Interest rate spreads hikes: What lies behind them?

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Abstract
The 2007–2009 financial turmoil and the euro area sovereign debt crisis that followed were characterized by severe interest rate spread hikes. In recent work we developed a novel general equilibrium model for a small-open euro-area economy, endowed with a rich characterization of the banking system that allows for regulatory capital requirements, defaulted loans and occasionally binding endogenous credit restrictions. In this article, we use our model to offer a model-based explanation of the endogenous mechanisms associated with sharp interest rate increases based on macroeconomic fundamentals. After briefly describing the model, we analyze the concomitant interest rate dynamics and decompose the overall spread into three components: a capital requirements-driven spread, a credit restrictions-driven spread, and a retail-driven spread. Results suggest that defaulted loans and occasionally biding credit restrictions—two of our novel mechanisms—contribute to severely amplify spread hikes under financial disturbances, but play lesser roles under non-financial ones. (JEL: E12, E32, E44)

Introduction

The 2007–2009 financial turmoil and the euro area sovereign debt crisis that followed were characterized, among other factors, by severe interest rate spread hikes. The explanations for the sharp increase in the price of credit are manifold and include not only a deterioration in the macroeconomic fundamentals, but also reactions based on other factors such as market fears and panic responses. Interbank market freezes, fears of default in the private and public sectors, spillover effects and rises in the nationwide risk premium are amongst the commonly discussed topics.

In Portugal, both the spread on bank loans and debt securities of non-financial corporations faced a double-stage increase, first on the verge of the financial turmoil and thereafter over the sovereign debt crisis period (see Figure 1). During this period, debt security interest rates reached similar levels

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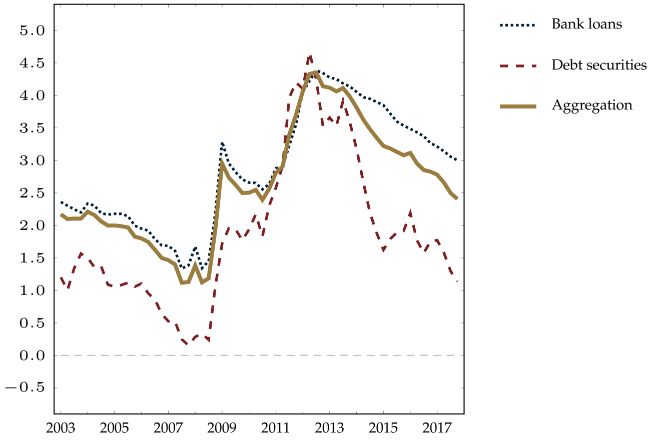

FIGURE 1: Interest rate spreads of Non Financial Corporations.

Notes: Interest rate spreads, calculated as the difference *vis-à-vis* the 3-month EURIBOR, use bank loans (dotted line), debt securities (dashed) and an aggregation of both. The cost of financing with bank loans and debt securities are measured, respectively, by the interest rates on new loans granted by resident banks, and interest rates on commercial paper and long-term bonds issued by Portuguese corporations.

as those of new loans granted by resident banks—in sharp contrast with the first part of the sample—which suggest different operating conditions in these market segments. More recently we notice a downward trend of interest rates *vis-à-vis* the 3-month EURIBOR, but particularly when based on commercial paper and long-term bonds.

A key criticism often addressed to general equilibrium models is their inability to identify the cumulative vulnerabilities before the worst recession of the postwar period (Christiano *et al.* 2018), let alone to signal meaningful policy warnings. The inability of financial frictions-based models to properly take into account rare or extreme events and to provide a convincing improvement over simpler and more standard alternatives—including interest rate spread dynamics such as those depicted in Figure 1—suggests that some work must be targeted to this area.

In a recent paper, Júlio and Maria (2018) develop a novel Dynamic Stochastic General Equilibrium (DSGE) model for a small-open euro-area economy, endowed with a rich characterization of the banking system. Such work has obvious policy implications. First, the model improves the explanatory power of the mechanisms behind interest rate spreads, particularly on the supply side. Second, the distribution of shocks matter to explain output fluctuations and in particular output downfalls; the mean is not sufficient. Third, a narrow set of negative small-sized financial-based shocks can trigger a deep and protracted recession, which may contribute decisively to enhance the predictive density of DSGE model in crisis periods. However, the opposite is not true: positive financial shocks may not trigger a sizable expansion. Fourth, our model predicts that defaulted loans mostly accumulate in banks balance sheet on the aftermath of financial shocks, which is in line with facts recorded in a number of euro area economies in the aftermath of the financial crisis. Fifth, the model provides a completely novel framework to analyze policy-oriented measures aimed at increasing the robustness of the financial and banking system, especially during crisis periods.

Credit supply decisions in Júlio and Maria (2018) are simultaneously driven by regulatory capital requirements, defaulted loans, and credit restrictions that become binding under shocks severely depleting banks' value. The banking system proposed therein intertwines two strands in the literature with two novel features. Capital requirements follow the approach in Benes and Kumhof (2015), and are coupled to a moral hazard-inspired credit constraint mechanism in the spirit of Gertler and Karadi (2011), Gertler *et al.* (2012), and Gertler and Karadi (2013). However, contrary to these studies, which assume an always binding incentive compatibility constraint, we propose and develop an occasionally binding mechanism which is slack in the steady state but endogenously affects credit supply decisions when banks' capital is severely affected. Simultaneously, we bring forth into the model a theory of optimal impairment loss recognition, which gives rise to an endogenous defaulted loans stock that bankers manage over time.

In this article we offer a model-based explanation of the mechanisms behind interest rate spread hikes triggered by macroeconomic fundamentals, *i.e.* intrinsic and endogenous transmission mechanisms. We leave aside non-fundamental issues (such as "sunspot events"). We calibrate the model for the specific case of Portugal, and decompose the overall interest rate spread into the sum of three components: the capital requirements-driven spread, the credit restrictions-driven spread, and the retail-driven spread. The capital requirements-driven spread is the interest margin required to cover the expected costs of a possible violation of capital requirements. We assume that the bank is allowed to remain in activity at all times, but has to pay some cost to place the capital back on track. This can be for instance a cost for restructuring the bank or some fraction of assets, or even a reputation cost. The credit restrictions-driven spread is defined as the interest margin induced by credit supply restrictions, which emerge when banks' value declines significantly. Specifically, during a financial meltdown the value of banks' capital collapses and bankers' must tighten credit conditions in order to limit the leverage position, triggering important spread hikes. Finally, the retail-driven spread is the margin required by retail banks to cover the expected losses generated by corporate bankruptcy. We define the wholesale interest rate spread in this framework as the sum of the capital requirements-driven spread and the credit-restrictions driven spread.

To disentangle the role played by defaulted loans and credit restrictions on the spread decomposition, we simulate versions of the model in which these mechanisms are deactivated. For illustrative purposes, we carry out this decomposition for three shocks with negative macroeconomic impacts—a supply-side shock, a domestic demand shock and a financial shock. Specifically, we simulate a contraction in technology, a decline in government consumption, and an increase in the riskiness of investment projects. All shocks have a temporary nature, and therefore the equilibrium reverts to the steady-state values in the long run.

For the financial shock—an risk increase—greater corporate default rates impose losses for the banking sector, to which banks respond by increasing the wholesale spread, specifically the capital requirements component. This generates larger margins, required to cope with greater expected losses arising from the larger likelihood of not complying with capital requirements. The wholesale spread hike is severely amplified by defaulted loans and credit restrictions. The sizable increase in the amount of due loans that follows the sharp increase in corporate default imposes extra losses in the banking system, severely contributing to the wholesale spread hike *via* the capital requirements component. The collapse of banks' value on the aftermath of credit losses leads bankers to impose tighter lending conditions, unfolding an additional contribution to the wholesale spread hike *via* the credit restrictions component.

Whereas the demand-side shock imposes a spread hike, the supply-side shock fosters a decline due to its inflationary effects, which reduce the real cost of credit and benefit corporate leverage. In both cases, credit restrictions remain slack at all times and the corresponding spread component is nil, since banks' value is barely affected. Changes in the retail spread reflect shifts in the corporate default rate, whereas changes in the wholesale spread—corresponding in this case to the capital requirements component—echo the banks' leverage position and the probability of not complying with regulatory capital requirements. Defaulted loans amplify variations in the wholesale spread, since they affect banks' costs and the risk of violating regulatory levels.

Defaulted loans and credit restrictions are strongly intertwined. On the one hand, a large increase in the former imposes extra losses in the banking system and depletes banks' value, leveraging the effects of credit restrictions and thus magnifying wholesale spreads hikes. On the other, more expensive credit that follows tighter lending conditions negatively impacts corporate balance sheets by rising interest expenses. This boosts the wholesale spread hike as banks cope with the increased amount of due loans that follows the higher corporate bankruptcy chance.

Results are quantitatively dependent on the model calibration, which is naturally subject to some uncertainty. Robustness checks suggest however that the above conclusions are qualitatively valid under plausible alternative values.

A DSGE model for a small-open euro area economy

This section briefly overviews the model presented in Júlio and Maria (2018). The domestic economy is composed of nine types of agents: households, intermediate goods producers (manufacturers), final goods producers (distributors), retailers, capital goods producers, entrepreneurs, banks, the government, and foreign agents.

Households are composed of three member types: workers, entrepreneurs and bankers. There is full consumption insurance within the family. When exiting activity, the last two member types transfer accumulated earnings back to the household. In each period and for each activity the number of entries and exits is the same. Households follow an infinitely-lived structure, renting labor services to manufacturers, paying lump-sum taxes to the government, and earning interest on money holdings. They also receive income for services provided in the repossession of assets from bankrupt corporations and in reducing the defaulted loans portfolio of banks—activities performed at no personal effort—and receive dividends from firms, in addition to the accumulated earnings from exiting entrepreneurs and bankers. Households are not allowed to hold foreign financial assets. A representative household derives utility from consumption and real money holdings, measured by the real value of deposits, and disutility from working. Money holdings do not affect the intratemporal consumption-leisure choice, and thus money is superneutral in the steady state. Households are also wage setters, setting the wage according to their disutility from working and taking into account their market power and the demand for labor. They face Calvo-type frictions when setting wages and are therefore unable to reoptimize in every period.

Capital goods producers combine the undepreciated installed productive capital stock bought from entrepreneurs with investment goods bought from retailers, to produce new installed productive capital. They face quadratic adjustment costs to reproduce the sluggishness in investment. Capital is sold to entrepreneurs, who will own it during the production cycle. Manufacturers combine capital—rented from entrepreneurs—with labor services—hired from households—to produce intermediate goods. They face Calvo-staggered price adjustment and quadratic costs when deciding to adjust the number of hired hours. Distributors combine intermediate goods—bought from manufacturers— with imported goods—bought from abroad—to produce the final good. They face Calvo-type price staggering and quadratic adjustment costs on import content changes. Finally, perfectly competitive retailers acquire the final good from distributors and reallocate it to different costumers—households, capital goods producers, government, and foreign distributors.

The government keeps the budget balanced at all times, financing public consumption with lump-sum taxes, levied on households. The foreign economy corresponds to the rest of the euro area. The domestic economy interacts with the foreign economy *via* goods and financial markets. In the goods market, domestic distributors buy imported goods from abroad to be used in the production stage. Likewise for foreign distributors, who buy export goods from domestic retailers for the same purpose. In the financial market, banks can finance balance sheet operations by trading assets with the foreign economy. Monetary policy is exogenous and unresponsive to domestic developments, a consequence of the small-open economy framework. Hence, developments in euro-area interest rates are orthogonal to domestic developments, as in Adolfson *et al.* (2007). The nominal exchange rate *vis-à-vis* the rest of the euro area is irrevocably set to unity.

The financial sector: entrepreneurs and banks

The financial transmission mechanism linking entrepreneurs to banks is modeled along the lines in Bernanke *et al.* (1999), Christiano *et al.* (2010), and Kumhof *et al.* (2010). Financial frictions affect the return on capital and therefore capital demand. Before each production cycle, capital goods producers buy the undepreciated productive capital stock from entrepreneurs, combining it with investment goods bought from retailers to produce new installed productive capital. This capital is then sold to entrepreneurs, which will own it during the next production cycle. Entrepreneurs do not have access to sufficient internal resources to finance desired capital purchases, but can borrow the difference from retail banks at a cost. They face an idiosyncratic shock that changes the value of the firm after decisions have been made. When hit by a severe shock, the value of assets collapses and the entrepreneur must declare bankruptcy, handing over the value of the firm to the bank.

The banking system builds on Benes and Kumhof (2015), and is composed of retail branches and wholesale banks. Retail branches operate in a perfectly competitive environment, celebrating loan contracts with entrepreneurs. These contracts set an unconditional, non-state contingent lending rate. Since entrepreneurs are risky, so are the individual loans of retail banks, who therefore charge a spread over the wholesale lending rate—the cost of obtaining funds from the wholesale bank or households—to cover for the losses incurred in the mass of entrepreneurs that declare bankruptcy. We hereinafter term this margin the retail-driven spread. Since a given retail branch lends to many entrepreneurs, by the law of large numbers the aggregate loan portfolio is risk-free, and hence *ex-ante* profits are zero. Retail branches are however exposed to non-diversifiable aggregate risk given the non-state contingent lending rate, and thus *ex-post* profits—to be transferred to wholesale banks—may differ from zero. When a corporate firm goes bankrupt, retail branches must pay a service to households—*i.e.* a repossession cost—in order to take possession of corporate assets.

Wholesale banks finance their activities, i.e. loans to retail branches, through equity, deposits, and foreign funds. We assume that repossessed assets are illiquid and accumulate as defaulted loans on the balance sheet. Over time, an exogenous fraction of defaulted loans is automatically transformed from illiquid into liquid at no cost, but banks can increase the pace of this transformation by requesting a liquidation service—henceforth interpreted as impairment losses—from households. Wholesale banks face an idiosyncratic shock affecting the return on their loan portfolio which, coupled with potential losses from retail branches, may trigger balance sheet effects and/or credit supply restrictions. They are subject to regulatory capital requirements and non-compliance results in adjustment costs and reputational losses. Banks therefore endogenously set capital buffers, which allow them to cushion adverse shocks that negatively affect the value of capital. For simplicity, we rule out bank failure.

Credit supply restrictions arise endogenously from a modified moral hazard/costly enforcement problem inspired in Gertler and Karadi (2011), Gertler *et al.* (2012), and Gertler and Karadi (2013). The banker has the option to divert a fraction of funds, though this only becomes attractive when the bank's value collapses well below the steady-state level, *i.e.* when the bank is and is expected to remain excessively leveraged. Households recognize this fact and restrain the amount of deposits placed at the bank, pushing down leverage and aligning their interests with the banker's incentives. In this way, wholesale banks become supply constrained with respect to the resources they can make available to the entrepreneurial sector.

The occasionally binding nature of credit restrictions is able to generate powerful asymmetric responses to financial or banking shocks—those whose nature is endowed with important effects on the banking system. Specifically, under "good shocks," *i.e.* those increasing banks' value, credit restrictions remain slack and play no role whatsoever. Under "bad shocks" depleting banks' value, they may become binding for some period of time and greatly affect the model dynamics, and particularly spreads.

The wholesale interest rate spread is the bank's margin, simply defined as the interest received by lending to retail branches minus the cost of raising funds, *i.e.* the interest rate paid to depositors. In equilibrium, this margin is driven by the possible violation of capital requirements and by credit supply restrictions. While the former—termed capital requirements-driven spread—implies a pecuniary or reputational cost, the latter—named credit restrictions-driven spread—triggers a *ceteris paribus* decline in banks' income. Defaulted loans impose extra losses in the banking sector, increasing the probability of non-compliance with regulatory requirements and depleting banks' value. They therefore affect the wholesale interest rate spread *via* both components, and interact strongly with credit restrictions. Figure 2 illustrates the relationship between interest rate spreads and agents in our small-open euro-area model.

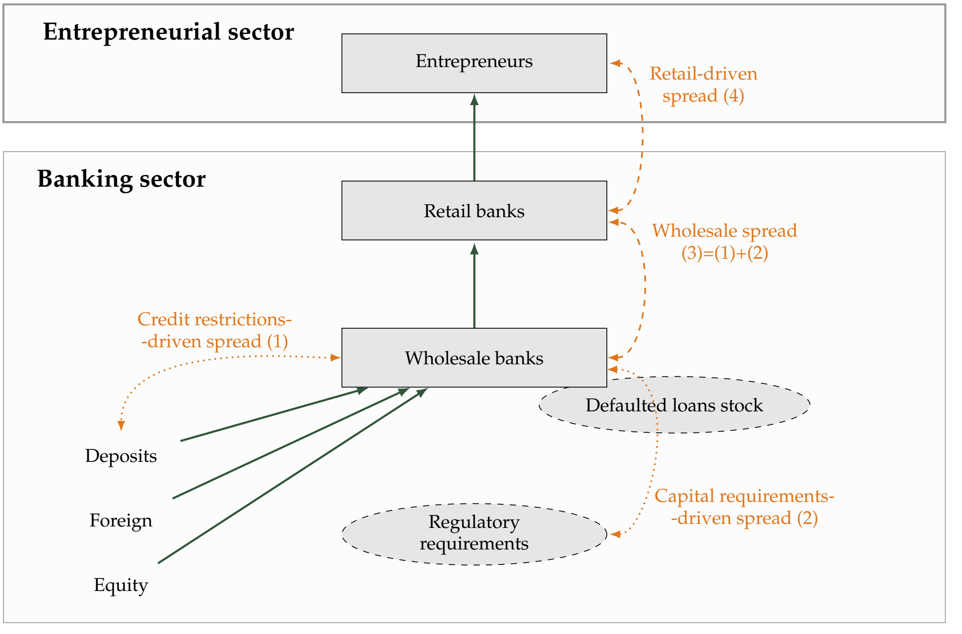

FIGURE 2: Interest rate spreads and agents.

Notes: The defaulted loans stock is managed by wholesale banks. Before the end of each period, retail banks are assumed to transfer all their defaulted loans to wholesale banks.

Calibration

The model is calibrated to match long-run data or studies for Portugal and euro area economies. Some parameters are exogenously set by taking into consideration common options in the literature, available historical data, or empirical evidence, whilst others are endogenously determined to match great ratios or other measures. We now describe briefly the main calibration features. Tables 1 and 2 present a selection of the model's calibrated parameters, whereas Table 3 exhibits implied key steady-state relationships.[1]

The interest rate target is set at 3.2 percent per year, matching the pre-crisis average for the 3-month Euribor. Steady-state inflation is set at 2 percent per year, in line with the ECB's price stability target. The inverse Frisch elasticity is set to 0.276. The discount factor is 0.996, resulting in a net foreign asset position of around -40 percent of GDP for a target ratio of -30 percent. The

1. A more complete and exhaustive description of the calibration is found in Júlio and Maria (2018). The calibration on defaulted loans has been revised herein and differs from the one depicted in the paper.

	Value
Households	
Inverse Frisch elasticity	0.276
Discount factor	0.996
Wage and price markups	
Wage markup	0.32
Intermediate goods price markup	0.21
Final goods price markup	0.09
EoS and technology	
EoS, intermediate goods	0.99
EoS, final goods	1.50
EoS, exports	1.50
Quasi-labor income share	0.60
Home bias in domestic distributors	0.67
Export market share	0.03
Calvo parameters	
Wage	0.75
Intermediate goods	0.75
Final goods	0.50
Miscellaneous	
Depreciation rate (annualized)	0.1
Interest rate target (annualized)	0.032
Inflation target (annualized)	0.02
Target NFA-to-GDP ratio	-0.30

TABLE 1. Selected main parameters (non-financial).

Sources: *Banco de Portugal* data, National accounts data, several studies on the Portuguese and euro area economies, and authors' own calculations.
Notes: EoS—Elasticity of Substitution; NFA—Net Foreign Assets.

deposits-to-GDP ratio is roughly 40 percent. Steady-state price markups are set at 6/19 for wage setting, 4/19 for the intermediate goods sector, and 1/11 for the final goods sector. The elasticity of substitution between capital and labor is nearly 1, whereas for domestic and foreign goods distributors the elasticity of substitution between inputs is 1.5. The depreciation rate of capital is calibrated at 10 percent per year. The labor quasi-share and the home bias parameters are endogenously calibrated to take into account the actual labor income share and the import share, whereas the export market share is adjusted according to the exports-to-GDP ratio. The investment and labor adjustment costs are parameterized to ensure plausible dynamics. Likewise for the parameter assessing the cost of under- or over-utilization of capital. The import content adjustment costs ensures plausible real exchange

	Value
Entrepreneurs	
Repossession costs (% of firm value)	0.40
Average lifetime (years)	6.25
Banks	
Average lifetime (years)	5
Capital ratio requirement	0.14
Defaulted loans	
Recovery fraction	0.04
Credit restrictions	
Fraction of corporate loans that can be diverted	0.16

TABLE 2. Selected main parameters (financial).

Sources: *Banco de Portugal* data, National accounts data, several studies on the Portuguese and euro area economies, and authors' own calculations.

rate fluctuations. Calvo parameters imply an average contract duration and intermediate goods average price duration of 1 year, and a final goods average price duration of half a year. We assume no indexing.

On the entrepreneurial side, we calibrate parameters to match a target leverage (net worth-to-debt ratio) of 1.2, a yearly default probability of 3.6 percent, and a yearly retail lending rate spread of 1.6 percentage points. An entrepreneur stays on the job on average around 6 years. For the banking sector, we set the capital requirement to 14 percent and let banks build an endogenous capital buffer of 3 percentage points, yielding a steady-state capital-to-loans ratio of 17 percent. The probability of non-complying with capital requirements is set at 4 percent, and the spread between the wholesale interest rate—matched by the 6-month Euribor—and the deposits rate is 0.5 percentage points. A banker stays in the job on average around 5 years. We consider that 4 percent of total loans are recovered in each quarter, and adjust parameters to obtain a defaulted loans-to-credit ratio of approximately 6.8 percent. New defaulted loans in each period amount to 0.56 percent of total credit, which in the steady state approximately matches the amount that is withdrawn from the balance sheet—0.29 percent is recovered and 0.23 percent is recognized as impairment loss and written off.[2] Repossession costs amount

2. The match is only approximate and not exact due to inflationary effects. Defaulted loans recovered respect previous period amounts, and thus they lose value to inflation.

	Model	Data	Period
Expenditure (GDP ratio)			
Private consumption	0.61	0.65	1995-2016
Private investment	0.19	0.18	1995-2016
Public consumption & investment	0.23	0.23	1995-2016
Exports	0.35	0.32	1995-2016
Imports	0.38	0.39	1995-2016
Shares (output ratio)			
Import share	0.28	0.30	1995-2008
Labor income share	0.60	0.67	1995-2016
External account (GDP ratio, in %)			
Net foreign assets (annualized)	-41.5	-83.5	1995-2016
Current and capital accounts	-0.8	-5.3	1995-2016
Trade balance	-3.0	-3.1	1995-2016
Financial sector, ratios			
Deposits-to-GDP ratio	0.41	0.46	1995-2016
Financial sector, Entrepreneurs			
Leverage ratio	1.2	1.2	1999-2008
Probability of default (in %)	3.6	3.6	1999-2008
Retail-wholesale interest rate spread (in p.p.)	1.6	1.7	1999-2008
Financial sector, Banks			
Probability of not fulfilling capital requirements (in %)	4.0	n.a.	
Capital-to-loans ratio (in %)	17.0	n.a.	
Endogenous capital buffer (in %)	3.0	n.a.	
Wholesale-deposits interest rate spread (in p.p.)	0.5	0.6	1999-2008
Financial sector, defaulted loans			
Defaulted loans-to-credit ratio (in %)	6.76	n.a.	
New defaulted loans-to-credit ratio (in %)	0.56	n.a.	
Defaulted loans recovered (in %)	0.29	n.a.	
Impairment-to-credit ratio (in %)	0.23	n.a.	
Repossession costs (credit ratio, in %)	0.37	n.a.	

TABLE 3. Key steady-state relationships.

Sources: *Banco de Portugal* data, National accounts data, and authors' own calculations.
Notes: Repossession costs are endogenously calibrated according to the retail-wholesale interest rate spread. We adjust the impairment-to-credit ratio to yield an overall loss-given default around 42 percent.

to 0.37 percent of total credit. This calibration results in a loss given default around 42 percent.[3]

3. Loss given default is understood herein as total losses in each period over the amount at risk given default.

The mechanism behind credit restrictions is endogenously calibrated so that agency problems do not arise in the steady state, but are triggered in the presence of shocks with large negative impacts on banks' terminal wealth. This results in a potential diversion of 16 percent of total loans.

Decomposing interest rate spreads

In this section we decompose the overall interest rate spread into the contribution of three well identified elements: the capital requirements-driven spread, the credit restrictions-driven spread, and the retail-driven spread. The wholesale interest rate spread is simply the sum of the two former components. To disentangle the role played by defaulted loans and credit restrictions on the spread decomposition, we simulate the complete model described in Section 3, henceforth named "banking model & DL & CR," and two additional models: the banking model deprived of credit restrictions (henceforth "banking model & DL"), and the banking model deprived of both defaulted loans and credit restrictions (hereinafter "banking model"). To appropriately compare the spreads across different models, we first calibrate and run the "banking model & DL & CR" and then successively deactivate parts of the model while fixing the values for all common parameters.

We perform the spread decomposition for three unexpected shocks of distinct natures: a demand side shock (on public consumption), a supply side shock (on technology), and a financial shock (on risk). All shocks have negative macroeconomic impacts and follow a standard autoregressive process of order 1 with a half-life of around 4 quarters. Shock sizes are merely illustrative.

Figure 3 depicts the interest rate spreads that follow an exogenous decline in public consumption. Credit restrictions remain slack at all time as the shock has minor impacts on banks' value, and therefore the corresponding spread component remains nil. Hence, the dynamics of the "banking model & DL & CR" and of the "banking model & DL" are identical.

The shock implies an increase in the capital requirements-driven spread, necessary to cope with an increased probability of violating regulatory requirements. Higher default rates that naturally arise during a demand-triggered recession lead to a decline in banks' returns, due to higher unexpected losses. Banks' capital is pushed downwards, therefore raising the probability of non-compliance with the regulatory requirements. The spread increase is empowered by defaulted loans, particularly over the medium term, as becomes visible when comparing the dynamics of the "banking model" with those of the "banking model & DL." Specifically, the downturn generated by the shock boosts corporate default and hence the amount of due loans. These impact negatively the income statement of banks, placing them closer to the minimum capital requirement and forcing them to charge

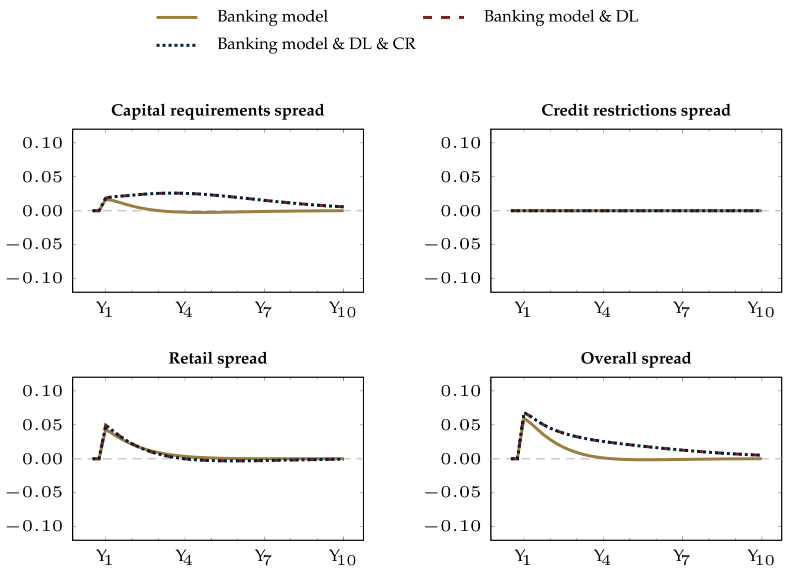

FIGURE 3: Government consumption shock.

Notes: The figure represents a negative government consumption shock of 1 percent of GDP.

even larger spreads to cover additional expenses and lost revenues while defaulted loans do not return to the pre-shock level. The effect is protracted in time, since defaulted loans have their own inertia and banks optimally prefer to spread impairment losses throughout time rather then recognizing them immediately in their income statement. The retail spread hike mostly reflects larger margins, required to cover higher corporate default rates.

For the technology shock, credit restrictions also remain slack at all times since banks' value is barely affected. The corresponding spread components is therefore nil at all times. However, the remaining spreads decline in this case as opposed to the previous shock, a direct consequence of a supply-triggered recession and hence of higher inflation. The decline in corporate default rates triggered by the lower real cost of credit that results from higher inflation is reflected into better banks' returns. This in turn implies a lower probability of violating regulatory capital requirements—and thus a decline in the corresponding spread. The downfall is strengthened by the decline in defaulted loans, since lower corporate default rates diminish the amount of due loans. As before, retail spreads are fairly identical across all models, and reflect lower corporate default rates associated with the lower real cost of credit.

In the case of a risk shock, the spread increase is severely amplified by both defaulted loans and credit restrictions, as banks' returns and value

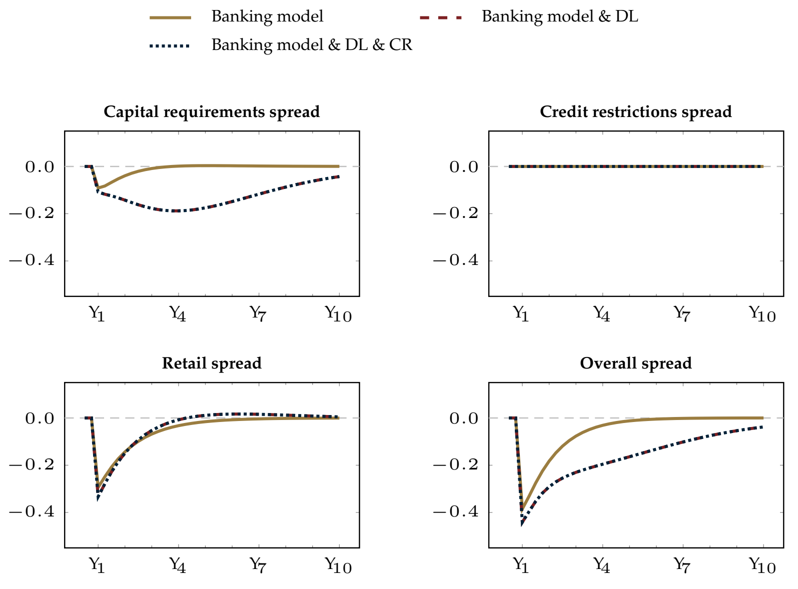

FIGURE 4: Technology shock.

Notes: The figure represents a 5 percent negative technology shock.

are severely affected in this case (Figure 5). The shock impacts directly the corporate default rate, leading to more expensive credit through a higher retail and wholesale spreads. The former translates greater margins on performing loans, required to cover higher losses on defaulting loans. The latter translates greater margins for banks, required to cope with higher losses on the aftermath of the income decline, triggered by the unexpected increase in corporate default.

Greater corporate default rates also lead to a substantial accumulation of defaulted loans. The wholesale spread is therefore further pushed upwards in the "banking model & DL," as banks require higher income to cope with regulatory requirements and defaulted loans opportunity and management costs. The powerful impact on bank returns and thus on their value forces bankers to hold back on credit, unfolding a large credit restrictions-driven wholesale spread hike, visible in the "banking model & DL & CR." Additionally, by negatively impacting returns, credit restrictions raise banks' leverage position. The risk of non-compliance with regulatory requirements therefore increases, feeding back to a higher capital requirements-driven spread.

Naturally, more expensive credit pushes corporate loans down, resulting in fewer investments and less capital accumulation. Entrepreneurs are forced to withhold investment decisions and hinder capital accumulation as external

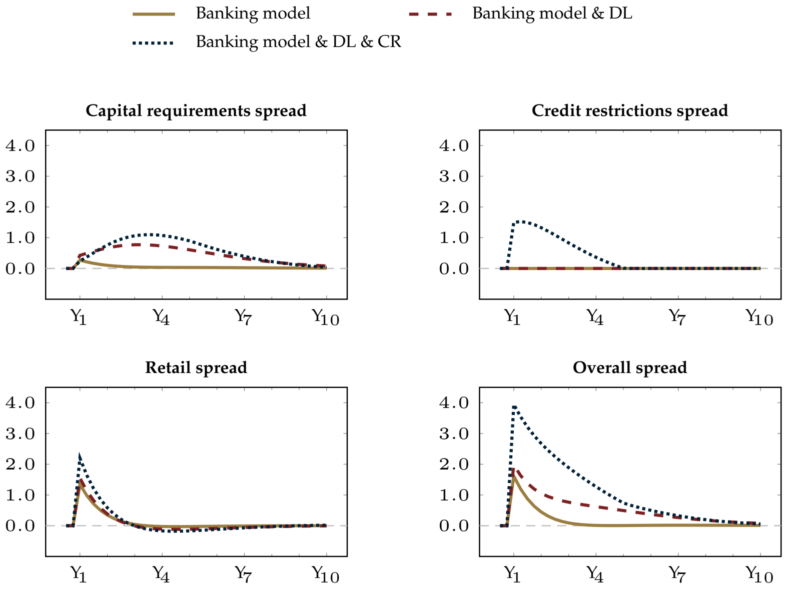

FIGURE 5: Risk shock.

Notes: The figure represents a 10 percent increase in risk.

finance collapses. In addition, corporate loans recover gradually as banks strive to keep the loans ratio and thus the probability of not complying with the regulatory requirements under control, generating a protracted recession.

Final remarks

In this article we borrow our work developed in Júlio and Maria (2018) and offer a model-based explanation of severe interest rate spread hikes, in line with those observed during the Great Recession. Our model proposes two novel features that are able to endogenously generate large interest spread movements: occasionally binding credit restrictions and defaulted loans. We borrow from the literature the endogenous capital requirements and the moral hazard-inspired credit constraint mechanisms. We then propose and develop an occasionally binding version of the latter mechanism, which is slack in the steady state but endogenously affects credit supply decisions when banks' capital is severely affected. As a result, credit is mostly demand/price driven but in some situations endogenously becomes supply/quantity driven. Simultaneously, we bring forth into the model a theory of optimal impairment loss recognition, which gives raise to an endogenous defaulted loans stock that bankers manage over time. Defaulted loans interact with regulatory capital requirements and credit restrictions.

In this article, we use the model to decompose the interest rate spreads in several components of interest, and analyze that decomposition under three shocks of distinct natures: a demand shock, a supply shock, and a financial shock. It is under the latter shock that the model provides a deeper insight on the interest rate spread decomposition, highlighting an higher and more persistent contribution of defaulted loans and credit restrictions to spread dynamics. We implemented an entrepreneurial risk shock as an illustrative financial disturbance, but conclusions qualitatively carry out for any type of financial disturbance affecting entrepreneurial or banking sectors, such as a nationwide risk shock, an entrepreneurial net worth shock, or a banks' capital shock. These type of disturbances have important impacts on banks' returns and hence banks' valuation, potentially triggering restrictive credit conditions and thus interest spread hikes.

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