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To be or not to be in Banking Union

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TO BE OR NOT TO BE IN BANKING UNION

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ABSTRACT

Banking Union (BU) membership comes with costs, such as foregoing the ability to tailor domestic banking regulation to the country's needs and preferences; and benefits, such as a more efficient provision of deposit insurance. We use a general equilibrium model that features a rich financial sector, risk shocks, bank capital regulation and government-provided deposit insurance to evaluate the implications of BU membership for welfare, macroeconomic activity and financial stability. A riskier and more consequential –for economic activity– banking sector favors BU membership. However, gains in macroeconomic performance and financial stability alone are not sufficient to make Banking Union membership welfare improving.

Keywords: Banking Union, costs, benefits, banking regulation, deposit insurance, welfare, macroeconomic activity, financial stability
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1 Introduction

Following the financial and sovereign debt crisis in Europe, the Eurozone countries embarked on the formation of a banking union (BU). Its key feature is the centralization of banking policy in participating member states at the EU level through the creation of a common regulatory framework (a single "rulebook") in the domains of bank supervision, resolution and deposit insurance. It involves the Single Supervisory Mechanism (SSM) that provides centralized supervision of the most significant -systemic- banks by the ECB in cooperation with national supervisory authorities; the Single Resolution Mechanism (SRM) that manages the resolution of failing banks; and the European Deposit Insurance Scheme (EDIS) which provides a uniform level of protection to depositors across participating countries.

The centralization of policy in an economic union typically carries both benefits and costs, thus giving rise to trade-offs in the membership decision. Consider, for instance, a monetary union, –a well researched entity– the delegation of the conduct of monetary policy to a central authority removes the ability to counter country-specific shocks. But at the same time, it may improve policy outcomes elsewhere (lower inflation bias, more efficient response to union wide, cost-push shocks,...) if the union central bank enjoys higher credibility than a national one. Whether a country is economically better or worse off in a monetary union depends on the similarity of economic structure and shocks –as monetary policy reacts to union wide aggregates– and the severity of its credibility problem (Clerc, Dellas and Loiser, 2012). Do similar considerations and trade-offs apply to banking unions?

This question has not been studied before. The main preoccupation in the existing literature has been with the identification of factors that support the centralization of banking regulation, with very little, if any, attention paid to the existence of potential trade-offs.[1] Domestic banking regulation failure has been identified as the main factor. In Schoemaker, 2013, there is coordination failure among national supervisors in dealing with international banks, which creates negative externalities across countries and can lead to contagion. In Beck, 2012, local regulators engage in inefficient forbearance due to their "proximity" to the local banking sector.[2] In Fahri and Tirole, 2018, local regulators/sovereigns "conspire" to extract resources from foreign creditors which fuels sovereign-banking doom loops but can be prevented by the externalization of banking regulation.

It is an open question whether domestic bank regulation is less efficient *across the board* than centralized from an individual country's perspective (for a contrarian view, see footnote

[1]One notable exception regards how the possibility of cross subsidization through the common deposit insurance scheme discourages some countries from participating. This concern seems to have been the main obstacle to the completion of BU in the EZ.

[2]Domestic regulatory "softness" represents the standard view. Allen et al, 2012, make the opposite claim. Namely, that the central authority is more likely to be perceived as the softer regulator because of its greater preoccupation with contagion and its more ample funds.

2). It is conceivable that domestic regulation outperforms the corresponding union wide regulation in certain domains, in a manner analogous to that suggested by Clerc et al, 2012 for MU. And that this advantage makes a country better off when designing its own banking policy rule book rather than adopting a one-size-fits-all, common BU rule book. Consequently, in order to evaluate the desirability of BU membership for a candidate country, a cost-benefit analysis of BU membership is needed. The objective of this paper is to provide a suitable, useful theoretical framework for carrying out this exercise.

Without loss of generality, we focus on two key banking regulation policies: bank capital requirements and deposit insurance[3]. The key trade off is between the cost of giving up the ability to adopt the country's preferred level of bank capital requirements and the benefit of having access to a more efficient, common, deposit insurance scheme. We study this trade off in a formal-quantitative, general equilibrium framework. This represents an additional point of departure from the existing work on BU membership, which is almost entirely descriptive (policy reports from the ECB, the European Commission, the IMF, and the Bruegel Institute, a comprehensive CEPR-VoxEU.org e-book (Beck, 2012), etc.) and focuses primarily on the institutional, legal and political economy aspects of BU. And when not –there is a tiny formal literature that has implications for BU– it does not focus on BU or offer a useful framework for studying its costs and benefits (Fahri and Tirole, 2018).

An additional advantage of our approach is that, besides welfare analysis, it produces the macroeconomic implications of BU membership, namely, its effects on the level and volatility of aggregate variables (such as output, consumption, investment, employment, deposits, credit, risk premia, etc.) as well as on financial stability (bank default).

Our model is based on Mendicino et al. (2018), as extended by Balfoussia et al. (2025). It is a DSGE model featuring a rich financial sector that is afflicted by multiple agency problems and risk and other shocks, bank capital regulations, government-provided deposit insurance, insured and uninsured deposits and bank default in equilibrium. Its key feature is that capital requirements reduce bank leverage and the default risk of banks but their relationship with social welfare is hump-shaped, reflecting a trade-off between bank default and underinvestment. The hump-shaped relationship gives rise to a meaningful, interior, optimal level of capital requirements, which differ across heterogeneous countries. Such differences play a crucial role in the evaluation of BU membership.

We study the welfare and macroeconomic properties of a generic country inside and outside BU. When *outside*, the government selects its optimal (welfare maximizing[4]) level of bank capital requirements and raises the funds required to satisfy its time varying deposit

[3]It is straightforward to include additional policies but doing so does not change the basic calculus.

[4]In order to indirectly take into account omitted factors such as domestic regulatory failure, we also allow domestic regulation to be suboptimally set. The trade off remains the same but its slope changes in favor of BU.

insurance obligations that arise from variable bank default. We assume that the funds are procured through taxation but also discuss the properties of the model when public debt is used instead.

When *inside* BU, the country faces an exogenous level of capital requirements set by the union.[5] It makes an *actuarially* fair payment to the central deposit insurance agency - DIA, (so the central agency breaks even and *there is no cross country subsidization*), with the agency assuming responsibility for the –time varying– insurance payments. We consider both lump sum and distortionary (labor income) taxation. Moreover, when outside BU, we also allow for partial repayment of insured depositors (bail-ins). In contrast, when inside BU, insured deposits are assumed to be fully safe.

Whether the country is better off inside BU or not primarily depends on three elements: a) the distance between the country's level of optimal capital requirements and the level adopted by the union, with the smaller the distance, the more likely membership to be welfare improving; b) the sensitivity of the country's economic activity to variation in capital requirements: Greater sensitivity makes departures from the optimal level of requirements more costly; and c) fiscal robustness, with weaker fiscal finances favoring membership. The first element relates to the degree of heterogeneity across countries (for example see Altavilla et al., 2026), with more heterogeneity implying a smaller optimal BU area (Balfoussia et al., 2026). The second relates to the riskiness of the banking sector, its importance for economic activity and the risk tolerance in the economy: riskier, less well monitored, more consequential banks and risk intolerance (high risk aversion) all favor BU. And the third relates to the cost of raising extra funds during a banking crisis either by public borrowing (the slope of the debt Laffer curve) or by raising taxes (the slope of the tax Laffer curve), as well as the likelihood of depositor bail in.

The range of capital requirements that supports BU is larger under distortionary taxes and in particular, when there is fiscal fragility and a possibility of bail-ins. Moreover, for the *same level of requirements inside and outside BU*, welfare inside the union as well as aggregate economic activity (output, investment, consumption, employment, deposits, credit,..) and financial stability (as measured by the bank default rate) is higher and its volatility lower, while tax distortions (the tax rate) are lower. This implies that countries whose optimal capital requirement is close to the common level in BU are likely to experience an increase in the level of welfare and economic activity and an improvement in financial stability when joining the union. The picture is more nuanced for countries whose optimal level is further away from the BU rate. A country may not benefit from union even if membership led to an improvement in macroeconomic performance and financial stability; and vice

[5]In a companion paper, Balfoussia et al, 2026, use a multi-country model to determine the Banking Union wide capital requirements as a weighted average of the optimal capital requirements in the member states.

versa, a country may benefit from participation even if it this led to worse macroeconomic-financial stability performance. The reason for this mixed pattern is that the optimal and macroeconomic performance maximizing capital requirement differ (and the curvatures of the corresponding functions differ too).

The differences in welfare and macroeconomic performance inside and outside the union *for the same level of capital requirements* emanate from two elements. The first concerns the average tax rate and its volatility. This rate is bound to be higher outside BU if there is a tax revenue/public debt Laffer curve, that is, the required tax rate is a convex function of the level of tax/public debt. Moreover, when taxes adjust to meet the variable deposit insurance obligations outside BU, tax and macroeconomic *volatility* are also higher too. So BU is good news on the fiscal front.[6].

The second element concerns the level of risk premia on *uninsured* deposits and arises from tax variability. Bank default inflicts losses on uninsured depositors, irrespective of whether the country is inside or outside BU. But when outside the union, uninsured depositors suffer an extra loss when there is bank default as taxes are raised to compensate insured depositors. This double loss –which is countercyclical due to the countercyclicality of bank default– makes default more costly and thus uninsured (and total) deposits more risky when outside the union. Higher risk premia worsen the liability side of bank balance sheets, increase the cost of credit and also amplify bank default. Consequently, the equilibrium outside BU is associated with lower total deposits, bank loans and economic activity. Note that all these effects are further magnified when we allow for *insured depositor bail-ins*, as this adds a risk premium also to insured deposits.

The rest of the paper is organized as follows. Section 2 gives a summary of the model (the full model is delegated to the appendix), section 3 discusses its calibration, section 4 the results and section 5 concludes.

2 The model

We use a DSGE model based on Clerc et al. (2015) and Mendicino et al. (2018) as extended by Balfoussia et al. (2025) to include insured depositor bail-ins (the 3-D model). Here we provide a heuristic description of its main elements, the formal model is described in Appendix A2.

The model features a rich financial sector that intermediates loans to households (mortgages) and entrepreneurs (corporate loans), is subject to various risk shocks, and more importantly from our point of view, has banking regulation (bank capital requirements) and

[6]The positive fiscal effect of BU remains even when allowing for union wide, systemic banking crises and a debt Laffer curve for the central deposit insurance agency as long as it is flatter than that of an individual country.

government-provided deposit insurance. The model contains two distortions that have countervailing effects on the level of bank loans and economic activity. On the one hand, there is under-lending because of the risk of default and the monitoring costs that banks must incur in order to make borrowers truthfully report their idiosyncratic shock. On the other hand, there is over-lending because the existence of bank deposit insurance and bankers' limited liability coupled with unobserved individual bank risk, makes banks prone to excessive risk taking and default. Banks may default because of either idiosyncratic or aggregate shocks to the performance of their loan portfolios.

There is no international banking in the model, that is, banks taking deposits from/issuing loans to residents of other countries. Allowing for international banking does not change anything of importance in the model as long as the BU regulations are not affected by the specifics of the candidate member considered: the trade off studied remains the same. International banking and in particular the existence of a union wide interbank market –as in Cooper and Nikolov, 2026– becomes consequential when studying a related question, namely the size of the BU (the optimal banking area) as well as the determination of the optimal policy at the union level.

Policymakers deploy capital requirements in order to manage excessive bank lending and risk taking. Their choice balances two forces: On the one hand, higher requirements improve financial stability by forcing banks to have more skin in the game. This reduces the likelihood of bank failure and the tax burden of deposit insurance. On the other hand, they increase the cost of bank funding because bank equity is more expensive than debt, leading to higher borrowing rates, and lower investment and economic activity. The optimal level of capital requirements balances these effects in a way that maximizes social welfare.

Each unit of bank debt consists of two components: a fraction k that is government-insured and pays a gross rate of R_t^D irrespective of whether there is bank default or not; and the remaining fraction $1-k$ that is uninsured and only pays back the promised rate if the issuing bank is solvent; otherwise, it pays a proportion $1-k$ of the net recovery value of the defaulting bank's assets. Savers do not observe the individual bank risk profiles, so their valuation of bank debt is done on the basis of the -anticipated- credit risk of an average unit of bank debt. They hold a diversified portfolio of insured and uninsured claims on banks.

The realized gross rate of return on one unit of bank debt (composite of the two types of deposits), $\tilde{R}_t^D$, is

$$\tilde{R}_t^D = kR_{t-1}^D + (1-k)(R_{t-1}^D - \Omega_t) = R_{t-1}^D - (1-k)\Omega_t \tag{1}$$

where R_{t-1}^D is the gross fixed interest rate set on deposits maturing in period t and Ω_t is the default loss per unit of bank debt in period t (defined in Appendix A2).

To study how fiscal fragility impacts the provision of deposit insurance, we also allow for the possibility that the domestic Deposit Insurance Agency -DIA- may not fully honor

its obligations on insured deposits if public finances are weak. In particular, we assume that it may only cover a fraction p ($0 \leq p \leq 1$) of what has been promised, with the remaining fraction of uncovered insured deposits, $k(1-p)$ simply being added to the fraction of uninsured bank debt as a claim on the failed bank's repossessed assets.

Consequently, from the point of view of bank creditors, one unit of uninsured debt is the same as one unit of insured debt that ends up not being honored by the deposit insurance agency. Only a fraction $\gamma = pk$ of bank debt is fully repaid, while the remaining fraction $1-\gamma$ is partially repaid using $(1-\gamma)$ of the recovered assets of the bank. We view $p = \frac{\gamma}{k}$ as a measure of the capacity of the Deposit Insurance Agency (DIA) –the government– to compensate failed banks' creditors. If $p = 1$, there is no fiscal capacity constraint and no bail-in in the case of bank default.

When depositor bail-in is allowed, the realized rate of return on one unit of bank debt is

$$\tilde{R}_t^D = pkR_{t-1}^D + [(1-k) + (1-p)k](R_{t-1}^D - \Omega_t) = R_{t-1}^D - (1-pk)\Omega_t = R_{t-1}^D - (1-\gamma)\Omega_t \quad (2)$$

where $\gamma = pk$. We discuss the determination of γ (or p) in the calibration section.

The government's objective is to provide deposit insurance and finance government spending. With lump-sum taxes, the budget constraint when outside BU is:

$$T_t = k\Omega_t d_{t-1} + G \quad (3)$$

where T_t is lump-sum taxes in period t, k is the share of bank debt (deposits) that is insured, Ω_t is the default loss per unit of bank debt, d_{t-1} is deposits "maturing" in period t and G denotes government consumption. Equation 3 indicates that the domestic government -DIA- fully covers the losses suffered on insured deposits in case of bank default.

When inside BU, the budget constraint is:

$$T = k\Omega d + G \quad (4)$$

$$S_t = k\Omega_t d_{t-1} - k\Omega d \quad (5)$$

where Ω is the default loss per unit of bank debt in the stochastic steady state inside BU, d is the stochastic steady state value of bank debt and S_t is the net transfer to (from) the central DIA in period t. Equation 4 says that in each period the country pays to the central DIA a fixed amount $k\Omega d$ that is equal to what would have been required to compensate insured deposits in the stochastic steady state. Equation 5 gives the central DIA net transfer: If the realized bank default rate is above its steady state level then the country receives a positive transfer; if it is below it effectively makes a transfer to the central DIA. The payment $k\Omega d$ thus represents an actuarily fair insurance fee that ensures that the central DIA breaks even

so there is no cross subsidization.[7]

The advantage of BU membership is that it eliminates domestic tax variability, which is consequential not only because of the standard reason but also because tax variability makes *uninsured* deposits and hence total bank debt riskier. This is because if the bank default rate is high, owners of uninsured deposits suffer larger losses and at the same time they also have to pay higher taxes which are needed for the compensation of insured depositors (a double loss). Risk premia on deposits are thus higher outside BU. The fact that such losses also tend to occur during bad times, because of the countercyclicality of bank default, accentuates the cost of holding uninsured deposits and thus deposit risk premia.

When a labor income tax is used to finance the deposit insurance scheme, the government budget constraint outside BU takes the form:

$$\tau_t^w w_t L_t = k\Omega_t d_{t-1} + G \tag{6}$$

where τ_t^w is the tax rate on labor income, w_t is the real wage rate and L_t denotes hours worked. Under this regime, the share of insured deposits k is fully covered by the domestic government.

Inside BU, the budget constraint is given by:

$$\tau_t^w w_t L_t = k\Omega d + G \tag{7}$$

$$S_t = k\Omega_t d_{t-1} - k\Omega d \tag{8}$$

where S_t is the net transfer to (from) the central DIA, and $k\Omega d$ is the fixed amount paid by the country to the central DIA each period, equal to the deposit insurance cost in the stochastic steady state inside BU.

Distortionary taxation amplifies the cost of non-participation in BU. The reason is that tax variability is accompanied by a higher average tax rate when the slope of the tax Laffer curve decreases in the tax rate (the standard assumption). While this effect would not be present in a linear model, it is present in our model.

Finally, when bail-in is possible, the government budget constraint is as in equation (6) with $\gamma = pk$ replacing k.

The rest of the model The remainder of the model is as follows (see Appendix A2).

The economy consists of households, entrepreneurs and bankers. Households are infinitely lived and consume, supply labor in a competitive market and invest in housing. There are two types of households, patient and impatient, that differ in their subjective

[7]For a small size BU, recurrent union wide banking crises might lead to a deficit for the central DIA. We assume that in such a case the DIA can borrow the required funds at zero cost from the ECB or EU fiscal authority.

discount factor. In equilibrium, patient households are savers and impatient households are borrowers. The latter negotiate limited liability, non-recourse mortgage loans from banks using their holdings of housing as collateral. They can individually choose to default on their mortgage, in which case they lose the housing units against which the mortgage is secured.

Entrepreneurs are the owners of the physical capital stock and finance their purchases of capital with their inherited net worth and bank corporate loans. Capital is used as collateral in securing bank loans.

Banks operate under limited liability and face default risk. Bankers contribute inside equity to these perfectly competitive financial intermediaries, which use household deposits and their equity to issue mortgage and corporate loans. Banks are subject to regulatory capital constraints that require the backing of a fraction of their loans by bank equity. Default occurs due to both idiosyncratic and aggregate shocks that affect the value their loan portfolios.

Finally, the final good, new capital and housing are all produced by perfectly competitive firms.

Sources of variability There is an aggregate shock (to TFP) and idiosyncratic shocks to the value of the assets of the impatient households, entrepreneurs and corporate and mortgage banks. These shocks determine the share of agents in each category (households, entrepreneurs, mortgage and corporate banks) that choose to default. Each of these four shocks is assumed to be independently and identically distributed across the corresponding agents and to follow a lognormal distribution with mean one and standard deviation $\sigma_{i,t+1}$. We introduce *risk shocks* by allowing aggregate shocks to affect the variances of these idiosyncratic distributions. The risk shocks follow an AR(1) stochastic process of the form:

$$\ln \tilde{\sigma}_{i,t} = \rho_i \ln \tilde{\sigma}_{i,t-1} + \epsilon_{i,t}, \tag{9}$$

where ρ_i is the persistence parameter, $\epsilon_{i,t} \sim \mathcal{N}(0, \sigma^2_{\epsilon,i})$, and $i \in \{m, e, H, F\}$.

3 Calibration

The model is calibrated at a quarterly frequency to match key features of the Greek economy over the period 2000Q1-2024Q4. The primary data source is Eurostat, with additional data from the ECB Data Portal, the Household Finance and Consumption Network, AMECO and the Bank of Greece. The calibration closely follows the approach of Clerc et al., (2015), Papageorgiou and Balfoussia (2016), Mendicino et al., (2018) and Balfoussia et al., (2025). The calibrated parameters are presented in Table 1.

In line with Clerc et al., (2015), capital requirements are set at 8% for corporate loans and 4% for mortgage loans.[8] The discount factors for patient –0.994– and impatient –0.98– households are calibrated using the interest rate on deposits and the interest rate on loans to households for consumption and other purposes, respectively.

The parameter of the inverse Frisch elasticity of labour, η, is set equal to 2; the preference parameter for the marginal disutility of labour, φ, to 1; and the coefficient of risk aversion to 2. The labour share, computed from AMECO data that adjusts for the income of the self-employed persons, is set to 0.6.

Following Mendicino et al., (2018), the asset repossession cost parameter, μ, is set equal to 0.3, implying a loss of 30% of asset value to creditors repossessing assets from defaulting units. The adjustment cost for housing and business investment is set to 2.

The calibration is more speculative when it comes to determining the parameters of the deposit insurance scheme as well as the size of debt haircuts. The steady-state –effective– deposit insurance parameter, γ is the product of k –the fraction of nominally insured deposits– and p –the degree of expected bail-in. Following Mendicino et al., (2018), we set $\gamma = 0.54$.

Several parameters are calibrated so that the stochastic steady state of the model replicates the empirical averages of the Greek economy. We use data from the Household Finance and Consumption Survey to calibrate the utility weight of housing, v. In particular, we choose the utility weight of housing for borrowers so that the stochastic steady state value of their housing as a share of total housing matches the share of indebted households in the data. The utility weight of housing for savers is calibrated in a similar manner.

The depreciation rates on capital and housing investment, δ and δ^H, have been set to match as closely as possible the average values of total investment –net of housing– to GDP (0.023) and of housing investment to GDP (0.005) in the data. The consumption shares of bankers and entrepreneurs, χ^b, χ^e, are set on the basis of the values of the rate of return on bank equity and the capital ratio of non-financial corporations, respectively.

The variances of the idiosyncratic shocks for households and entrepreneurs, σ_m and σ_e, are calibrated so that the model can match the average household debt-to-GDP ratio and the corporate debt-to-GDP ratios in the data. This yields $\sigma_m = 0.21$ and $\sigma_e = 0.415$, indicating higher uncertainty in the corporate sector.

We set the standard deviation of the idiosyncratic shocks to corporate and mortgage banks, σ_F and σ_H, to match a target probability of default in the banking sector. To construct this target from the data, we exploit the "sovereign-bank nexus" that characterized the Greek sovereign debt crisis. Given the very high exposure of Greek banks to sovereign

[8]This is consistent with the weights of Basel I and with the treatment of non-rated corporate loans in Basel II and III. The capital requirement parametrization for mortgage loans is compatible with their 50% risk-weight in Basel I.

government bonds, we identify the bank default probability with the corresponding default probability embedded in Greek government bond yields.

Specifically, we adopt a risk-neutral pricing framework in which the return on a risky 10-year Greek government bond satisfies a no-arbitrage condition relative to a risk-free benchmark, proxied by the yield on 10-year German bond. Let R^* denote the gross risk-free rate and R the gross return on Greek government bonds. We assume a payoff structure in which, with probability p_b , the bond is fully repaid, while with probability $1-p_b$, it yields zero payoff. The pricing condition is therefore given by $R^* = p_b R + (1-p_b)0$, which implies that the repayment probability is $p_b = R^*/R$, and the corresponding probability of default is $\pi = 1 - p_b$.

This procedure yields an average annual bank default probability of 3.52%. Accordingly, we set the standard deviation of the risk shocks to corporate and mortgage banks to the values $\sigma_F = 0.0339$ and $\sigma_H = 0.0142$, respectively, so that the model-implied default probability for each type of bank in the stochastic steady state matches this target.

We set the persistence parameters of the exogenous shocks equal to 0.9 and we estimate their standard deviation from data. Following standard practice in the literature, the standard deviations of the exogenous shocks are estimated from the residuals of the corresponding AR(1) specifications.[9] In particular, the standard deviation of the TFP shock is obtained using real labor productivity per hour worked, which serves as an empirical proxy for aggregate productivity.

To calibrate the volatility of the risk shocks, we exploit observable indicators of credit risk in the data. In particular, we assume that the shocks to the variances of the idiosyncratic bank shocks are perfectly correlated across the two types of banks and we estimate the standard deviation of the bank risk shocks using the ratio of non-performing loans (NPLs) to total loans, which is widely used as a proxy for systemic banking risk. The standard deviation of shocks to the variance of idiosyncratic household risk is estimated using the ratio of credit granted to households to gross disposable income of households, while the standard deviation of shocks to the variance of entrepreneurial risk is calibrated using the ratio of credit to non-financial corporations relative to their gross operating surplus.

Finally, the government consumption-to-output ratio in the stochastic steady state is set equal to 0.2.

4 Welfare and macroeconomic performance

Our objective is to study the welfare and macroeconomic implications of BU membership. In particular, we highlight the trade-offs involved in this choice and identify the conditions

[9] All series are detrended using a quadratic deterministic trend.

Table 1: Calibrated parameters

Description	Parameter	Value
Discount Factor, patient and impatient households	β^s , β^m	0.994, 0.98
Utility Weight of Housing, patient and impatient	υ^s , υ^m	0.21, 0.35
Marginal Disutility of labor, patient and impatient	φ^s , φ^m	1
Inverse of Frisch Elasticity of Labor	η	2
Coefficient of risk aversion in the utility function	σ	2
Fraction of effectively insured deposits	γ	0.54
Capital Requirement for Mortgage Loans	ϕ^H	0.04
Capital Requirement for Corporate Loans	ϕ^F	0.08
Repossession Cost	$\mu^m, \mu^e, \mu^H, \mu^F$	0.3
Capital Share in Production	α	0.40
Capital Depreciation Rate	δ	0.023
Housing Depreciation Rate	δ^H	0.005
Capital Adjustment Cost Parameter	ξ_K	2
Housing Adjustment Cost Parameter	ξ^H	2
Dividend Payout of Bankers (Entrepreneurs)	χ^b , χ^e	0.035, 0.05
Std of Mortgage Bank Idiosyncratic Shock	σ_H	0.0142
Std of Corporate Bank Idiosyncratic Shock	σ_F	0.0339
Std of Household Idiosyncratic Shock	σ_m	0.21
Std of Entrepreneurial Idiosyncratic Shock	σ_e	0.415
Std of TFP shock	σ_A	0.0074
Std of Risk Shock to Mortgage Banks	$\tilde{\sigma}_H$	0.017
Std of Risk Shock to Corporate Banks	$\tilde{\sigma}_F$	0.017
Std of Risk Shock to Households	$\tilde{\sigma}_m$	0.021
Std of Risk Shock to Entrepreneurs	$\tilde{\sigma}_e$	0.035
Persistence – TFP shock	ρ_A	0.9
Persistence – Mortgage Bank Risk Shock	$\rho_{\tilde{\sigma}_H}$	0.9
Persistence – Corporate Bank Risk Shock	$\rho_{\tilde{\sigma}_F}$	0.9
Persistence – Household Risk Shock	$\rho_{\tilde{\sigma}_m}$	0.9
Persistence – Entrepreneurial Risk Shock	$\rho_{\tilde{\sigma}_e}$	0.9

that favor participation. We also examine how membership affects the level and volatility of macroeconomic and financial aggregates. The analysis applies to a generic country, but the quantitative results rely on calibrated parameter values from the Greek economy.

When outside BU, the country selects its optimal level of capital requirements and is responsible for providing deposit insurance to the depositors of the domestic banks. When inside, it faces a union-wide bank capital requirement, makes a fixed payment to the central DIA and is absolved of any domestic deposit insurance obligations. The fixed payment is set equal to the stochastic steady state deposit insurance obligations so that the *average* amount of insurance payments made by the central DIA is equal to the country's contribution. In other words, the DIA breaks even and there are no cross country subsidies. The model is solved with either lump sum or distortionary (labor income) taxes. Furthermore, we assume that insured deposits are perfectly safe inside BU, but may be subject to a hair cut (bail-in)

outside, when the country's fiscal situation is fragile (and taxes are distortionary). Hair cuts represent a known share of the value of insured deposits and occur with a known probability $1-p$. We have also carried out the analysis with p varying either exogenously or as a function of the state of the economy.

The model is solved in Dynare using a quadratic approximation to its equations. The steady state considered is the *stochastic* steady state of the model, which takes into account the risk shocks. The analysis outside the steady state is based on the policy functions computed around the deterministic steady state of the model.[10] Welfare W_j for household of type j, $j \in \{s, m\}$ -patient and impatient- is $W_j = \sum_{t=0}^{\infty} \beta_j^t u_{j,t}$, where $u_{j,t}$ is period t utility and β_j is the discount factor of household of type j. We use its recursive form, $W_{j,t} = u_{j,t} + E_t \beta_j W_{j,t+1}$ and apply the quadratic approximation to that form too. Social welfare is the weighted sum of the utilities of the patient and impatient dynasties, with the weights being their relative steady state consumption share.[11] The comparison of macroeconomic performance inside and outside BU is done on the basis of first and second moments of macroeconomic and financial aggregates.

4.1 Results: Distortionary taxation

Figure 1 depicts social welfare and output as a function of bank capital requirements, ϕ, Figure 2 shows the effect of membership on macroeconomic aggregates, Figure 3 shows its effects on financial variables and Figure 4 its effect on macroeconomic and financial volatility. We report the most noteworthy findings.

First, for the *same* level of ϕ inside and outside BU, a country is always better off in BU as it suffers no cost but enjoys the benefit of better insurance provision. It also experiences a higher level of macroeconomic (output, consumption, investment,..) and financial (bank deposits, loans,..) activity as well as lower tax rates and lower macroeconomic and financial volatility. Bank default rates are lower and so are the –uninsured– deposit risk premia and the tax bill.

The behavior of the tax revenue requirement for deposit insurance as well as that of uninsured deposit risk premia hold the key to these findings. Outside BU, the country has to make variable deposit insurance claims. Doing so by varying tax rates/collections (rather than through public debt) leads to greater macroeconomic variability relative to that when inside BU, as in the latter case, deposit insurance related tax revenue is constant

[10] This is the procedure contained in the Dynare package. When the risk shocks are sufficiently small, the stochastic steady state is close to the deterministic one and the Dynare approach does not introduce any significant approximation error.

[11] There exists no commonly accepted criterion for the choice of the weights in the social welfare function in economies with agents with different discount factors. For instance, Curdia and Woodford (2016) use the population fractions of the two types instead of their consumption shares as weights.

(the constant fee paid to the central agency). Volatility in taxes is welfare worsening and economic activity worsening and destabilizing, and even more so when the labor supply elasticity varies with the size of the tax rate. Note that reliance on public debt issuance to meet deposit insurance obligations eliminates the macroeconomic volatility that is induced by tax volatility but it still has a negative footprint on the average tax rate and the level of economic activity if the interest rate on public debt is a convex function of its size.

The second crucial element driving the findings reported above is the behaviour of the risk premia on uninsured deposits and the closely connected bank default rate. Bank default inflicts losses on uninsured depositors, irrespective of whether the country is inside or outside BU. But when outside the union, uninsured depositors suffer an extra loss when there is bank default as taxes are raised to compensate insured depositors. This double loss –which is countercyclical due to the countercyclicality of bank default– makes default more costly and thus uninsured (and total) deposits more risky when outside the union. Higher risk premia worsen the liability side of bank balance sheets, increase the cost of credit and make bank default more likely. Note that the ability to use public debt instead of taxes to smooth deposit insurance payments relieves insured depositors from this double loss, with a favorable effect on deposit premia.

Second, there is a range of values for ϕ around the country's optimal value such that for union-wide levels in that range, BU membership makes the country better off. The length of this range and hence the probability of welfare improving BU participation depends on the vertical distance of the two curves, as well as on the curvature of the welfare function. These in turn depend on how risky the banking sector is, how consequential it is for real economic activity and on the risk tolerance of savers. Costly monitoring, a large variance of bank risk shocks, a high share of capital in production, and high risk aversion all make the welfare function flatter, working in favor of BU.[12]

Third, welfare improving membership does not automatically translate into higher levels of economic activity and financial stability. This is because the welfare function and the functions of the other variables may differ in their curvature and location of the their peak as a function of ϕ. It is conceivable that a country could be better off in BU for a given union wide ϕ^U, but at that value of ϕ, economic activity and/or financial stability –as measured by the rate of bank default– would worsen when joining BU. Subsequently, for an arbitrary level of union-wide ϕ, BU membership may have quite different effects on the macroeconomic performance and financial stability of its members. Furthermore, as output is a concave function of ϕ, a country might experience a decline in output irrespective of whether its capital requirements increased or decreased when joining BU.

Fourth, similar considerations apply to the comparison of the effects of the two regimes

[12]Graphs 8-10 in the Appendix demonstrate these model properties.

when the domestic choice of capital requirements is sub-optimal. This could, for instance, happen if domestic regulators were "captured" by domestic banks, an argument that has been made in the literature in favor of externalizing banking regulation. We entertain this possibility by allowing the capital requirements outside BU to be chosen on the basis of additional criteria besides social welfare. For instance, we have also included the return to bankers equity in the objective function maximized by the social planner. When policy outside BU is suboptimal, the comparison of the two regimes uses an horizontal line that lies below the tangent at the maximum point. Naturally, this case works in favor of BU membership as it expands the range of union-wide ϕ values that support BU.

And fifth, it is obvious that the greater the dispersion in optimal bank capital requirements across countries (the greater country heterogeneity) the smaller the set of countries that would benefit from BU.

4.2 Results: Distortionary taxation, bank bail-ins

So far we have assumed that insured deposits are totally safe both inside and outside BU. This may not be the case when a country with fragile public finances faces a large scale banking crisis.[13] We now allow for the possibility that deposit insurance promises may not be fully honored. In particular, we assume that when a bank defaults, only a fraction p of the amount promised to the holders of insured depositors is paid out. In the baseline version of the model we assume a constant p.[14] In contrast, insured deposits are perfectly safe in BU.

In order to close the door to cross country subsidies, we again assume that the country receives *on average* from the central DIA an amount that is equal to its fixed contribution (the stochastic steady state insurance payments). The premise here is that while the country has the fiscal capacity needed to compensate insured depositors in the stochastic steady state of the model (that is, at the stochastic steady state level of bank default), it cannot easily raise the larger amounts needed when the bank default rate –significantly– exceeds its average level.

Allowing for bank bail-ins has two implications. First, insured deposits become risky and carry a risk premium too. Consequently, the liability side of banks' balance sheets deteriorates further, magnifying bank default and lowering total bank deposits and credit (Figure 7) and output (right panel of Figure 5). The same is true for the other macroeco-

[13]This proved to be the case in the banking crisis in Cyprus in 2013. But even without a hair cut, other measures such as the capital controls instituted in 2015 in Greece to fend off the collapse of the banking system inflict costs on owners of insured deposits as they lose their liquidity.

[14]We have also solved the model with p varying either exogenously or as a function of the state of the economy, for instance, with the deposits or credit to GDP ratio. This extension does not matter for the properties of the model.

nomic aggregates (Figure 6). All these adverse effects work in favor of BU, so the range of ϕ values that support membership expands (left panel of Figure 5). Second, in contrast to the case without insured depositor bail-ins, and depending on the size of the haircuts (p), the fiscal burden of deposit insurance could be *lower* when outside BU. This becomes obvious in the extreme case with a value of p close to 0 (a negligible amount of effectively insured deposits). In general, whether the tax rate is lower or higher outside BU depends on various elements such as the size of p, the value of insured deposits, the deposit rate, the size of the tax base (due to lower output/wages), etc. In the baseline calibration where all of the deposit insurance obligations are honored ($\gamma = 0.54$) the tax burden is higher outside BU. With a substantial probability of a hair cut, namely, a $\gamma = 0.40$ the average tax rate is raised when the country joins BU.[15]

5 Conclusions

We have provided a quantitative, general equilibrium framework for evaluating the welfare, macroeconomic and financial stability implications of banking union membership. A country contemplating entry in BU faces a trade-off between being able to regulate its banks as it sees it fit and enjoying access to a more efficient deposit insurance scheme. This trade-off is more likely to favor BU membership when the country's banking sector is consequential (bank credit is important for financing production and housing), when it faces large bank risk shocks and when the marginal cost of taxation/raising extra debt is high and when domestic regulatory policy is suboptimal. But even under these circumstances, a large deviation between the union wide capital requirement and the country-specific chosen one may suffice to make BU membership unattractive. This is more likely to happen when there exists a great deal of heterogeneity across countries in the characteristics of their banking sectors.

A novel, important implication of our analysis is that, for a sufficiently large gap between the national and the union wide levels of capital requirements, BU membership may adversely impact on macroeconomic performance and financial stability *even when it is welfare improving*. And that such a possibility exists both for countries that experience an increase and for countries that experience a decrease in their capital requirements upon entry.

Our analysis has taken for granted the existence of a group of countries that have formed BU and have set values for the regulatory instruments (such as capital requirements). And it has simply studied the choice faced by an individual country whether to join or not this particular BU. A related question is what type of countries form a union and how

[15] A value of $\gamma = 0.54$ means that all insured deposits at defaulting banks are fully honored. A value of $\gamma = 0.4$ implies a haircut of about 25%.

the value of the common regulatory instrument is determined. The concept of the Optimal Banking Area (OBA) is useful for addressing this issue. Much like an Optimal Currency Area (OCA), an OBA consists of countries that are better off in BU and the union wide values of the regulatory instruments may be chosen by maximizing the weighed welfare of these union members. Our paper suggests that OBA members are necessarily countries whose optimal regulations belong to a specific range around the union wide optimal regulations. That is, countries that are sufficiently homogeneous with regard to the relevant banking and macroeconomic characteristics. These issues are the subject of a companion paper (Balfoussia et al. 2026) that characterizes the largest possible BU within the Eurozone by applying the analysis of the present paper individually to 12 EZ countries.

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7 Appendix 1

7.1 The benchmark case: Table 1 parameter values

Figure 1: Distortionary taxation, no bail-in

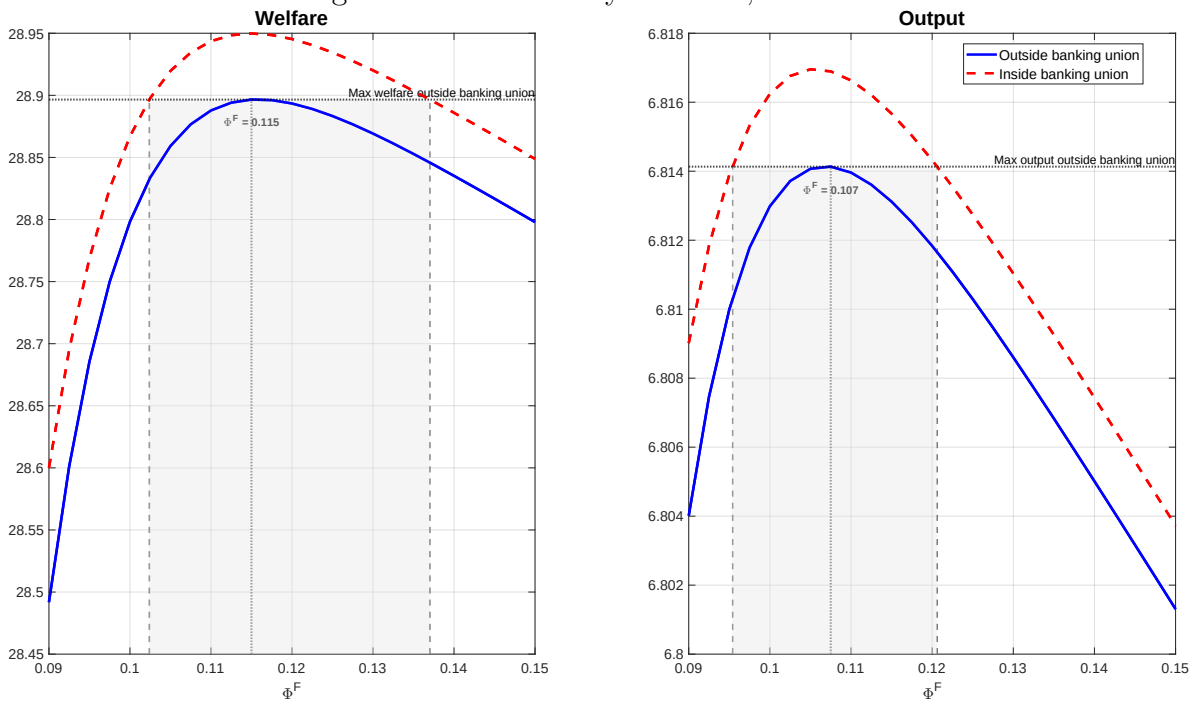


Figure 2: Distortionary taxation, no bail-in, macro aggregates

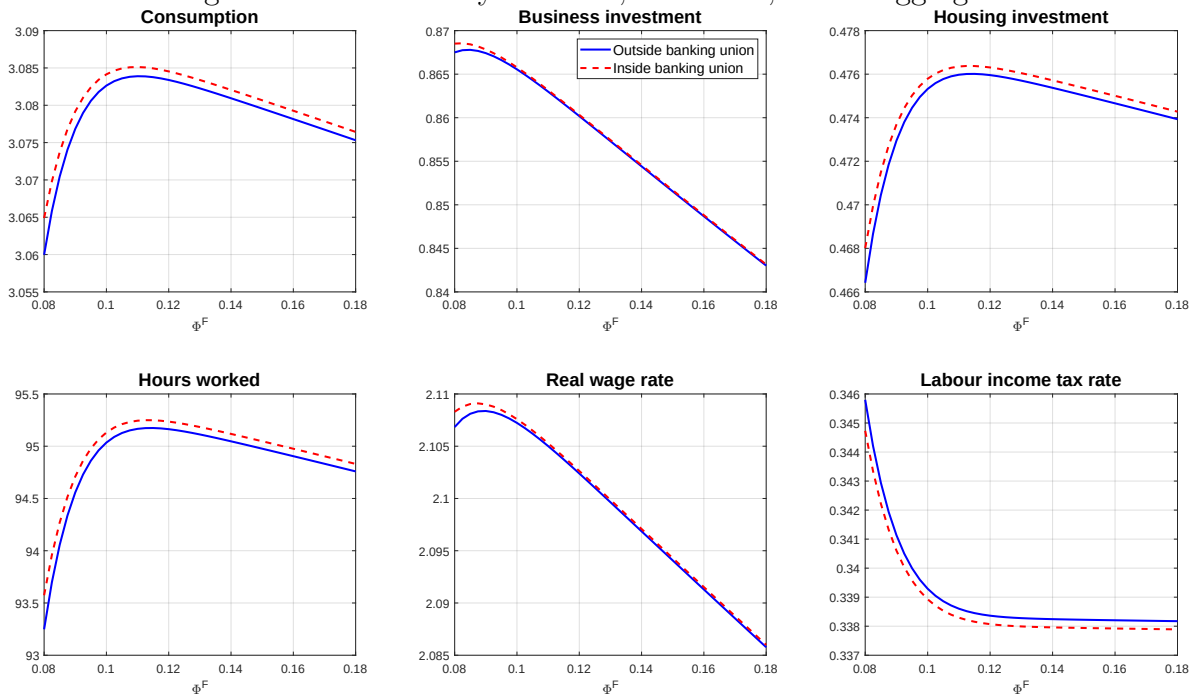


Figure 3: Distortionary taxation, no bail-in, financials

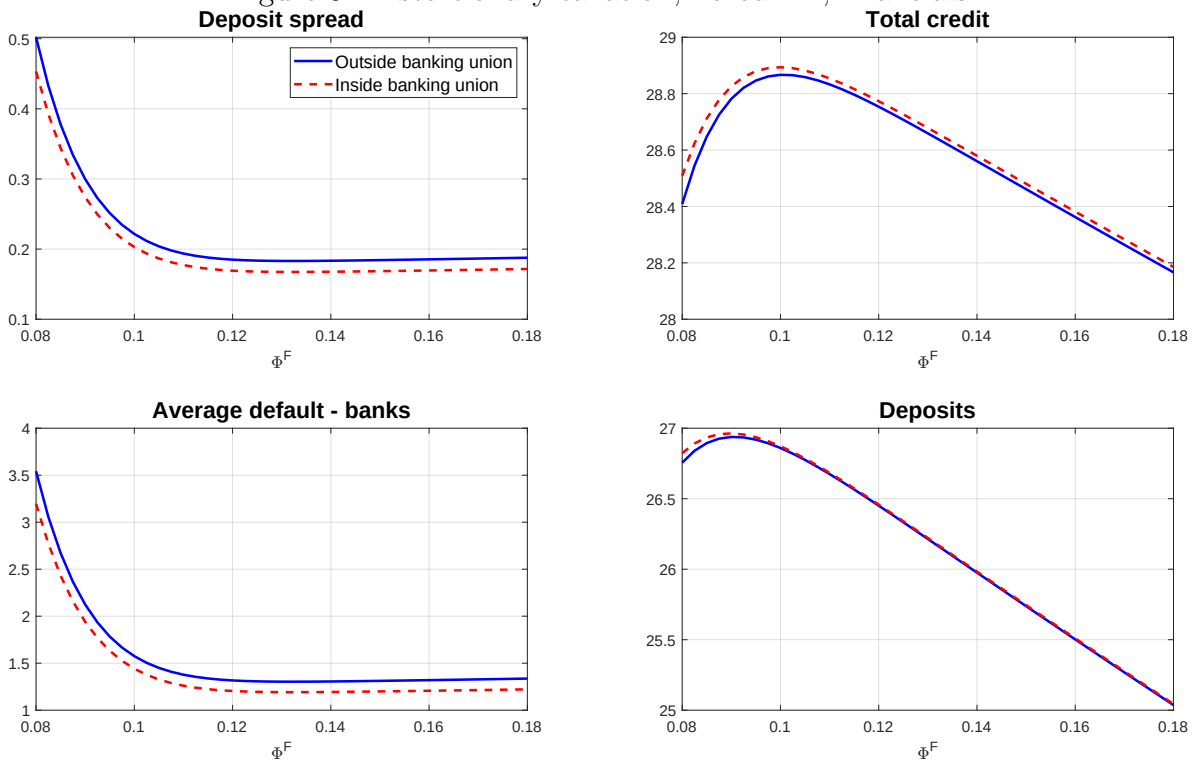


Figure 4: Volatility, distortionary taxation, no bail-in

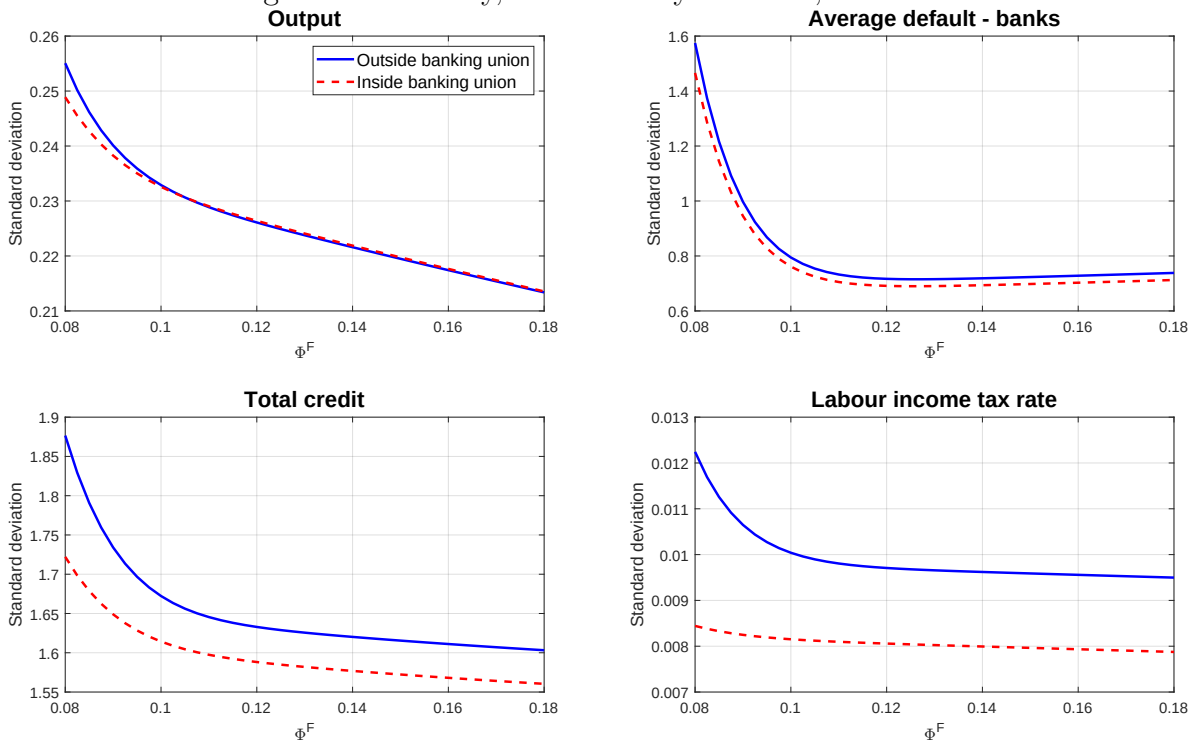


Figure 5: Distortionary taxation, bail-in

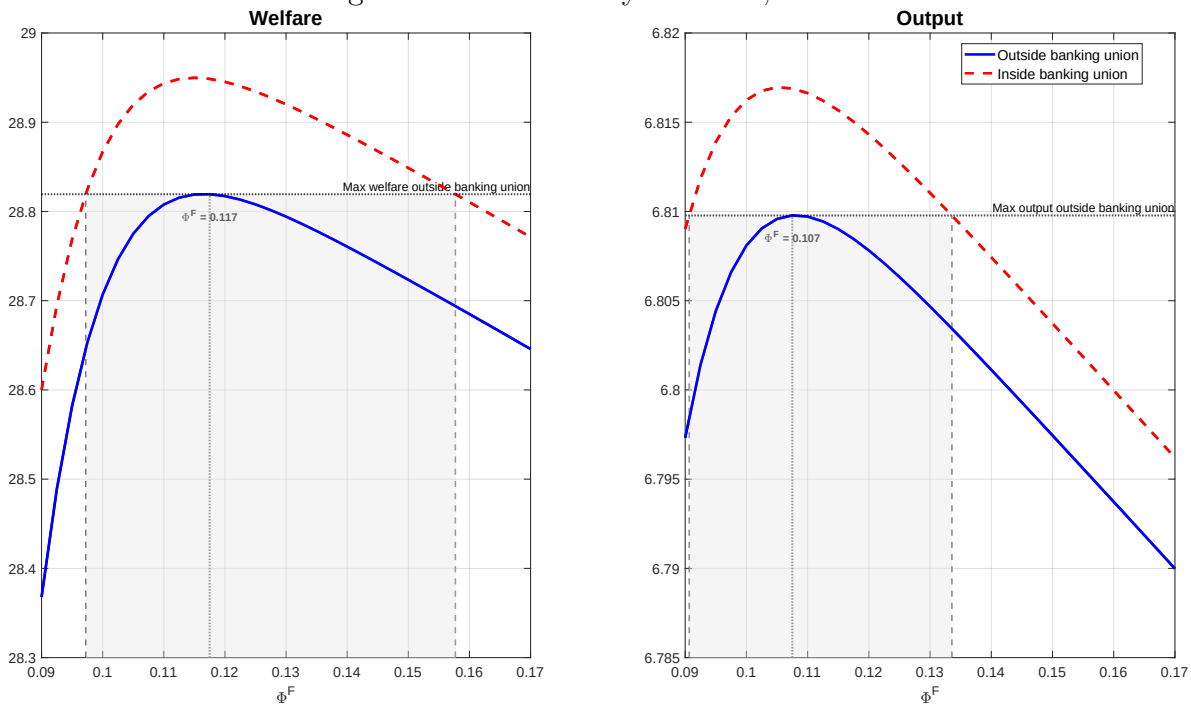


Figure 6: Distortionary taxation, bail-in, macro aggregates

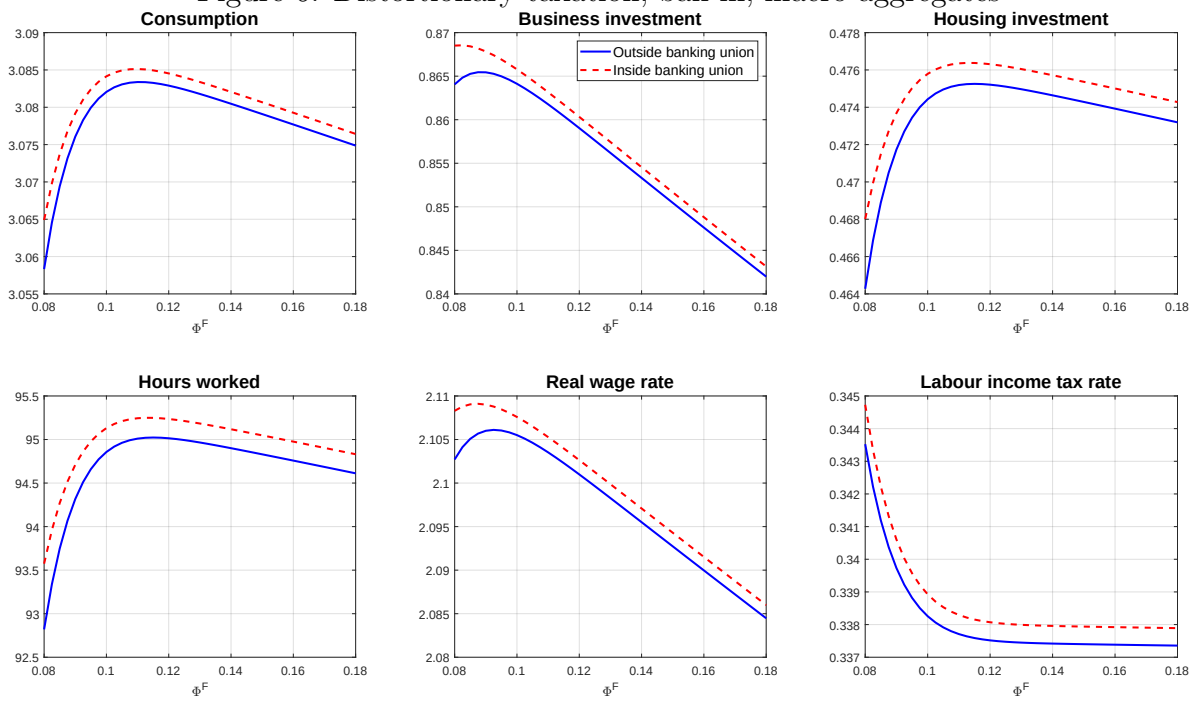
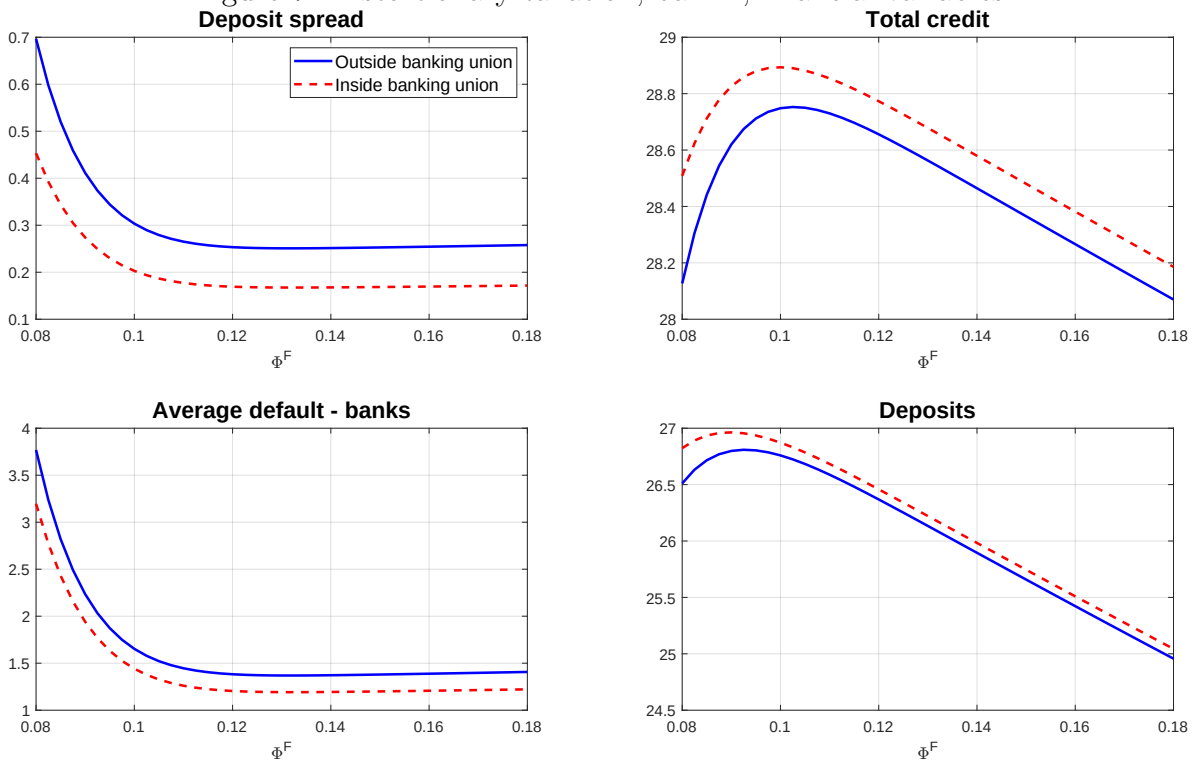


Figure 7: Distortionary taxation, bail-in, financial variables



7.2 Sensitivity analysis: Deviating from benchmark parameter values

Figure 8: Sensitivity: Distortionary taxation, no bail-in, high risk shocks

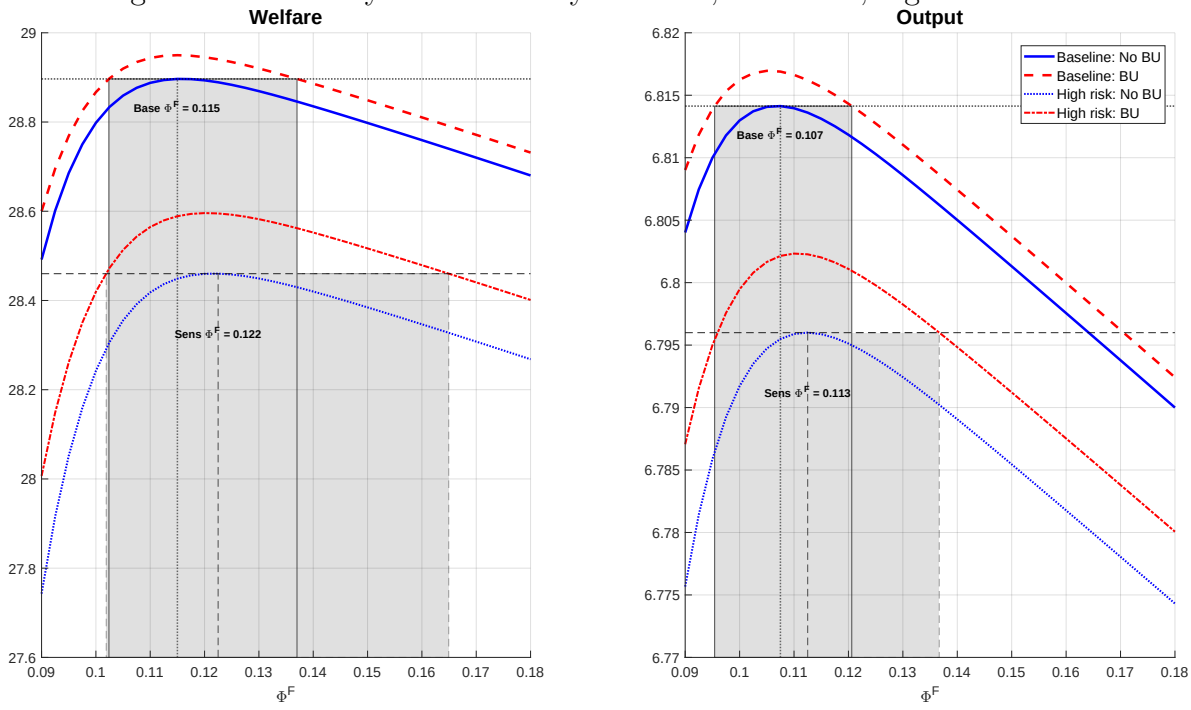


Figure 9: Sensitivity: Distortionary taxation, no bail-in, high cost of taxation

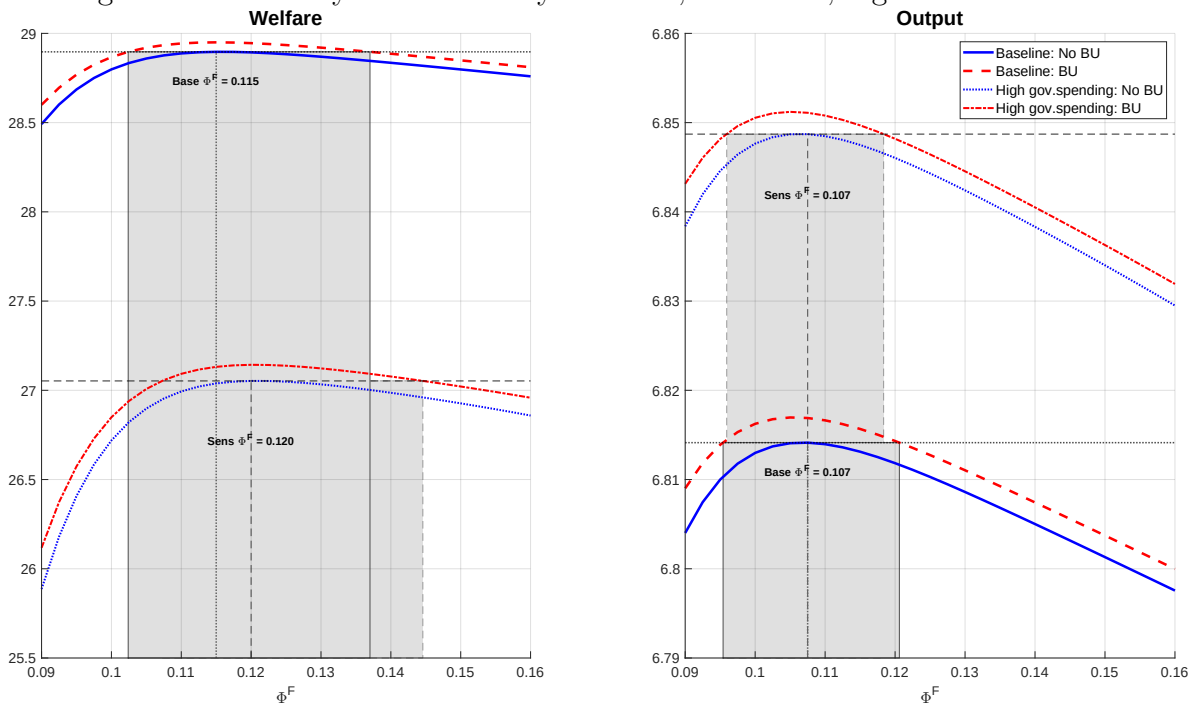
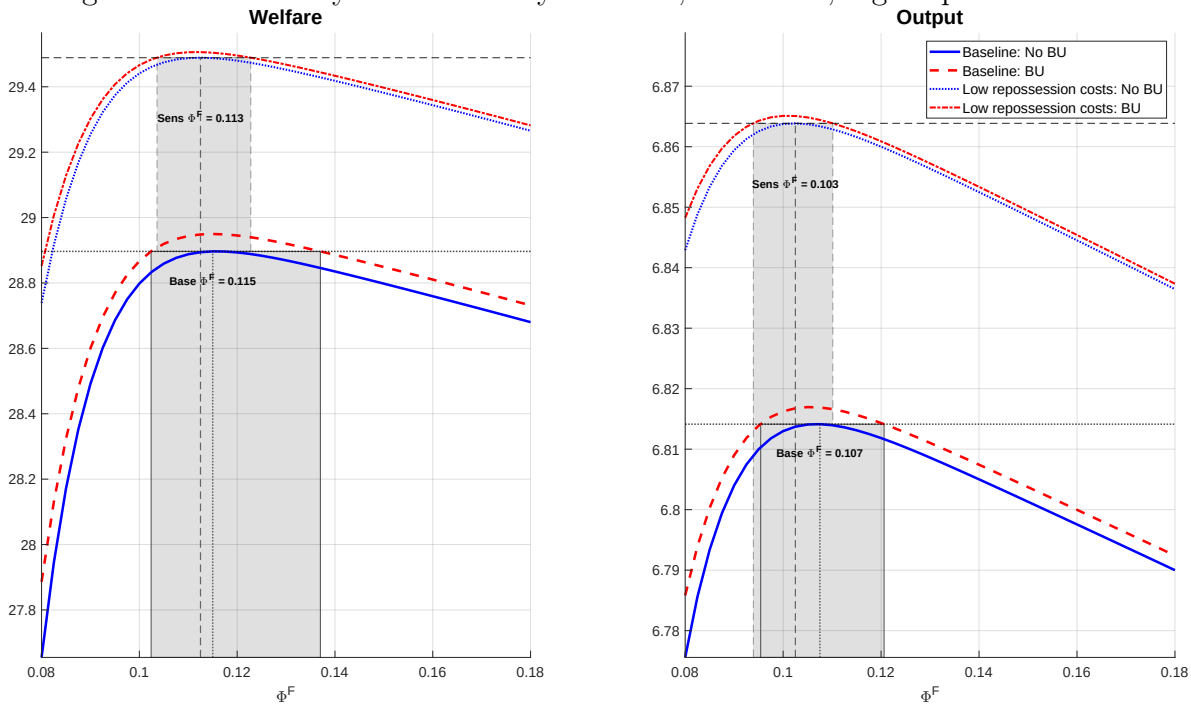


Figure 10: Sensitivity: Distortionary taxation, no bail-in, high repossession cost



8 Appendix

A2.1 Households

There are two representative dynasties of ex ante identical infinitely lived households that differ only in the subjective discount factor. One dynasty, indexed by the superscript s, is made up of relatively patient households with a discount factor β^s. The other dynasty, identified by the superscript m, consists of more impatient households with a discount factor $\beta^m < \beta^s$. In equilibrium, the patient households save and the impatient households borrow from banks.

A2.1.1 Saving Households

The dynasty of patient households maximizes

$$\mathbb{E}_t \sum_{i=0}^{\infty} (\beta^s)^{t+i} \left[\log c^s_{t+i} + v^s \log h^s_{t+i-1} - \varphi^s \frac{(l^s_{t+i})^{1+\eta}}{1+\eta} \right] \tag{A.1}$$

subject to

$$c^s_t + q^H_t h^s_t + d_t \leq (1-\tau^w_t) w_t l^s_t + q^H_t (1-\delta^H) h^s_{t-1} + \tilde{R}^D_t d_{t-1} - T_t + \Pi^s_t \tag{A.2}$$

where c^s_t denotes the consumption of non-durable goods, h^s_t denotes the total stock of housing, l^s_t denotes hours worked, η is the inverse of the Frisch elasticity of labor supply and v^s and ϕ_s are preference parameters. Also, q^H_t is the price of housing, δ^H is the depreciation rate of housing units and w_t is the real wage rate. As owners of the firms, households receive profits, Π^s_t, that are distributed in the form of dividends. τ^w_t is the tax rate on labor income and T_t are lump-sum taxes. Tax revenues are used to finance deposit insurance.

d_t denotes bank debt. It consists of two components: government-insured deposits (a fraction k of total bank debt liabilities) that promise to pay back the gross deposit rate, R^D_t, irrespective of whether there is bank default or not. And another component (the remaining fraction $1-k$ of bank debt) that is uninsured and only pays back the promised rate if the issuing bank is solvent; otherwise, it pays a proportion $1-k$ of the net recovery value of bank assets. Savers do not observe the individual bank risk profiles, so their valuation of bank debt is done on the basis of the anticipated credit risk of an average unit of bank debt. Moreover, each saver holds a diversified portfolio of insured and uninsured claims on banks.

The realized rate of return on total bank debt (insured and uninsured) is:

$$\tilde{R}^D_t = R^D_{t-1} - (1-k)\Omega_t \tag{A.3}$$

where R^D_t is the gross fixed interest rate set on deposits in period t and Ω_t is the default loss per unit of bank debt in period t (see Eq. A33 below).

To bring fiscal fragility into the picture, we assume that the Deposit Insurance Agency, DIA, may not honor all of its obligations on insured deposits in case of bank default if the finances of the governments are fragile. In particular, we assume that it covers a fraction p ($0 \leq p \leq 1$) of what it has promised, with the remaining fraction simply being added to the fraction of uninsured bank debt as a claimant on the failed bank's repossessed assets. This means that, from the point of view of bank creditors, one unit of uninsured debt is the same as one unit of insured debt that ends up not being honored by the DIA. Consequently, only a fraction $\gamma = p \cdot k$ of the loans to the banks is fully repaid, while the remaining fraction $1-\gamma$ is partially repaid using $1-\gamma$ of the recovered assets of the bank. We view $p = \gamma/k$ as a measure of the capacity of DIA – the government – to compensate failed banks' creditors. If $p = 1$, there is no capacity constraint and no depositor bail-in in the case of bank default. For values of $p < 1$, the share of deposits that is nominally insured differs from the share that is effectively insured because the government partially reneges on its promises. Since the share of nominally insured deposits k is not a choice variable in this model, we will use γ as the measure of fiscal robustness, with robustness increasing in γ.

For simplicity, we are implicitly assuming here that fiscal robustness is linear in the amount of fully repaid bank liabilities. This need not be the case in general as the degree of bail in (and hence the measure of fiscal fragility) may depend itself on the share of insured bank liabilities (that is, p may be a function of k).

When the bank bail-ins are allowed, the realized rate of return on one unit of bank debt is:

$$\tilde{R}_t^D = R_{t-1}^D - (1-\gamma)\Omega_t \tag{A.4}$$

where γ is the fraction of deposits that is effectively insured. The remaining fraction, $1-\gamma$, consists of the uninsured debt as well as the DIA-insured deposits that are subject to bail-in.

A2.1.2 Borrowing Households

Impatient households have the same preferences as patient households except for the discount factor, which is $\beta^m < \beta^s$. The budget constraint of the representative dynasty is:

$$c_t^m + q_t^H h_t^m - b_t^m \leq (1-\tau_t^w) w_t l_t^m + \int_0^\infty \max\{\omega_t^m q_t^H (1-\delta_H) h_{t-1}^m - R_{t-1}^m b_{t-1}^m, 0\} dF_m(\omega_t^m) \tag{A.5}$$

where b_t^m is aggregate borrowing from the banks and R_{t-1}^m is the contractual gross interest rate on the housing loan agreed upon in period $t-1$. ω_t^m is an idiosyncratic shock to the efficiency units of housing owned from period $t-1$ that each household experiences at the beginning of each period t. The shock is assumed to be independently and identically distributed across the impatient households and to follow a lognormal distribution with density and cumulative distribution functions denoted by $f(\cdot)$ and $F(\cdot)$, respectively. This shock affects the effective resale value of the housing units acquired in the previous period,

$\tilde{q}_t^H = \omega_t^m q_t^H (1-\delta^H)$, and makes default on the loan ex post optimal for the household whenever $\omega_t^m q_t^H (1-\delta^H) h_{t-1}^m < R_{t-1}^m b_{t-1}^m$. The term in the integral reflects the fact that the housing good and the debt secured against it are assumed to be distributed across the individual households that constitute the dynasty.

After the realization of the shock, each household decides whether to default or not on the individual loans held from the previous period. Then, the dynasty makes the decisions for consumption, housing, labour supply and debt in period t and allocates them evenly across households. As shown in Clerc et al. (2015), individual households default in period t whenever the idiosyncratic shock ω_t^m satisfies:

$$\omega_t^m \leq \bar{\omega}_t^m = \frac{x_{t-1}^m}{R_t^H} \tag{A.6}$$

where $R_t^H = \dfrac{q_t^H(1-\delta^H)}{q_{t-1}^H}$ is the ex post average realized return on housing and $x_t^m = \dfrac{R_t^m b_t^m}{q_t^H h_t^m}$ is a measure of household leverage. The net housing equity after accounting for repossessions of defaulting households can be written as:

$$(1-\Gamma^m(\bar{\omega}_t^m)) R_t^H q_{t-1}^H h_{t-1}^m, \tag{A.7}$$

where

$$\Gamma^m(\bar{\omega}_t^m) = \int_0^{\bar{\omega}_t^m} \omega_t^m f_m(\omega_t^m)\, d\omega_t^m + \bar{\omega}_t^m \int_{\bar{\omega}_t^m}^{\infty} f_m(\omega_t^m)\, d\omega_t^m$$

is the share of gross returns (gross of repossession costs) accrued by the bank and $1-\Gamma^m(\bar{\omega}_t^m)$ is the share of assets accrued to the dynasty.

Since each of the impatient households can default on its loans, the loans taken in period t should satisfy the participation constraint for the lending banks:

$$\mathbb{E}_t\left[(1-\Gamma^H(\bar{\omega}_t^H))\left(\Gamma^m\left(\bar{\omega}_{t+1}^m\right) - \mu^m G^m\left(\bar{\omega}_{t+1}^m\right)\right)\right] R_{t+1}^H q_t^H h_t^m \geq \rho_t \phi_t^H b_t^m \tag{A.8}$$

The left-hand side of the inequality accounts for the total equity returns associated with a portfolio of housing loans to the various members of the impatient dynasty. The interpretation of the banking participation constraint is that the expected gross return for bankers should be at least as high as the gross equity return of the funding of the loan from the bankers, $\rho_t \phi_t^H b_t^m$, where ρ_t is the required expected rate of return on equity from bankers (defined below) and ϕ_t^H is the capital requirement on housing loans. The term $\mu^m G^m(\omega_{t+1}^m)$ is the expected cost of default, where μ^m is the asset repossession cost and

$$G^m(\omega_{t+1}^m) = \int_0^{\bar{\omega}_{t+1}^m} \omega_{t+1}^m f(\omega_{t+1}^m)\, d\omega_{t+1}^m$$

is the share of assets that belong to households that default. Finally, $1-\Gamma^H(\bar{\omega}_t^H)$ is the share of assets accrued to bankers in the case of a bank default, where $\bar{\omega}_t^H$ is the threshold level to the idiosyncratic shock of banks that specialize in mortgage loans (defined below).

Given the above, the problem of the representative dynasty of the impatient households can be written as a contracting problem between the representative dynasty and its bank. In particular, the problem of the dynasty is to maximize utility subject to the budget constraint and the participation constraint of the bank:

$$\max_{\{c^m_{t+i},h^m_{t+i},l^m_{t+i},x^m_{t+i},b^m_{t+i}\}_{i=0}^{\infty}} \mathbb{E}_t \sum_{i=0}^{\infty}(\beta^m)^{t+i}\left[\log c^m_{t+i} + v^m \log h^m_{t+i} - \phi^m \frac{1+\eta}{(l^m_{t+i})^{1+\eta}}\right] \tag{A.9}$$

subject to

$$c^m_t + q^H_t h^m_t - b^m_t \;\leq\; \omega_t\, l^m_t \;+\; \left(1-\Gamma^m\left(\frac{x^m_t}{R^H_{t+1}}\right)\right) x^m_t R^H_{t+1} q^H_t h^m_t \tag{A.10}$$

and

$$\mathbb{E}_t\left[(1-\Gamma^H(\bar{\omega}^m_{t+1}))\left(\Gamma^m\left(\frac{x^m_t}{R^H_{t+1}}\right)x^m_t R^H_{t+1} \;-\; \mu^m G^m\left(\frac{x^m_t}{R^H_{t+1}}\right)R^H_{t+1}\right)\right] q^H_t h^m_t = \rho_t \phi^H_t b^m_t \tag{A.11}$$

A2.2 Entrepreneurs

Entrepreneurs are risk neutral agents that live for two periods. Each generation of entrepreneurs inherits wealth in the form of bequests and purchases new capital from capital good producers and depreciated capital from the previous generation of entrepreneurs that they rent out to final good producers. They finance capital purchases with their initial wealth and with corporate loans from banks, b^e_t. The entrepreneurs derive utility from the transfers made to the patient households in period $t+1$ (dividends), c^e_{t+1}, and the bequests left to the next cohort of entrepreneurs (retained earnings), n^e_{t+1}, according to the utility function $c^{e\,\chi_e}_{t+1} n^{e\,1-\chi_e}_{t+1}$, $\chi_e \in (0,1)$. Thus, the problem of the entrepreneurs in period $t+1$ is:

$$\max_{c^e_{t+1},n^e_{t+1}} (c^e_{t+1})^{\chi_e}(n^e_{t+1})^{1-\chi_e} \tag{A.12}$$

subject to

$$c^e_{t+1} + n^e_{t+1} \leq W^e_{t+1} \tag{A.13}$$

where W^e_{t+1} is the wealth resulting from the activity in the previous period.

The optimization problem of the entrepreneur in period t is to maximize expected wealth:

$$\max_{k_t,b^e_t,R^F_t} \mathbb{E}_t W^e_{t+1} \tag{A.14}$$

subject to the period t resource constraint $q^K_t k_t - b^e_t = n^e_t$ and the banks participation constraint (defined below), where

$$W^e_{t+1} = \max\{\omega^e_{t+1}(r^k_{t+1} + (1-\delta)q^K_{t+1})k_t - R^F_t b^e_t,\; 0\},$$

q_t^K is the price of capital at period t, k_t is the capital held by the entrepreneur in period t, b_t^e is the amount borrowed from the bank in period t, r_t^k is the rental rate of capital, δ is the depreciation rate of physical capital and R_t^F is the contractual gross interest rate of the corporate loan. ω_{t+1}^e is an idiosyncratic shock to the efficiency units of capital which is independently and identically distributed across entrepreneurs. It is realized after the period t loan with the bank is agreed to and prior to renting the available capital to consumption good producers on that date. Similar to the case of borrowing households, entrepreneurs default on their loans whenever

$$\omega_{t+1}^e(r_{t+1}^k + (1-\delta)q_{t+1}^K)k_t < R_t^F b_t^e.$$

As shown in Clerc et al. (2015), the entrepreneur will repay their corporate loan in period $t+1$ whenever the idiosyncratic shock ω_{t+1}^e exceeds the following threshold:

$$\bar{\omega}_{t+1}^e \equiv \frac{R_t^F b_t^e}{R_{t+1}^K q_t^K k_t} \equiv \frac{x_t^e}{R_{t+1}^K} \tag{A.15}$$

where $R_{t+1}^K = \dfrac{r_{t+1}^k + (1-\delta)q_{t+1}^K}{q_t^K}$ is the gross return per efficiency units of capital in period $t+1$ of capital owned in period t, $x_t^e = \dfrac{R_t^F b_t^e}{q_t^K k_t}$ denotes the entrepreneurial leverage that is defined as the ratio of contractual debt repayment obligations in period $t+1$, $R_t^F b_t^e$, to the value of the purchased capital at t, $q_t^K k_t$.

Given the above, the maximization problem of the entrepreneurs in period t can be compactly written as:

$$\max_{x_t^e, k_t} \ \mathbb{E}_t \left[(1 - \Gamma^e(\frac{x_t^e}{R_{t+1}^K})) R_{t+1}^K q_t^K k_t \right] \tag{A.16}$$

subject to

$$\mathbb{E}_t \left[(1 - \Gamma^F(\bar{\omega}_{t+1}^F))\Gamma^e(\bar{\omega}_{t+1}^e) - \mu^e G^e(\bar{\omega}_{t+1}^e) \right] R_{t+1}^K q_t^K k_t = \rho_t \phi_t^F (q_t^K k_t - n_t^e) \tag{A.17}$$

where

$$\Gamma^e(\bar{\omega}_{t+1}^e) = \int_0^{\bar{\omega}_{t+1}^e} \omega_{t+1}^e f_e(\omega_{t+1}^e)\, d\omega_{t+1}^e + \bar{\omega}_{t+1}^e \int_{\bar{\omega}_{t+1}^e}^{\infty} f_e(\omega_{t+1}^e)\, d\omega_{t+1}^e$$

is the share of gross returns that will accrue to the bank, $G^e(\bar{\omega}_{t+1}^e) = \int_0^{\bar{\omega}_{t+1}^e} \omega_{t+1}^e f_e(\omega_{t+1}^e)\, d\omega_{t+1}^e$ is the fraction of the returns coming from the defaulted loans of entrepreneurs, μ^e denotes the asset repossession costs incurred by the bank and $1 - \Gamma^F(\bar{\omega}_t^F)$ is the share of assets accrued to bankers in the case of a bank default, where $\bar{\omega}_t^F$ is the default threshold for the idiosyncratic shock of banks that specialize in corporate loans (defined below). Similar to the case of impatient households, the interpretation of the participation constraint is that, in equilibrium, the expected return of the corporate loans must equal to the expected rate of return on equity, ρ_t, that the bankers require for their contribution to the funding of loan, $\varphi_t^F(q_t^K k_t - n_t^e)$, where φ_t^F is the capital requirement applied on corporate loans.

A2.3 Bankers

Like entrepreneurs, bankers are risk-neutral and live for two periods. They invest their initial wealth, inherited in the form of bequest from the previous generation of bankers, n_t^b, as banks' inside equity capital. In period $t+1$ the bankers derive utility from transfers to the patient households in the form of dividends, c_{t+1}^b, and the bequests left to the next generation of bankers (retained earnings), n_{t+1}^b, according to the utility function $c_{t+1}^{b\,\chi_b} n_{t+1}^{b\,1-\chi_b}$, where $\chi_b \in (0,1)$. Thus, the problem of the banker in period $t+1$ is:

$$\max_{c_{t+1}^b, n_{t+1}^b} (c_{t+1}^b)^{\chi_b} (n_{t+1}^b)^{1-\chi_b} \tag{A.18}$$

subject to

$$c_{t+1}^b + n_{t+1}^b \leq W_{t+1}^b \tag{A.19}$$

where W_{t+1}^b is the wealth of the banker in period $t+1$.

Regarding the decision problem of the bankers in period t, the banker born in period t with initial wealth n_t^b decides how much of this wealth to allocate as inside equity capital across the banks that specialize in housing loans (H banks) and the banks that specialize in entrepreneurial loans (F banks). Let e_t^F be the amount of the initial wealth n_t^b invested as inside equity in F banks and the rest, $n_t^b - e_t^F$, in H banks. The net worth of the banker in period $t+1$ is

$$W_{t+1}^b = \tilde{\rho}_{t+1}^F e_t^F + \tilde{\rho}_{t+1}^H (n_t^b - e_t^F),$$

where $\tilde{\rho}_{t+1}^F$, $\tilde{\rho}_{t+1}^H$ are the ex post gross returns on the inside equity invested in banks F and H respectively. The maximization problem of the banker is to decide on the allocation of their initial wealth in order to maximize the expected wealth:

$$\max_{e_t^F} \mathbb{E}_t W_{t+1}^b = \mathbb{E}_t \left[\tilde{\rho}_{t+1}^F e_t^F + \tilde{\rho}_{t+1}^H (n_t^b - e_t^F) \right] \tag{A.20}$$

An interior solution in which both types of banks receive positive equity requires that $\mathbb{E}_t \tilde{\rho}_{t+1}^F = \mathbb{E}_t \tilde{\rho}_{t+1}^H = \rho_t$, where ρ_t denotes the required expected gross rate of return on equity investment at time t. This expected return is endogenously determined in equilibrium but it is taken as given by individuals and banks.

A2.4 Banks

Banks are institutions that provide loans to households and entrepreneurs. There are two types of banks: banks indexed by H are specialized in mortgage loans and banks indexed by F are specialized in corporate loans. Both types of banks ($j = H, F$) issue equity bought by bankers and bank debt bought by households.

Each bank maximizes the expected equity payoff,

$$\pi^j_{t+1} = \omega^j_{t+1}\tilde{R}^j_{t+1}b^j_t - R^D_t d^j_t,$$

that is, the difference between the return from loans and the repayments due to its debt, where ω^j_{t+1} is an idiosyncratic portfolio return shock, which is i.i.d. across banks and follows a log-normal distribution with mean one and a distribution function $F_j(\omega^j_{t+1})$, b^j_t and d^j_t are respectively the loans extended and deposits taken by bank at period t, R^D_{t+1} is the gross interest rate paid on the deposits taken in period t and $\tilde{R}^j_{t+1}$ is the realized return on a well-diversified portfolio of loans of type j.

Each bank faces a regulatory capital constraint:

$$e^j_t \geq \varphi^j_t b^j_t \tag{A.21}$$

where φ^j_t is the capital-to-asset ratio of banks of type j. The regulatory capital constraint states that the bank is restricted to back with equity at least a fraction of the loans made in period t. The problem of each bank j can be written as:

$$\pi^j_{t+1} = \max\{\omega^j_{t+1}\tilde{R}^j_{t+1}b^j_t - R^D_t d^j_t,\ 0\} \tag{A.22}$$

subject to the aforementioned regulatory capital constraint.

In equilibrium, the constraint will be binding so that the loans and bank debt can be expressed as

$$b^j_t = \frac{e^j_t}{\varphi^j_t}, \qquad d^j_t = \frac{1-\varphi^j_t}{\varphi^j_t}e^j_t,$$

respectively. Accordingly, the threshold level of ω^j_{t+1} below which the bank defaults is

$$\bar{\omega}^j_{t+1} = \frac{(1-\phi^j_t)R^D_t}{R^j_{t+1}}$$

and the probability of default of each bank of type j is $F_j(\bar{\omega}^j_{t+1})$. Thus, bank default is driven by fluctuations in the aggregate return $\tilde{R}^j_{t+1}$ and the bank idiosyncratic shock ω^j_{t+1}. In the case in which a bank defaults, the DIA repossesses $(1-\mu_j)\omega^j_{t+1}\tilde{R}^j_{t+1}b^j_t$, where μ_j is the repossession cost.

Given the above, the equity payoffs can then be written as:

$$\begin{aligned}\pi^j_{t+1} &= \max\{\omega^j_{t+1} - \bar{\omega}^j_{t+1}, 0\}R^j_{t+1}\frac{e^j_t}{\phi^j_t} \\ &= \left[\int_{\bar{\omega}^j_{t+1}}^{\infty} \omega^j_{t+1}f^j(\omega^j_{t+1})d\omega^j_{t+1} - \bar{\omega}^j_{t+1}\int_{\bar{\omega}^j_{t+1}}^{\infty} f^j(\omega^j_{t+1})d\omega^j_{t+1}\right] \times R^j_{t+1}\frac{e^j_t}{\phi^j_t}\end{aligned} \tag{A.23}$$

where $f_j(\omega^j_{t+1})$ denotes the density distribution of ω^j_{t+1}. Then, the equity payoffs can be written as:

$$\pi_{t+1}^{j} = (1 - \Gamma_j(\bar{\omega}_{t+1}^{j}))R_{t+1}^{j}\frac{e_t^j}{\phi_t^j}$$

and the required ex post rate of return from the bankers that invest in the bank j is:

$$\rho_{t+1}^{j} = \frac{(1 - \Gamma_j(\bar{\omega}_{t+1}^{j}))R_{t+1}^{j}}{\phi_t^j},$$

where

$$\Gamma_j(\bar{\omega}_{t+1}^{j}) = \int_0^{\bar{\omega}_{t+1}^{j}} \omega_{t+1}^{j} f_j(\omega_{t+1}^{j})\, d\omega_{t+1}^{j} + \bar{\omega}_{t+1}^{j} \int_{\bar{\omega}_{t+1}^{j}}^{\infty} f_j(\omega_{t+1}^{j})\, d\omega_{t+1}^{j}$$

and

$$G_j(\bar{\omega}_{t+1}^{j}) = \int_0^{\bar{\omega}_{t+1}^{j}} \omega_{t+1}^{j} f_j(\omega_{t+1}^{j})\, d\omega_{t+1}^{j}.$$

Finally, the average default rate for banks can be written as:

$$PD_t^b = \frac{d_{t-1}^H F^H(\bar{\omega}_{t+1}^H) + F^F(\bar{\omega}_{t+1}^F) d_{t-1}^F}{d_{t-1}^H + d_{t-1}^F} \tag{A.24}$$

and the expression for the realized returns on loans after accounting for loan losses can be expressed as:

$$R_{t+1}^H = \Gamma^m\left(\frac{x_t^m}{R_{t+1}^H}\right) R_{t+1}^H - \mu^m G^m\left(\frac{x_t^m}{R_{t+1}^H}\right)\frac{R_{t+1}^H q_t^H h_t^m}{b_t^m} \tag{A.25}$$

$$R_{t+1}^F = \Gamma_e\left(\frac{x_t^e}{R_{t+1}^K}\right) R_{t+1}^K - \mu^e G^e\left(\frac{x_t^e}{R_{t+1}^K}\right)\frac{R_{t+1}^K q_t^K k_t}{q_t^K k_t - n_t^e} \tag{A.26}$$

A2.5 Production sector

The final good in this economy is produced by perfectly competitive firms that use capital, k_t, and labour, l_t. The production technology is:

$$y_t = A_t k_{t-1}^a l_t^{1-a} \tag{A.27}$$

where A_t is total factor productivity and a is the labour share in production.

A2.6 Capital and housing production

Capital and housing producing firms are owned by patient households. Capital producers combine a fraction of the final good, I_t, and previous capital stock k_{t-1} to produce new units of capital goods that are sold to entrepreneurs at price q_t^K. The law of motion for the physical capital stock is given by:

$$k_t = (1 - \delta)k_{t-1} + \left[1 - S_K\left(\frac{I_t}{I_{t-1}}\right)\right] I_t \tag{A.28}$$

where $S_K\left(\frac{I_t}{I_{t-1}}\right) = \frac{\xi_K}{2}\left(\frac{I_t}{I_{t-1}} - 1\right)^2$ is an adjustment cost function that satisfies $S(\cdot) = S'(\cdot) = 0, S''(\cdot) > 0$.

The objective of the representative capital producing firm is to maximize expected profits:

$$\mathbb{E}_t \sum_{i=0}^{\infty} \beta_s^i \left(\frac{c_t^s}{c_{t+i}^s}\right) \left\{ q_{t+i}^K I_{t+i} - \left[1 + S_K\left(\frac{I_{t+i}}{I_{t+i-1}}\right)\right] I_{t+i} \right\} \tag{A.29}$$

Housing producers are modelled in a similar manner. In particular, the law of motion of the aggregate housing stock is:

$$h_t = (1 - \delta^H) h_{t-1} + \left[1 - S_H\left(\frac{I_t^H}{I_{t-1}^H}\right)\right] I_t^H \tag{A.30}$$

And the maximization problem of the representative housing producing firm is:

$$\mathbb{E}_t \sum_{i=0}^{\infty} \beta_s^i \left(\frac{c_t^s}{c_{t+i}^s}\right) \left\{ q_{t+i}^H I_{t+i}^H - \left[1 + S_H\left(\frac{I_{t+i}^H}{I_{t+i-1}^H}\right)\right] I_{t+i}^H \right\} \tag{A.31}$$

A2.7 Macroprudential policy

The macroprudential authority sets the capital requirements on bank lending in period t according to the following rule:

$$\phi_t^j = \bar{\phi}_0^j + \bar{\phi}_1^j \log\left(\frac{b_t}{b}\right), \quad j = H, F \tag{A.32}$$

where b_t is the total credit in the economy at time t, $\bar{\phi}_0^j$ is the reference level of capital requirements and $\bar{\phi}_1^j > 0$ is a feedback parameter that captures the cyclical adjustments in capital requirements that depends on the state of the economy.

A2.8 Government

The government's objective is to provide deposit insurance and finance government spending. With lump-sum taxes, $\tau_t^w = 0$, and its budget constraint when outside Banking Union (BU) is:

$$T_t = k\Omega_t d_{t-1} + G \tag{A.33}$$

where T_t represents lump-sum taxes, k is the share of bank debt (deposits) that is insured, d_{t-1} denotes deposits maturing in period t and G is government consumption. Ω_t is the average default loss per unit of bank debt that is computed as a weighted average of the losses of each bank:

$$\Omega_t = \frac{d_{t-1}^H}{d_{t-1}} \Omega_t^H + \frac{d_{t-1}^F}{d_{t-1}} \Omega_t^F \tag{A.34}$$

where

$$\Omega_t^H = [\bar{\omega}_t^H - \Gamma_H(\bar{\omega}_t^H) + \mu^H G^H(\bar{\omega}_t^H)] \tilde{R}_{t+1}^H \left(\frac{q_{t-1}^H h_{t-1}^m x_{t-1}^m}{R_{t-1}^m}\right) \tag{A.35}$$

$$\Omega_t^F = \left[\bar{\omega}_t^F - \Gamma^F(\bar{\omega}_t^F) + \mu^F G^F(\bar{\omega}_t^F)\right] \tilde{R}_{t+1}^F \left[q_t^K k_t - (1 - x_t^e) W_{t-1}^e\right] \tag{A.36}$$

Equation (A.33) indicates that the domestic government – DIA – fully covers the losses suffered on insured deposits in case of bank default.

When inside the BU, the government's budget constraint is:

$$T = k\Omega d + G \tag{A.37}$$

$$S_t = k\Omega_t d_{t-1} - k\Omega d \tag{A.38}$$

where Ω is the default loss per unit of bank debt in the stochastic steady state inside BU, d is the stochastic steady state value of bank debt and S_t is the net transfer to (from) the central DIA in period t. Equation (A.37) says that in each period the country pays to the central DIA a fixed amount T that is equal to what would have been required to compensate insured deposits in the steady state. Equation (A.38) gives the central DIA net transfer: If the realized bank default rate is above its steady state level then the country received a positive transfer; if it is below, it effectively receives a negative transfer. T thus represents an actuarily fair insurance fee, which ensures that the central DIA breaks even so there is no cross subsidization.

When a labor income tax is used to finance the deposit insurance scheme, $T_t = 0$, and the government budget constraint outside BU takes the form:

$$\tau_t^w w_t L_t = k\Omega_t d_{t-1} + G \tag{A.39}$$

where τ_t^w is the tax rate on labor income, w_t is the real wage rate and L_t denotes hours worked. Under this regime, the share of insured deposits k is fully covered by the domestic government.

Inside BU, the budget constraint is given by:

$$\tau_t^w w_t L_t = k\Omega d + G \tag{A.40}$$

$$S_t = k\Omega_t d_{t-1} - k\Omega d \tag{A.41}$$

where S_t is the net transfer to (from) the central DIA, and $k\Omega d$ is the fixed amount paid by the country to the central DIA each period, equal to the deposit insurance cost in the stochastic steady state inside BU.

Finally, when bail-in is possible, the government budget constraint is as in equations (A.33), (A.39) with $\gamma = pk$ replacing k.

A2.9 Stochastic environment

Productivity shocks, A_t, and the shocks to the variances of the idiosyncratic shocks of the borrowers (i.e., the risk shocks), $\tilde{\sigma}_{m,t}$, $\tilde{\sigma}_{e,t}$, $\tilde{\sigma}_{H,t}$, and $\tilde{\sigma}_{F,t}$, follow an AR(1) stochastic process

of the form:

$$\ln z_t = \rho_z \ln z_{t-1} + e_{z,t} \tag{A.42}$$

where ρ_z is the persistence parameter, $e_{z,t} \sim \mathcal{N}(0, \sigma_z^2)$, and $z \in \{A_t, \tilde{\sigma}_{m,t}, \tilde{\sigma}_{e,t}, \tilde{\sigma}_{H,t}, \tilde{\sigma}_{F,t}\}$.

A2.10 Aggregate output

Aggregate output, y_t, equals households' consumption, plus investment in housing and physical capital, plus the resources lost in the repossession of the defaulted bank loans (mortgage and corporate) and bank debt:

$$\begin{aligned} y_t = {} & c_t^s + c_t^m + I_t + I_t^H + S_t + G \\ & + \mu^m G^m(\bar{\omega}_t^m) R_t^H q_{t-1}^H h_{t-1}^m \\ & + \mu^e G^e(\bar{\omega}_t^e) R_t^K q_{t-1}^K k_{t-1} \\ & + \mu^H G^H(\bar{\omega}_t^H) \tilde{R}_{t+1}^H \left(\frac{q_{t-1}^H h_{t-1}^m x_{t-1}^m}{\tilde{R}_{t-1}^m} \right) \\ & + \mu^F G^F(\bar{\omega}_t^F) R_{t+1}^F \left[q_t^K k_{t-1} - (1 - x_t^e) W_{t-1}^e \right] \end{aligned} \tag{A.43}$$

The measure of output reported in the paper is net of bankruptcy costs, that is $\tilde{y}_t = c_t^s + c_t^m + I_t + I_t^H + S_t + G$.

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