in our final merged sample. The corresponding matching rates for France and Sweden are 78 percent and 85 percent, respectively. These rates are comparable to those in the literature. For example, Autor and others (2020) use web-based matching algorithms and obtain a 72 percent matching rate when merging US Patent Office data with Compustat.

Annex II. Model

In this Annex, we describe the full general equilibrium model.

1. Environment

Time is continuous. There is a unit continuum of products indexed by j ∈ [0,1], which are aggregated into a final good using a Cobb–Douglas aggregator:

$$Y = \int_0^1 y_j dj.$$

We normalize the price of the final good to one. A representative household consumes the final good and supplies labor, L, inelastically. At any date, each product is made by a single producer, and the production function is

$$y_j = a_j l_j.$$

As in standard quality ladder models, firms set the price equal to the marginal cost of their competitor, which is lower by a factor λ_i. Given the Cobb-Douglas aggregation, each product generates revenue equal to Y. Profits per product are therefore

$$\pi_i = (1 - 1/\lambda_i)Y,$$

Since all product lines are symmetric in equilibrium, the relevant state variable of the firm is just n, as the firms receive $n\pi_i$ amount of profits and hire nl labor.

In addition, firms face a size-dependent regulation: a deadweight cost ϕY is incurred if employment exceeds 50 workers. Equivalently, firms with more than $\bar{n}$ product lines are subject to this regulation.

2. Innovation

In the model, both incumbents and entrants can innovate. When innovation occurs, it randomly draws a product line and increases the productivity of that product. The innovator becomes the new incumbent on that line, replacing the current incumbent. When the average innovation rate in the economy is m, a firm with n lines loses a product at hazard rate nm.

Firms choose R&D expenditure to determine the Poisson arrival rate x of innovation. Innovation becomes easier as firms accumulate product lines, reflecting knowledge capital from past innovations. Let $\boldsymbol{C(x_i; n_i)}$ denote the flow cost of generating arrival rate $\boldsymbol{x_i}$ for a firm with n_i product lines:

$$\boldsymbol{C(x_i; n_i)} = (\mathbf{1} - \boldsymbol{s})\big(1 + \tau(n_i)\big)x_i^{\eta} n_i^{1-\eta} Y/\alpha,$$

where s is the R&D subsidy rate, $\tau(n_i)$ is financial friction costs, which decreases with n_i, and α is a cost shifter. Entrants face the same R&D cost as incumbents with one product line and additionally pay a fixed entry cost δY.

Firms differ in innovation step size: some firms achieve larger productivity gains than others from a given innovation. Specifically, $\lambda_i \in \{\lambda^H, \lambda^L\}$, with $\lambda^H > \lambda^L > 1$. Entrants are born as high-type firms and transition to low type at a Poisson rate $\kappa > 0$, following Acemoglu and others (2018).

3. Equilibrium

The value function of incumbent firms with n product lines, $q \in \{L, H\}$ type is as below:

$$rV(n,q) - \dot{V}(n,q) = max_x\, n\pi(q)Y - \phi \cdot \mathbb{1}(l \geq 50) - C(x;n) + x\big(V(n+1,q) - V(n,q)\big) - m\big(V(n-1,q) - V(n,q)\big) + \kappa\big(V(n,L) - V(n,q)\big),$$

where it chooses the innovation rate x to maximize the expected value. By guess and verify, we can define the normalized value function, v, by dividing it by Y, as follows:

$$\begin{aligned} rv(n,q) - \dot{v}(n,q) \\ &= max_x\, n\pi(q) - \phi \cdot \mathbb{1}(l \geq 50) - c(x;n) + x\big(v(n+1,q) - v(n,q)\big) \\ &\quad - m\big(v(n-1,q) - v(n,q)\big) + \kappa\big(v(n,L) - v(n,q)\big), \end{aligned}$$

Where $c(x;n) = \frac{C(x;n)}{Y}$. Then, the innovation rate of the incumbents is

$$x(n,q) = \big[\big(v(n+1,q) - v(n,q)\big)/(\eta(1-s)\big(1+\tau(n)\big)\big]^{\eta-1} n.$$

Absent frictions, innovation scales linearly with firm size. Subsidies raise innovation, while financial frictions reduce it.

Likewise, the value function of potential entrant is defined as

$$rV^E - \dot{V^E} = \max_x xV(1,H) - C(x;1) - \delta Y,$$

which can be normalized as below:

$$rv^E - \dot{v^E} = \max_x xv(1,H) - c(x;1) - \delta.$$

And the innovation rate of the potential entrant is

$$x^E = \big[(v(1,H))/(\eta(1-s)\big(1+\tau(1)\big)\big]^{\eta-1}.$$

Given the firm distribution $\mu(n,q)$, the aggregate growth rate is

$$g = \int \log(\lambda^H)\, x(n,H) d\mu(n,H) + \int \log(\lambda^L)\, x(n,L) d\mu(n,L) + \log(\lambda^H)\, x^E.$$