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Global Lending Conditions and International Coordination of Financial Regulation Policies.*

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Abstract

Using a model of strategic interactions between two countries, I investigate the gains to international coordination of financial regulation policies, and how these gains depend on global lending conditions. When global lending conditions are determined non-cooperatively, I show that coordinating regulatory policies leads to a Pareto improvement relative to the case of no cooperation. In the non-cooperative equilibrium, one region—the core—determines global lending conditions, leaving the other region—the periphery—in a sub-optimal situation. The periphery then tightens regulatory policy to reduce the cost of sub-optimal lending conditions. Yet, in doing so, it fails to internalise a cross-border externality: tightening regulatory policy in one region limits ex ante borrowing in the other region, which increases the cost of sub-optimal lending conditions for the periphery. The equilibrium with cooperative regulatory policies can then improve on this outcome as both regions take into account the cross-border externality and allow for larger ex ante borrowing, ending in a lower cost of suboptimal lending conditions for the periphery.

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1 Introduction

Traditionally, there have been two main justifications for coordinating financial regulatory policies across countries. First is the well-known problem of a regulatory "race to the bottom," a tendency for policymakers to eschew stringent regulatory standards in an effort to provide domestic banks with a competitive advantage relative to their peers from other jurisdictions. Second is the issue of "leakages," situations in which banks can (easily) circumvent domestic regulations by setting up subsidiaries in other jurisdictions with laxer regulatory standards.[1]

In this paper, I propose an additional mechanism in support of cross-border regulatory coordination. The key feature of the mechanism, which has two main parts, is the interplay between regulatory policies and global lending conditions. The first part takes into account the well-documented fact that external developments—primarily monetary policy in major advanced economies—significantly influence lending conditions in emerging market economies (henceforth periphery).[2] As a result, global lending conditions do not necessarily accord with the macroeconomic conditions in the periphery, which can lead to an inefficient allocation of credit.

The second part recognizes that policymakers in the periphery may have an incentive to actively use regulatory policy to regain partial control over domestic lending conditions. In practice, this may involve a unilateral imposition of controls on capital flows, regulations on bank funding or borrowing limits on firms and households in order to narrow the wedge between global lending conditions and those that are optimal in light of the periphery's macroeconomic conditions.[3] However, using such tightening measures in a unilateral or non-cooperative fashion will incur costs in terms of foregone mutually beneficial financial

[1] The race to the bottom problem was originally raised in the context of capital taxation policies. In a world of high capital mobility, fiscal authorities can lower taxes to attract capital to their jurisdiction, a dynamic that can lead to unnecessary tax competition (see Persson and Tabellini (1995)). With regards to undesirable regulatory leakages, Aiyar et al. (2014) provide empirical evidence of such effects in the case of the UK; a theoretical analysis of macro-prudential policy under imperfect enforcement is provided by Bengui and Bianchi (2018).

[2] Albagli et al (2019) and Gilchrist et al (2020) provide empirical evidence of US monetary policy spillovers to international bond markets. See also Mohan and Kapur (2014) for a review of the channels through which monetary policy in advanced economies spills over to emerging market economies.

[3] Akinci and Olmstead-Rumsey (2018) provide empirical evidence that macro-prudential policy is indeed effective in curbing credit growth. Using data from Brazil, Forbes et al. (2016) also show that taxes on foreign investment in bonds causes significant decreases in portfolio allocations to Brazil. Last Coman and Lloyd (2019) suggest that tight prudential policies can reduce spill-overs to emerging market economies from US monetary tightening shocks.

trades. In particular, such unilateral actions by the periphery do not take into account the impact on the core, who responds by tightening its own domestic policies. In doing so, the core partly offset the benefits for the periphery in terms of narrowing the wedge between the actual lending conditions and those that are optimal for the periphery.

In my model, regulators in the core and the periphery can therefore achieve better outcomes by setting regulatory policies cooperatively, taking into account the effect that their respective actions have on each other. In the cooperative equilibrium, policymakers in both regions internalize the externality whereby limiting the ability to borrow ex ante imposes costs beyond their borders. As a result, under a cooperative-setting of regulatory policies, banks trade more and earn greater profits, while the wedge between effective lending conditions and those that would be optimal for the periphery is smaller.

From a modelling standpoint, I investigate the benefits of international coordination of regulatory policies in a two-period, two-region model of strategic interactions. In this model, banks invest in risky projects, which can pay early or late, and choose the optimal mix of ex ante and ex post borrowing. Returns on risky projects are negatively correlated across regions. As a result, banks can diversify by trading claims ex ante on the output of the risky projects, with banks from the other region. Alternatively, banks may raise funding ex post, i.e. once uncertainty on the timing of risky projects' output has been resolved. Banks whose risky projects pay late can then borrow from banks whose risky projects pay early. Turning to policymakers, they set regulation policy by putting a cap on domestic banks ex ante borrowing. They also set the return on ex post lending (lending conditions). Yet, because perfect arbitrage on market for ex post funding, one region—the periphery—can be priced out and thereby lose *direct* control over domestic lending conditions.

In this framework, policymakers typically set easier—cheaper—lending conditions ex post when domestic banks have borrowed more ex ante. This is because at the equilibrium, ex ante borrowing is more expensive when ex post lending conditions are tighter. Yet, this can give rise to a trade-off for regulatory policy in the periphery. On the one hand, allowing domestic banks to borrow more ex ante raises profits as claims issued ex ante can be sold at a high price, given their diversification properties. On the other hand, more borrowing by banks in the periphery implies less borrowing by banks in the core, which can lead to a—

possibly undesirable—tightening in global lending conditions ex post.[4]

Using this model, I derive two main analytical results. First, when ex post lending conditions are determined non-cooperatively, coordinating regulatory policies delivers a Pareto improvement. In this equilibrium, global lending conditions depend on ex ante borrowing by banks in the core, while the periphery is priced out. To regain some control over global lending conditions, the periphery then tightens regulatory policy on domestic banks. This way, it ensure banks in the core can borrow larger amounts ex ante so that global lending conditions ease. However doing so creates a negative externality on the core because at the equilibrium, ex ante borrowing from the core falls when the periphery reduces ex ante borrowing. As a result, the gains for the periphery from tighter regulation policy are partly offset. Internalising this externality through coordinated regulatory policies can therefore lead to better outcomes for both the core and the periphery.

Second, when ex post lending conditions are determined cooperatively, there are no gains to coordinating regulatory policies. In this equilibrium, global lending conditions depend on banks' *global* borrowing. However, each regional policymaker only controls *domestic* bank borrowing.[5] As a result, the opportunity cost of easing ex post lending conditions—by limiting domestic ex ante borrowing—becomes too large. The optimal regulatory policy then consists in allowing banks to borrow ex ante as much as possible.

Last, I parametrize the model to quantify cooperation gains. I start with the global economy and then slice and dice these gains by region and policy. First, the median gain of moving from Nash to cooperative policies is slightly above 1%. Second, cooperation gains are asymmetric: in the core, the median gain is about 0, but in the periphery, it is around 2%. Third, gains from coordinating global lending conditions are larger than gains from coordinating regulatory policies. However, only the latter are positive for both regions. Coordinating regulation policies can therefore mitigate the inefficiency that arises when global lending conditions are determined non-cooperatively, while making all regions better-off.

This paper relates to three different strands of literature: the literature investigating gains to cross-border policy coordination; the literature documenting the impacts of monetary and macro-prudential policies; and

[4] In addition to the usual role assigned to financial regulation policy in ensuring banking and financial stability, the model stresses the trade-off facing policymakers in controlling lending conditions at the cost of possibly limiting beneficial trades with the rest of world.

[5] Pushing the argument to the limit, if there were a large number of equal-size economies, policy maker in each economy would have virtually no influence on global lending conditions, which would end up being "almost" exogenous.

the literature modelling liquidity provision.

First, benefits from monetary policy cooperation have been shown to be rather limited (Obstfeld and Rogoff 2002). By contrast, the literature on financial regulatory policy coordination, which is much thinner (Bengui (2014)), provides less definitive conclusions. In addition, understanding how the benefits to regulatory policy cooperation depend on the conduct of other policies is still largely unexplored territory.

Second, a body of empirical evidence has highlighted the cross-border spillovers of monetary policies. For instance, US monetary policy has been shown to affect GDP, sovereign yields and capital flows in and out of emerging market economies (see Fratzscher et al. (2014); Bowman et al. (2015); Iacoviello and Navarro (2018); Kalemli-Özcan (2019) or Kolasa and Wesolowski (2020) among others). In addition, macro-prudential and capital flow management policies have been shown to be effective in curbing domestic credit growth (see Cerutti et al. (2017); Akinci and Olmstead-Rumsey (2018) or Bruno et al. (2017)).

Last, my paper relates to the literature modelling liquidity provision. It builds on the Hölmstrom and Tirole (1998) framework where firms may need outside liquidity to face aggregate shocks. In my model, outside liquidity is provided by the rest of the world and gives rise to mutually advantageous cross-border capital flows. My modelling of policies builds in turn on Jeanne and Korinek (2020), where regulatory policy comes ex ante as a constraint on agents' choices, while lending conditions determine the cost of ex post funding. Unlike recent papers, which have highlighted the aggregate demand externalities associated with borrowing choices (see Farhi and Werning (2016) and Korinek and Simsek (2016)), my mechanism rather hinges on a cross-border externality in borrowing choices that is closer to the traditional pecuniary externality approach of the international finance literature (see Gromb and Vayanos (2002), Caballero and Krishnamurthy (2003), Lorenzoni (2008), Jeanne and Korinek (2010) or Stein (2012)).

The road map for the paper is as follows. The next section presents the analytical framework. I derive in section 3 the decentralized equilibrium for given lending conditions and regulatory policies. Then section 4 determines optimal lending conditions under the Nash and the cooperative equilibria, while section 5 investigates optimal regulatory policies with and without cooperation. Section 6 provides a quantification of cooperation gains and conclusions are finally drawn in section 7.

2 Timing and Technology

2.1 Framework

I consider a single good, world economy consisting of two regions—denoted c and p (core and periphery)—lasting for three dates, 0; 1 and 2. In each region, there is a unit measure of risk neutral banks maximizing date-2 expected profits.

At date 0, banks start with a unit endowment and invest in a risky project. A unit investment in a risky project returns a unit of output at date 1 with a probability $\frac{1}{2}$ but no output with a probability $\frac{1}{2}$. Projects which do not deliver at date 1 can still deliver output at date 2 if reinvestment takes place at date 1 and reinvestment has a unit return. Returns to risky projects are observable, verifiable and perfectly correlated *within* regions, but imperfectly correlated *across* regions. For the sake of simplicity and without loss of generality, I impose that when risky projects deliver output at date 1 in one region, then they do not deliver anything in the other region. Banks whose risky projects do not deliver at date 1 are called *distressed;* those whose risky projects pay-off at date 1 are called *intact*.

At date 0, banks can trade claims with banks from the other region. I denote A^i the assets banks from region $i = \{c, p\}$ hold on banks from the other region and L^i the liabilities banks from region i owe to banks from the other region. Banks are limited in the amount of liabilities they can issue at date 0: liabilities L^i cannot exceed a fraction μ^i of date-0 investment, $L^i \leq \mu^i \left(1 + L^i - A^i\right)$, where μ^i is a policy choice (*regulatory policy*).

At date 1, uncertainty is resolved. Intact banks—say from region i—then pay a return R_1^i on liabilities L^i issued at date 0. However, distressed banks only earn βR_1^i, with $\beta < 1$, as resources $(1 - \beta) R_1^i$ are devoted to cover costs associated with the settlement of cross-border claims issued ex ante. Conversely, distressed banks make no payment to intact banks for the liabilities issued ex ante.[6] In addition, a market for ex post funding opens where distressed banks can raise funds to finance reinvestment, although subject to a borrowing limit. A distressed bank—say from region i—can raise an amount $D^i \leq 1 - \lambda^i$ $(0 < \lambda^i < 1)$ at a

[6] In Appendix, I examine the case where banks issue contingent debt instead of risk sharing liabilities and show that the main results still hold in this more general framework.

cost denoted R_2^i.[7] However, intact banks always have the option of parking their funds in one of the deposit facilities, available in each region. Depositing in region i yields a return r^i, which policymakers in region i can set freely (*lending condition policy*).[8].

2.2 Timing

First, regulatory policy and financial conditions are announced in each region. Policymakers set their decision on the maximum amount of liabilities domestic banks can issue at date 0 before they set the return on their deposit facilities. To simplify the analysis we will consider that decisions on ex post lending conditions are made ex ante at date 0 under perfect commitment.[9,10] Second, banks take lending and borrowing decisions: they decide the liabilities L^i to issue, the assets A^i to hold on the banks from the other region and invest in their risky projects. Third, uncertainty is resolved, risky projects deliver output in one region, intact banks pay to distressed banks $R_1^i L^i$.

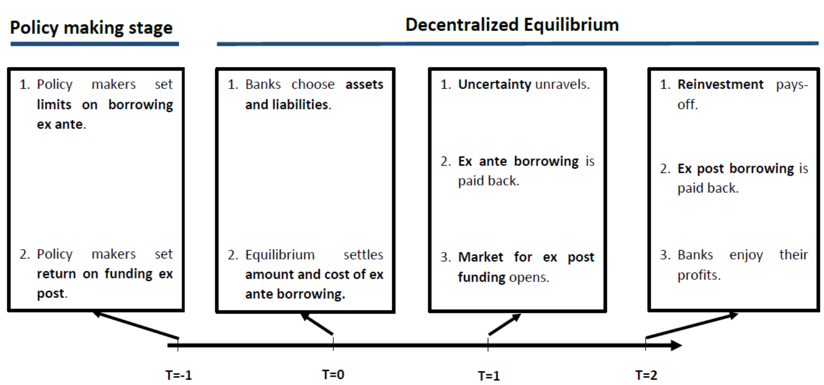

Figure 1: Timing of the model

[7] Assuming a fixed borrowing capacity on the market for ex post funding avoids unnecessary complications. For instance, when banks' borrowing capacity depends positively on their internal funds, then there can be multiple equilibria: If banks in one region hold a large (small) amount of assets on banks from the other region, then they would have a large (small) amount of internal funds for reinvestment. As a result they would be able to borrow large (small) amounts when in distress, which would lead to tight (easy) lending conditions ex post and validate the need for banks to hold large (small) amounts of cross-border assets.

[8] Note that limiting to date 1 banks' access to deposit facilities ensures that policy makers can affect the cost of capital -through changes in the return to the deposit facility- without having full control on it.

[9] Regulatory policy decisions are naturally taken ex ante, at date 0, before uncertainty is resolved. Conversely, interest rate decisions can be made either at date 0 or at date 1. In practise, lending conditions being set in response to shocks affecting the economy, it seems natural in the context of the model to assume that regulatory policy is decided before lending conditions.

[10] In appendix, I relax the assumption that lending conditions are set at date 0, to allow for state-contingent lending conditions and show that the logic of the model is preserved when two conditions are (i) policymakers in the core face a quadratic cost in setting lending conditions that deviate from a "natural" interest rate and (ii) this "natural" interest rate is decreasing in domestic bank ex ante borrowing.

The market for ex post borrowing opens: distressed banks borrow up to $1-\lambda^i$ from intact banks and reinvest. Last, risky projects of distressed banks deliver output, distressed banks pay back intact banks for ex post borrowing and banks from both regions enjoy their profits.

3 The decentralized equilibrium

Solving the model starts by determining the decentralized equilibrium and its properties. Once this is established, I work out the optimal lending condition assuming a Nash or a cooperative equilibrium. Then assuming a given equilibrium for lending conditions, I look at optimal regulatory policies. Here again, I consider the Nash and the cooperative solutions.

3.1 Optimal portfolio allocation decisions.

At date 0, banks from region i borrow L^i from banks from the other region, and invest A^i in risky projects run by banks from the other region. As a result, they invest $1 + L^i - A^i$ in their own risky project. At date 1, with a probability $\frac{1}{2}$, they reap $1 + L^i - A^i$, pay $R_1^i L^i$ to banks from the other region and earn date-1 profits:

$$\Pi_1^i = 1 + L^i - A^i - R_1^i L^i \tag{1}$$

Intact banks have no investment opportunity between date 1 and date 2. They hence lend the amount Π_1^i on the market for ex post funding and earn $\Pi_1^i R_2^{-i}$ at date 2.

Alternatively, with a probability $\frac{1}{2}$, they do not reap any output nor pay anything to banks from the other region. But, they can enjoy the proceeds of the assets A^i held on banks from the other region and use these funds to reinvest. Combined with borrowing D^i, they can reinvest $\beta R_1^{-i} A^i + D^i$, so that the date-2 profits then write as

$$\Pi_2^i = \beta R_1^{-i} A^i + \left(1 - R_2^i\right) D^i \tag{2}$$

Let us now determine ex post borrowing D^i. On the market for ex post funding, distressed banks borrow up to the limit but only if it is profitable, i.e. $D^i = \left(1 - \lambda^i\right) \mathbf{1}\left[R_2^i \leq 1\right]$ while intact banks lend only if the return exceeds that of the deposit facilities, i.e. $R_2^i \geq \max\left(r^i; r^{-i}\right)$. Assuming the two conditions—$\max\left(r^i; r^{-i}\right) \leq R_2^i \leq 1$—are met, banks choose at date 0 the assets A^i and the liabilities L^i they want to exchange with banks from the other region, solving:

$$\begin{gathered}\max_{A^i;L^i} \left(1 - A^i + \left(1 - R_1^i\right) L^i\right) R_2^{-i} + \beta R_1^{-i} A^i + \left(1 - R_2^i\right)\left(1 - \lambda^i\right) \\ \text{s.t. } 0 \leq A^i \leq 1 + L^i \text{ and } L^i \leq \mu^i \left(1 + L^i - A^i\right)\end{gathered} \tag{3}$$

Banks cannot buy assets A^i in excess of their total resources $1 + L^i$, hence the constraint $0 \leq A^i \leq 1 + L^i$ and they have to comply with the constraint $L^i \leq \mu^i \left(1 + L^i - A^i\right)$ imposed by policymakers that limits the liabilities L^i they can issue ex ante.[11] Denoting $m^i = \mu^i / \left(1 - \mu^i\right)$, banks' asset purchases A^i and liability issuance L^i then satisfy:

$$A^i = \mathbf{1}\left[\beta R_1^{-i} > R_2^{-i}\right]\left(1 + L^i\right) \text{ and } L^i = \mathbf{1}\left[R_1^i \leq 1\right] m^i \left(1 - A^i\right) \tag{4}$$

Banks choose to hold claims on risky projects of banks from the other region when the marginal benefit of holding such claims is larger than the opportunity cost of doing so, hence the condition $\beta R_1^{-i} > R_2^{-i}$. Similarly, banks choose to issue liabilities L^i when the cost of doing so is lower than the return on risky projects, hence the condition $R_1^i \leq 1$.

3.2 Equilibrium of the market for ex post funding.

Let us assume banks from region i are distressed. Then given that banks are homogeneous, the equilibrium on the market for ex post funding at date 1 writes as

$$1 + L^{-i} - A^{-i} - \beta R_1^{-i} L^{-i} = 1 - \lambda^i \tag{5}$$

[11] A micro-foundation for the constraint on ex bank ante borrowing can be as follows. Suppose banks when intact can default strategically on liabilities issued at date 0, in which case they pay back only a fraction p of their liabilities but lose a fraction τ^i of the return, τ^i being a policy parameter. The incentive constraint precluding default then writes as $(1-p) R_1^i L^i \leq \left(1 - A^i + L^i\right)\tau^i$. Moreover, to recover a fraction p of their assets, creditors need to pay $\theta \ln\left[\frac{1}{1-p}\right]$. As a result, creditors choose p such that $(1-p) R_1^i = \theta$ and the incentive constraint writes as $L^i \leq \mu^i \left(1 - A^i + L^i\right)$ where $\mu^i = \tau^i/\theta$.

On the left hand-side of (5) lies the supply for funds from intact banks while the demand for funds from distressed banks is on the right hand side of (5).[12] As noted above, intact banks lend and distressed banks borrow provided the conditions $\max\left(r^i;r^{-i}\right) \leq R_2^i \leq 1$ hold. Hence using the property that the liabilities of banks from one region are the assets of the banks from the other region, i.e. $L^i = A^{-i}$, the equilibrium cost of ex post funding R_2^i satisfies:

$$R_2^i = \begin{cases} 1 \text{ if } L^i > \lambda^i + \left(1 - \beta R_1^{-i}\right) L^{-i} \\ \max\left(r^i;r^{-i}\right) \text{ if } L^i \leq \lambda^i + \left(1 - \beta R_1^{-i}\right) L^{-i} \end{cases} \tag{6}$$

The cost R_2^i for banks from region i of raising funds ex post therefore increases when they collectively issue more liabilities L^i ex ante but decreases when banks from the other region collectively issue more liabilities L^{-i}. When banks in a region issue a large amount of liabilities ex ante and turn out to be distressed, the amount of funding that banks from the other region can supply is lower and hence the cost to raise funding ex post is higher.

3.3 Characterizing the decentralized equilibrium

We can now determine the equilibrium as a function of the primitives of the models, $(r^c;r^p)$ and $(m^c;m^p)$, making use of the expressions (4) for optimal bank ex ante lending and borowing and the expression (6) for the cost of ex post funding.

Proposition 1 *Assuming* $\max\left(r^c;r^p\right) \leq \beta$, *there is a unique decentralized equilibrium where*

(i) The return to cross-border assets and the cost of ex post funding are equalized:

$$\beta R_1^c = R_2^c \text{ and } \beta R_1^p = R_2^p \tag{7}$$

[12] The implicit assumption in the equilibrium condition (5) is that the resources $(1-\beta) R_1^{-i} L^{-i}$ devoted to cover the costs associated with the settlement of the cross-border risk sharing claims are incurred at the end of date 2. And assuming perfect competition, the marginal cost of settlement operations would equate the cost of ex post funding R_2^i.

(ii) The regulatory constraints on ex ante borrowing are binding:

$$L^c = m^c \frac{1-m^p}{1-m^c m^p} \text{ and } L^p = m^p \frac{1-m^c}{1-m^c m^p} \tag{8}$$

(iii) The market for ex post funding is in excess supply:

$$R_2^c = R_2^p = \max\left(r^c; r^p\right) \text{ and } L^c \leq \lambda^c + (1-r)\, L^p \text{ and } L^p \leq \lambda^p + (1-r)\, L^c \tag{9}$$

Proof. cf. appendix ■

The decentralized equilibrium has three important properties. First returns on ex post lending and returns on assets issued ex ante are equalised, i.e. $\beta R_1^c = R_2^c$ and $\beta R_1^p = R_2^p$. For instance, if banks—say from the core— invest in their own risky assets and turn out to be intact, they can lend on the market for ex post funding at date 1 and reap a final return R_2^p. Alternatively, if they buy assets on banks from the periphery and turn out to be distressed, they can use the proceeds βR_1^p for reinvestment in which case the final return is βR_1^p. Indifference between domestic investment and foreign asset holdings then requires that returns are equalized.

Second, there is excess supply on the market for ex post funding. To see this, note first that the demand and supply for ex post funding being piece-wise inelastic, the market for ex post funding is either in excess supply or excess demand. Now in case of an excess demand for ex post funding, the cost of ex post funding would be equal to one and banks would not issue any liability ex ante: it would cost $1/\beta$ and banks issuing such claims would be making losses. But if banks do not issue any liability ex ante, then the borrowing capacity of distressed banks D^i cannot absorb the funding supply because $D^i = 1 - \lambda^i < 1$, since $\lambda^i > 0$. There can hence be no excess demand for ex post funding.

Last, given the excess supply in ex post funding, banks have incentives (i) to issue as many liabilities ex ante as policymakers allow for, and (ii) to hold as few assets on banks from the other region as possible. Indeed, when ex post funding is cheap, the opportunity cost of investing in risky projects of banks from the other region is relatively high. Similarly, because of the no-arbitrage condition between buying assets ex ante and borrowing ex post, when ex post funding is cheap, the cost of leveraging up ex ante is low and banks therefore leverage up ex ante as much as policymakers allow for. Finally, given the excess supply for ex post funding, the costs of ex post funding $(R_2^c; R_2^p)$ are determined by the returns on deposit facilities $(r^c; r^p)$ that policy makers choose.

4 Optimal lending conditions.

Let's now shift the focus to ex post lending conditions. To do so, we first consider the Nash equilibrium where each policymaker sets the return on their domestic deposit facility, with the aim to maximize domestic profits, taking as policymakers' actions in the other region. Second, we consider the cooperative equilibrium in which returns on deposit facilities are set to maximize global profits, i.e. the sum of expected profits of banks across the two regions.

4.1 Nash vs. cooperative equilibrium.

In the non-cooperative equilibrium, the problem for policymakers in region $i = \{c; p\}$ consists in choosing the return r^i to solve

$$\begin{gathered} \max_{r^i} \quad \pi^i\left(r^i\right) = \left[1 + \left(1 - \frac{r}{\beta}\right) L^i\right] r + (1 - r)\left(1 - \lambda^i\right) \\ \text{s.t.} \begin{cases} r = \max\left(r^i; r^{-i}\right) \text{ and } r^i; r^{-i} \leq \beta \\ L^i \leq \lambda^i + (1 - r) L^{-i} \text{ and } L^{-i} \leq \lambda^{-i} + (1 - r) L^i \end{cases} \end{gathered} \tag{10}$$

In the cooperative equilibrium, each policymaker still determines the optimal policy as a best response to the other policymaker's decision, the only difference being that policymakers now maximize a common criterion, i.e. the sum of bank regional expected profits. The problem then consists in choosing the returns r^i and r^{-i} which solve

$$\begin{gathered} \max_{r^c; r^p} \quad \pi^c\left(r^c\right) + \pi^p\left(r^p\right) \\ \text{s.t.} \begin{cases} r = \max\left(r^c; r^p\right) \text{ and } r^c; r^p \leq \beta \\ L^c \leq \lambda^c + (1 - r) L^p \text{ and } L^p \leq \lambda^p + (1 - r) L^c \end{cases} \end{gathered} \tag{11}$$

The following proposition details the cooperative and non-cooperative equilibrium in lending conditions:

Proposition 2 *Denoting* $\frac{\lambda_n}{L_n} = \max\left\{\frac{\lambda^c}{L^c}; \frac{\lambda^p}{L^p}\right\}$ *and* $\frac{\lambda_c}{L_c} = \frac{\lambda^c+\lambda^p}{L^c+L^p}$*, ex post lending conditions in the Nash equilibrium* (r_n) *and in the cooperative equilibrium* (r_c) *respectively write as*

$$r_s = \min\left\{\beta; \frac{\beta}{2}\left[1 + \frac{\lambda_s}{L_s}\right]\right\} \text{ for } s = \{n; c\} \tag{12}$$

and bank ex ante borrowing L^c *and* L^p *should satisfy*

$$L^c \leq \lambda^c + (1 - r_s)\, L^p \text{ and } L^p \leq \lambda^p + (1 - r_s)\, L^c \text{ for } s = \{n; c\} \tag{13}$$

Proof. In the Nash equilibrium, the return r^i which maximises expected profits π^i writes as

$$r^i = \max\left\{r^{-i}; \frac{\beta}{2}\left[1 + \frac{\lambda^i}{L^i}\right]\right\}$$

Similarly, in the cooperative equilibrium, the interest rate r^i which maximizes the sum of expected profits $\pi^c + \pi^p$ writes as

$$r^i = \max\left\{r^{-i}; \frac{\beta}{2}\left[1 + \frac{\lambda^c + \lambda^p}{L^c + L^p}\right]\right\}$$

Moreover, interest rates should satisfy $r^c; r^p \leq \beta$, so that the costs to issue liabilities ex ante satisfies $R_1^c; R_1^p \leq 1$. Hence, ex post lending conditions in the Nash and the cooperative equilibrium respectively writes as $r_s = \min\left\{\beta; \frac{\beta}{2}\left[1 + \frac{\lambda_s}{L_s}\right]\right\}$ for $s = \{n; c\}$. Last, applying proposition 1, this situation is an equilibrium if and only if bank ex ante borrowing L^c and L^p satisfy (13). ■

Policy makers setting returns on deposit facilities face a simple trade-off: a high return raises profits when banks are intact as they can then lend to distressed banks at a higher rate. But, it reduces the profits of banks when distressed, which face a higher funding cost. Moreover, a higher return also raises the cost to issue liabilities ex ante. This is why at the equilibrium—with or without cooperation—ex post lending conditions are easier (tighter) when banks have issued more (less) liabilities ex ante.

Moreover, as is visible from (12), ex post lending conditions in the Nash equilibrium are optimal for one region but are too tight for the other region. We will therefore call in what follows the former region "core" and the latter one "periphery". In this equilibrium, the core can directly affect ex post lending conditions while the periphery is priced out and can only affect lending conditions indirectly through ex ante borrowing choices. Conversely, lending conditions in the cooperative equilibrium are easier as they lie between the returns that each region would set individually. Moreover they depend on bank ex ante global borrowing, which both the core and the periphery can affect but only at the margin.

5 Optimal regulatory policy.

As stated above, policymakers can affect ex ante borrowing L^c and L^p by easing or tightening the borrowing constraint on banks through the parameters m^c and m^p.

5.1 Optimal regulatory policy with non-cooperative lending conditions.

With non-cooperative lending conditions, the expected profits $\pi^i\left(r_n; L^i\right)$ of banks from region i write as:

$$\pi^i\left(r_n; L^i\right) = 1 - \lambda^i + r_n\left[\lambda^i + \left(1 - \frac{r_n}{\beta}\right)L^i\right]$$

Then, with non-cooperative regulatory policies, the problem for policymakers in region i consists in solving:

$$\max_{m^i} \quad \pi^i\left(r_n; L^i\right)$$
$$\text{s.t.} \begin{cases} \frac{\lambda_n}{L_n} \leq 1 \text{ and } L^i = \frac{m^i\left(1-m^{-i}\right)}{1-m^i m^{-i}} \text{ and } L^{-i} = \frac{m^{-i}\left(1-m^i\right)}{1-m^i m^{-i}} \\ L^i \leq \lambda^i + (1-r_n)L^i \text{ and } L^{-i} \leq \lambda^{-i} + (1-r_n)L^i \end{cases} \tag{14}$$

Conversely, with non-cooperative regulatory policies, policymakers in each region choose m^c and m^p to solve

$$\max_{m^c;m^p} \quad \pi^c\left(r_n;L^c\right)+\pi^p\left(r_n;L^p\right)$$
$$\text{s.t.} \quad \begin{cases} \frac{\lambda_n}{L_n}\leq 1 \text{ and } L^c=\frac{m^c(1-m^p)}{1-m^c m^p} \text{ and } L^p=\frac{m^p(1-m^c)}{1-m^c m^p} \\ L^c\leq \lambda^c+\left(1-r_n\right)L^p \text{ and } L^p\leq \lambda^p+\left(1-r_n\right)L^c \end{cases} \tag{15}$$

Now, before describing optimal regulatory policies, let us derive the following lemma.

Lemma 3 *When ex post lending conditions are set non-cooperatively, then irrespective of how regulatory policy is conducted, region c is the core and region p is the periphery if and only if* $\lambda^c > \lambda^p$.

Proof. cf. appendix. ■

Policymakers set easier lending conditions when domestic banks are more leveraged. As a result, when banks' borrowing on the market for ex post funding is lower, i.e. the λ parameter is higher, then policymakers in this region sets tigher lending conditions and this region thereby becomes the "core". Now to fix ideas, we will assume throughout this section that $\lambda^c > \lambda^p$ so that region c is the core.[13] We can now turn to the analysis of regulatory policy, starting with the non-cooperative equilbrium and then moving to the cooperative equilibrium.

Proposition 4 *When lending conditions and regulatory policies are set non-cooperatively, then optimal bank ex ante borrowing satisfies*

$$L^c=\lambda^c+\left(1-r_n\right)L^p \text{ and } L^p=\min\left\{L_n^p;\lambda^p+\left(1-r_n\right)L^c\right\} \tag{16}$$

where

$$L_n^p=1-2\lambda^c\frac{\lambda^c-\lambda^p L^c}{\left(\lambda^c\right)^2+\left(L^c\right)^2}$$

[13]Note that for this reason, it is natural to assume that financial policy determines bank ex ante borrowing L rather than ex post borrowing λ. Otherwise, regulatory policy could set the ex post borrowing capacity strategically to be the core or the periphery region. In practise however, being part of the core or the periphery is not a policy choice, but rather some pre-determined, exogenous characteristic, hence the assumption that ex post borrowing capacities λ are exogenous and not amenable to policy.

Proof. In the core, expected profits of banks are strictly increasing in m^c:

$$\frac{\partial \pi^c}{\partial m^c} = \frac{\partial \pi^c}{\partial L^c}\frac{\partial L^c}{\partial m^c} + \underbrace{\frac{\partial \pi^c}{\partial r_n}}_{=0}\frac{\partial r_n}{\partial L^c}\frac{\partial L^c}{\partial m^c} > 0 \tag{17}$$

Allowing banks in the core to borrow more increases their profits because borrowing is profitable. Moreover when banks in the core borrow more, policymakers ease ex post lending conditions by setting a lower return r_n. However this has no effects on banks' expected profits given that r_n is by definition the profit maximizing ex post return. Policy makers in the "core" region therefore always choose to maximize bank borrowing L^i:

$$L^c = \lambda^c + (1 - r_n) L^p \tag{18}$$

Conversely, in the periphery, a change in the parameter m^p affects banks' expected profits in two opposite ways:

$$\frac{\partial \pi^p}{\partial m^p} = \underbrace{\left(1 - \frac{r_n}{\beta}\right) r_n \frac{\partial L^p}{\partial m^p}}_{>0} + \underbrace{\left[\lambda^p + \left(1 - \frac{2}{\beta} r_n\right) L^p\right] \frac{\partial r_n}{\partial L^c}\frac{\partial L^c}{\partial m^p}}_{<0}$$

When policymakers in the periphery allow domestic banks to borrow more, this has a direct positive impact on expected profits. But, at the same time, there also has an indirect negative impact: When periphery banks borrow mor ex ante, core banks have to cut borrowing L^c. This tightens ex post lending conditions r_n and reduces expected profits for banks in the periphery as ex post lending conditions in the Nash equilibrium r_n are too tight for banks from the periphery. Given these two opposite effects, optimal regulatory policy in the periphery is such that:

$$\frac{\partial \pi^p}{\partial m^p} = \frac{\beta}{4}\left[1 - \left(\frac{\lambda^c}{L^c}\right)^2 - 2\left[\frac{\lambda^c}{L^c} - \frac{\lambda^p}{L^p}\right]\frac{\lambda^c}{L^c}\frac{L^p}{1 - L^p}\right]\frac{\partial L^p}{\partial m^p} = 0 \tag{19}$$

And simplifying the first-order condition (19), optimal bank borrowing in the periphery satisfies

$$\left(\frac{L^c}{\lambda^c}\right)^2 = 1 + 2\frac{L^p - \lambda^p \frac{L^c}{\lambda^c}}{1 - L^p} \tag{20}$$

Denoting L_n^p the value of L^p which satisfies (20), optimal bank borrowing in the Nash equilibrium satisfies

$$L^c = \lambda^c + (1 - r_n) L^p \text{ and } L^p = \min \{L_n^p; \lambda^p + (1 - r_n) L^c\} \tag{21}$$

■

In this equilibrium, policy makers in the periphery trade-off the benefits of larger borrowing against the cost of tighter lending conditions. When regulatory policy is loosened in the periphery, banks in the core have to cut their borrowing and this tightens global ex post lending conditions, which -in the Nash equilibrium- are already too tight for banks from the periphery. As a result, tighter lending conditions reduce expected profits of periphery banks. For this reason, policymakers in the periphery prefer to restrict bank borrowing even if this precludes some profitable trade because restricting bank borrowing contributes to ease global lending conditions and hence raise domestic bank profits. Let us now look at regulatory policies in the cooperative equlibrium.

Proposition 5 *When regulatory policies are set cooperatively, under the assumption of non-cooperative lending conditions, bank ex ante borrowing satisfies*

$$L^c = \lambda^c + (1 - r_n) L^p \text{ and } L^p = \lambda^p + (1 - r_n) L^c \tag{22}$$

Proof. Easing regulatory policy in the core raises global expected profits $\pi^c + \pi^p$:

$$\frac{\partial (\pi^c + \pi^p)}{\partial m^c} = \frac{\beta}{4} \left[\left(1 - \left[\frac{\lambda^c}{L^c} \right]^2 \right) (1 - m^p) + 2 \left[\frac{\lambda^c}{L^c} - \frac{\lambda^p}{L^p} \right] \frac{L^p}{L^c} \frac{\lambda^c}{L^c} \right] \frac{\partial L^c}{\partial m^c} > 0 \tag{23}$$

When policymakers in the core allow domestic banks to borrow more, global bank borrowing $L^c + L^p$ increases and so do global expected profits. Moreover lending conditions are too tight for the global economy, i.e. $\frac{\partial(\pi^c+\pi^p)}{\partial r^n} < 0$. Larger borrowing by banks in the core, insofar as it contributes to ease lending conditions r_n, hence further contributes to increase global expected profits. Optimal regulatory policy in the core therefore consists in maximizing domestic bank ex ante borrowing:

$$L^c = \lambda^c + (1 - r_n) L^p \tag{24}$$

Turning to optimal regulatory policy in the "periphery" region, let us assume it is an *interior* solution. In this case, it should be such that:

$$\frac{\partial (\pi^c + \pi^p)}{\partial m^p} + \frac{\partial (\pi^c + \pi^p)}{\partial m^c} \frac{dm^c}{dm^p} = 0 \text{ with } \frac{dm^c}{dm^p} = \frac{1 - m^c}{1 - m^p} B \text{ and } B = \frac{1 - r_n + \left(1 + \frac{\partial r_n}{\partial L^c} L^p\right) m^c}{(1 - r_n) m^p + 1 + \frac{\partial r_n}{\partial L^c} L^p} \tag{25}$$

the second expression measuring how policymakers in the core respond to a change in regulatory policy in the periphery along the optimal policy path $L^c = \lambda^c + (1 - r_n) L^p$. Then using the expressions for $\frac{\partial(\pi^c+\pi^p)}{\partial m^c}$ and $\frac{\partial(\pi^c+\pi^p)}{\partial m^p}$, the first order condition (25) simplifies as

$$1 - \left[\frac{\lambda^c}{L^c}\right]^2 = -2 \left[\frac{\lambda^c}{L^c} - \frac{\lambda^p}{L^p}\right] \frac{L^p}{L^c} \frac{\lambda^c}{L^c} \frac{B - m^c}{1 - m^c + (1 - m^p) B}$$

Yet given that $B > m^c$ (recall that $m^c m^p < 1$), this condition would imply that $L^c < \lambda^c$, which is not possible given that we have $L^c = \lambda^c + (1 - r_n) L^p > \lambda^c$. There is hence no regulatory policy in the periphery that maximizes global expected profits $\pi^c + \pi^p$ **and** is an interior solution. Optimal regulatory policy in the "periphery" is therefore necessarily a corner solution. It is then straightforward to note that maximising bank ex ante borrowing is the optimal choice for policymakers in the periphery. Optimal regulatory policies under cooperation therefore satisfy

$$L^c = \lambda^c + (1 - r_n) L^p \text{ and } L^p = \lambda^p + (1 - r_n) L^c \tag{26}$$

And one can check that under such a solution we have $\frac{\partial(\pi^c+\pi^p)}{\partial m^p} + \frac{\partial(\pi^c+\pi^p)}{\partial m^c} \frac{dm^c}{dm^p} > 0$ so that the constraint $L^p \leq \lambda^p + (1 - r_n) L^c$ is effectively binding. ■

Under cooperative regulatory policies, bank ex ante borrowing is larger and lending conditions are easier relative to the Nash equilibrium. To understand why, recall that lending conditions are optimal for banks in the core, but too tight for banks in the periphery. As a result, with non-cooperative regulatory policies, the periphery restricts domestic bank borrowing with the aim that this will help banks in the core to increase ex ante borrowing, which will give policymakers in the core incentives to ease ex post lending conditions. In the non-cooperative equilibrium, regulatory policymakers in the periphery therefore trade off the benefits of larger domestic bank borrowing against the cost of suboptimal lending conditions.

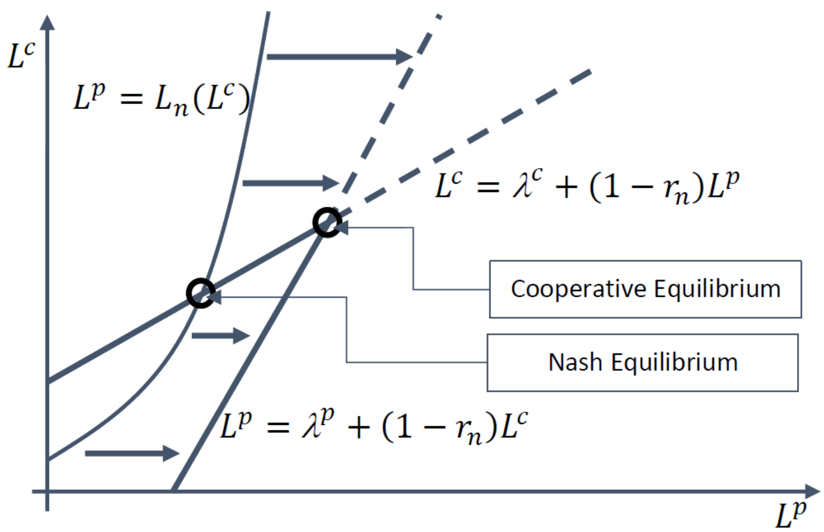

Figure 2: Optimal financial policies under non-cooperative interest rate policies.

But under cooperation, policymakers in the periphery internalise that borrowing by banks from the core is positively and not negatively correlated with borrowing by banks from the periphery. When banks in the periphery increase ex ante borrowing, banks in the core are better diversified and being better diversified, they can in turn increase their ex ante borrowing. As banks in the core borrow more ex ante, policymakers in the core set easier lending conditions ex post, which is precisely what policymakers in the periphery trying to achieve in the Nash equilibrium, by restricting domestic bank borrowing. In other words, policymakers realise in the cooperative equilibrium that easing funding conditions is best achieved by allowing domestic banks to borrow more not less.

5.1.1 Gains to cooperative regulatory policies.

Let us denoting π_c^i (resp. π_n^i) expected profits of banks from region i under cooperative regulatory policies (resp. under Nash regulatory policies). Then expected profits for banks in the core under cooperation write as:

$$\pi_c^c = \pi_n^c + \frac{\beta}{4}\left[1 - \frac{\lambda^c}{L_n^c}\frac{\lambda^c}{L_c^c}\right](L_c^c - L_n^c) \tag{27}$$

where L_c^c (resp. L_n^c) represents ex ante borrowing by banks from the core under cooperative (resp. non-cooperative) regulatory policies. Turning to the case of banks in the periphery, expected profits under cooperation write as:

$$\pi_c^p = \pi_n^p + \frac{\beta}{4}\left[1 - \frac{\lambda^c}{L_n^c}\frac{\lambda^c}{L_c^c}\right](L_c^p - L_n^p) + \frac{\beta}{4}\frac{\lambda^c}{L_n^c}\left[\left(\frac{\lambda^c}{L_n^c} - \frac{\lambda^p}{L_n^p}\right)L_n^p + \left(\frac{\lambda^c}{L_c^c} - \frac{\lambda^p}{L_c^p}\right)L_c^p\right](L_c^c - L_n^c) \tag{28}$$

As is visible from (27) and (28), both banks in the core and bank in the periphery are strictly better-off under cooperative regulatory policies. But unlike banks in the core whose profits increase exclusively because of increased borrowing, banks in the periphery also derive benefits from the easing in global lending conditions (captured by the second term on the right hand side of (28)).

5.2 Optimal regulatory policy with cooperative lending conditions.

We now move to study regulatory policies when lending conditions are set cooperatively. When lending conditions are set cooperatively, policymakers setting regulatory policies cooperative choose the policy parameters m^c and m^p to solve:

$$\max_{m^c;m^p} \quad \pi^c(r_c; L^c) + \pi^p(r_c; L^p)$$
$$\text{s.t.}\begin{cases} L^c = \frac{m^c(1-m^p)}{1-m^c m^p} \text{ and } L^p = \frac{m^p(1-m^c)}{1-m^c m^p} \\ r_c = \frac{\beta}{2}\left(1 + \frac{\lambda_c}{L_c}\right) \text{ and } L_c \geq \lambda_c \\ L^c \leq \lambda^c + (1-r_n)L^p \text{ and } L^p \leq \lambda^p + (1-r_n)L^c \end{cases} \tag{29}$$

Proposition 6 *Denoting $\underline{r} = \frac{\beta}{2-\beta}$, when lending conditions and bank ex ante borrowing are determined* *cooperatively then optimal regulatory policies are such that L^c and L^p satisfy:*

$$L^c = \lambda^c + (1 - \underline{r}) L^p \text{ and } L^p = \lambda^p + (1 - \underline{r}) L^p \tag{30}$$

Proof. Using the expression for r_c, it is straightforward to note that global expected profits are increasing in both m^c and m^p. Policymakers in both regions maximize bank borrowing, i.e. $L^c = \lambda^c + (1 - r_c) L^p$ and $L^p = \lambda^p + (1 - r_c) L^c$. ■

In this equilibrium, policymakers choose to maximize bank ex ante borrowing because there is no trade-off between managing bank borrowing and managing global lending conditions: By definition, the latter maximizes global expected profits, i.e. $\frac{\partial(\pi^c + \pi^p)}{\partial r_c} = 0$. Increasing bank borrowing therefore always raises global profits as global lending conditions adjust so that global bank borrowing has no indirect impact on global expected profits. Policymakers therefore choose to maximize bank ex ante borrowing, which yields expression (30).

Let us now turn to optimal non-cooperative regulatory policies. Assuming cooperative lending conditions, policymakers in region i choose m^i to solve:

$$\max_{m^i} \quad \pi^i \left(r_c; L^i \right)$$
$$\text{s.t.} \begin{cases} L^i = \frac{m^i (1 - m^{-i})}{1 - m^i m^{-i}} \text{ and } L^{-i} = \frac{m^{-i} (1 - m^i)}{1 - m^i m^{-i}} \\ r_c = \frac{\beta}{2} \left(1 + \frac{\lambda_c}{L_c} \right) \text{ and } L_c \geq \lambda_c \\ L^i \leq \lambda^i + (1 - r_n) L^{-i} \text{ and } L^{-i} \leq \lambda^{-i} + (1 - r_n) L^{-i} \end{cases} \tag{31}$$

We can now derive the following proposition.

Proposition 7 *Denoting $\underline{r} = \frac{\beta}{2 - \beta}$, under cooperative lending conditions, optimal non-cooperative regulatory policy is such that policymakers still choose to maximize bank borrowing:*

$$L^c = \lambda^c + (1 - \underline{r}) L^p \text{ and } L^p = \lambda^p + (1 - \underline{r}) L^c \tag{32}$$

Proof. When policymakers in region i allow banks to increase borrowing, the change in expected profits writes as:

$$\frac{\partial \pi^i \left(r_c; L^i\right)}{\partial m^i} = r_c \left(1 - \frac{1}{\beta} r_c\right) \frac{\partial L^i}{\partial m^i} + \frac{\partial r_c}{\partial \left(L^i + L^{-i}\right)} \frac{\partial \left(L^i + L^{-i}\right)}{\partial m^i} \left[\lambda^i + \left(1 - \frac{2}{\beta} r_c\right) L^i\right] \tag{33}$$

The first term of the right hand side of (33), which represents the direct effect of borrowing on expected profits is always positive: allowing domestic banks to borrow more ex ante always raise, everything else equal, domestic banks' expected profits. But the second term, which represents the indirect effect of borrowing on profits—via the induced change in global lending conditions r_c—can be either positive or negative.

Let us consider as a working assumption that $\frac{\lambda^c}{L^c} > \frac{\lambda^p}{L^p}$. Under this assumption, the second term of (33) is positive for banks from the periphery but negative for banks from the core. Policy makers in the periphery therefore maximize domestic bank borrowing and choose m^p such that

$$L^p = \lambda^p + (1 - r_c) L^c \tag{34}$$

Conversely policymakers in the core face a trade-off: increasing bank borrowing has a direct positive effect on bank profits. However, increasing bank borrowing eases lending conditions r_c which reduces domestic profits because, lending conditions r_c are too easy for banks from the core. Now given that π^c is convex in m^c, policymakers in the core can choose either to minimize m^c, and set $L^c = \lambda^c + \lambda^p - L^p$, or to maximize m^c, and set $L^c = \min\left\{\lambda^c + (1 - r_c) L^p; \frac{\lambda^c}{\lambda^p} L^p\right\}$. Comparing expected profits under these two alternative options shows that maximizing m^c always yields larger expected profits. Hence policymakers in the core choose

$$L^c = \min\left\{\lambda^c + (1 - r_c) L^p; \frac{\lambda^c}{\lambda^p} L^p\right\} \tag{35}$$

Last policymakers in the core set $L^c = \lambda^c + (1 - r_c) L^p$ if and only if $\lambda^c + (1 - r_c) L^p \leq \frac{\lambda^c}{\lambda^p} L^p$ which simplifies as $\frac{\lambda^p}{L^p} \leq \frac{\lambda^c}{L^c}$ and is precisely our working assumption. A similar set of arguments can be developed under the opposite working assumption, i.e. $\frac{\lambda^c}{L^c} < \frac{\lambda^p}{L^p}$ to show that optimal non-cooperative regulatory policies, under cooperative lending conditions, always satisfy:

$$L^c = \lambda^c + (1 - \underline{r})\, L^p \text{ and } L^p = \lambda^p + (1 - \underline{r})\, L^c \tag{36}$$

■

When global lending conditions are determined cooperatively, ex post lending conditions is too tight for banks from one region but too easy for banks from the other region. When the inequality $\frac{\lambda^c}{L^c} > \frac{\lambda^p}{L^p}$ holds, the periphery typically faces too tight lending conditions ex post. As a result, there is no trade-off between allowing domestic banks to borrow more and easing global lending conditions as more borrowing leads to a easier lending conditions, both of which contribute to increase expected profits. But in the core, ex post lending conditions are too easy. As a result, policymakers do face a possible trade-off: allowing banks to borrow more, which has a positive direct effect on banks expected profits, also carries a negative indirect effect as larger bank borrowing eases global lending conditions even further and cuts domestic banks profits given that lending conditions are too easy from a domestic perspective. Yet, the previous result shows that policymakers always choose to maximize bank borrowing. Why? In the cooperative game, lending conditions depend on *global* bank borrowing, while each policymaker can only directly affect *domestic* bank borrowing. As a result, the cost of setting lending conditions in line with domestic needs becomes too large relative to the benefits of simply allowing banks to enjoy larger borrowing. This is why policymakers in the core prefer to maximize bank borrowing.

The conclusion is hence that under cooperative lending conditions, optimal regulatory policy —cooperative or non-cooperative— always consists in maximizing bank borrowing. In other words, with cooperative lending conditions, there are no gains to regulatory policy cooperation.

6 Quantifying the gains to policy coordination.

In this section, I parametrize the model to determine the size of cooperation gains, focusing on three parameters of the model. The first one is the parameter β which scales the friction on the market ex ante borrowing. The second and the third are respectively the parameters λ^c and λ^p, which determines how much banks can borrow ex post in each region. For each of these parameters I consider a range of possible values as follows. The β parameter scaling the friction on the market for ex ante borrowing ranges from 0.55 to 0.95. This means that between 5% and 45% of the return on assets traded on the market ex ante borrowing is paid by the issuer without being earned by the buyer. Turning to the parameters λ^c and λ^p, I assume that λ^c ranges between 0.4 and 0.8, while the parameter λ^p ranges between 0.0 and 0.4. This means that ex ante leverage for banks from the core is at least as high as 40% of initial capital and always exceeds that of banks from the periphery, the difference in ex ante leverage between the core and the periphery ranging between 0 and 80% of initial capital.

I first compare global expected profits under cooperative lending conditions and regulatory policies with global expected profits under Nash lending conditions and regulatory policies. Figure 3 plots the distribution of these gains for all possible combinations of the parameters $(\beta; \lambda^c; \lambda^p)$ within the ranges described above. Global gains range roughly from 0 to 4.5%, the median is around 1.1% and the inter-quartile range goes from around 0.5% to around 2%. Cooperation gains at the global level therefore tend to exhibit a relatively wide dispersion.

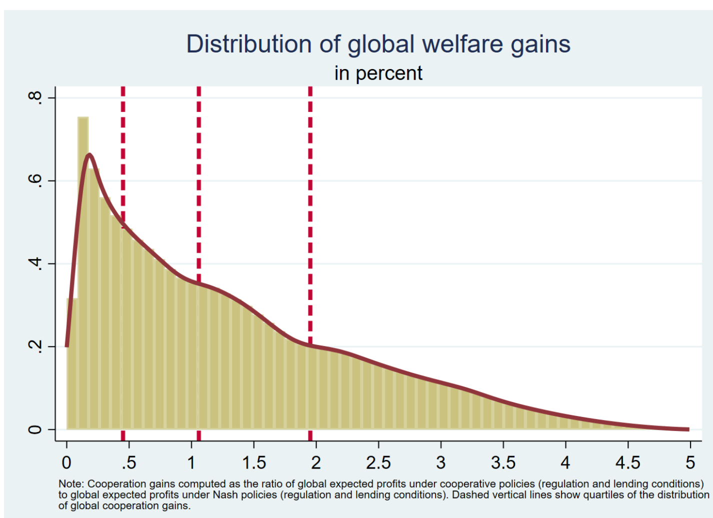

Figure 3: Distribution of global welfare gains.

I then decompose gains at the global level, first by region and then by policy. The left hand panel in Figure 4 shows that the periphery (green box) tends to enjoy significantly larger gains than the core. At the median, expected profits increase globally by 1.06% (average is 1.3%) but this increase overwhelmingly comes from the periphery (whose median gain stands at 1.8% for an average gain of 2.26%).

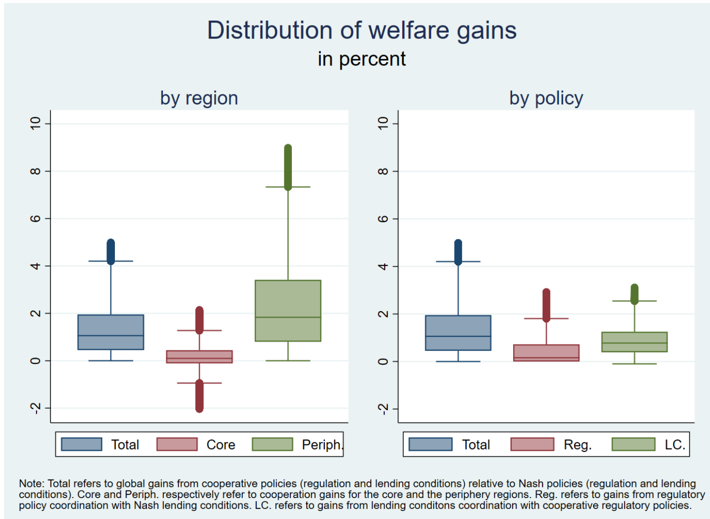

Figure 4: Distributions of welfare gains by region, by policy.

In the core, the median gain is only 0.10% (average at 0.16%). Moreover the core is actually worse-off under coordinated policies in more than one third of the different combinations of parameters (37.7% of the cases) with a an average loss of 0.28% (median at 0.19%). As highlighted above, the core can suffer losses because coordinating policies means it has to abandon its dominant role in setting lending conditions globally, which implies moving from domestically optimal to domestically suboptimal lending conditions. Secondly I decompose global cooperation gains by policy. The right hand panel in Figure 4 shows that global gains from coordinating lending conditions typically tend to outweigh those from regulatory policy coordination. For example the average global gain is about 1.30% (median is 1.06%). But the contribution of coordinating lending conditions is about two thirds of the total (0.87 percentage point), while that of regulatory policy coordination is only one third (0.43 percentage point).[14] This is not surprising: cooperating on lending conditions is optimal from a global perspective and makes the conduct of regulatory policy—Nash or cooperation—irrelevant. By contrast under non-cooperative lending conditions, cooperating on regulatory policy reduces the inefficiency of sub-optimal lending conditions from a global standpoint, but it does not

[14]Looking at medians, total welfare gains are even more reliant on gains from monetary policy coordination: the latter represent about 73% of the former (0.78% out of 1.06%).

eliminate it. This is why gains from coordinating lending conditions tend to outpace those from regulatory policy coordination at the global level.

Last, I look at cooperation gains across policies and regions. The left hand panel in figure 5 shows that the majority of the gains for the periphery (around 75%) come from coordinating lending conditions (1.62% out of 2.25% at the median) while regulatory polcy coordination only accounts for the remaining 25% (0.63% out of 2.25% at the median).

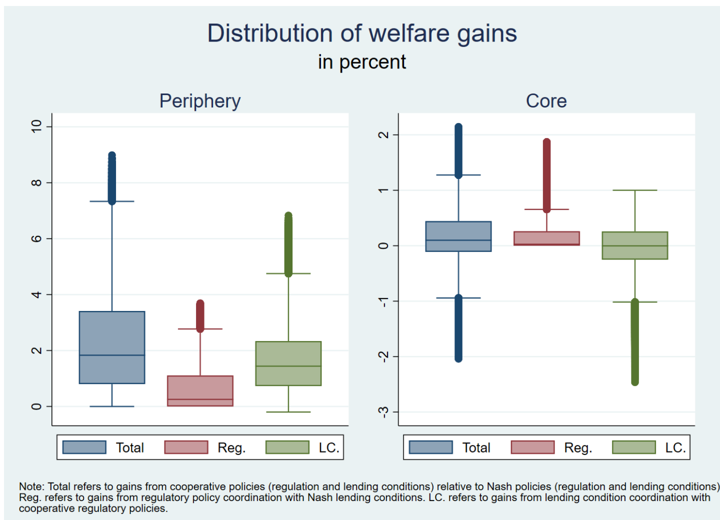

Figure 5: Welfare gains of policy coordination across regions.

Conversely, in the core region, gains are smaller and all come from regulatory policy coordination (+0.19% on average) while coordinating lending conditions yields no gain (-0.03% on average). These findings confirm the conclusion derived analytically: regulatory policy coordination unlike lending condition coordination is a Pareto improvement, it always raises expected profits both in the core and in the periphery.

7 Conclusions

This paper provides a theoretical model which underpins a new motive for coordinating regulatory policies across countries. When lending conditions are set non-cooperatively, regulatory policy can help policymakers regain some control over domestic lending conditions. Yet, by doing so, policymakers fails to internalize the implication of their choices on those of other regions, which leads inefficiently low levels ex ante borrowing.

Cooperating on regulatory policies can then improve the situation as countries then internalize the aforementioned cross-region externality. In addition, when lending conditions are set cooperatively, then Nash and cooperative regulatory policies are identical. Hence, in the absence of cooperation on lending conditions, coordinating regulatory policy is a second best that can deliver gains to all regions.

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Appendix: Proof of proposition 1.

Let us first show that the equilibrium is such that $\beta R_1^i = R_2^i$ and $\beta R_1^{-i} = R_2^{-i}$. For the equilibrium to hold, liabilities issued by banks in one region should equal the external assets banks from the other region are willing to hold, i.e. $L^i = A^{-i}$ and $L^{-i} = A^i$. Considering the first equality, given optimal portfolio choices:

$$L^i = \mathbf{1}\left[R_1^i \leq 1\right] m^i \left(1 - A^i\right) \text{ and } A^{-i} = \mathbf{1}\left[\beta R_1^i > R_2^i\right]\left(1 + L^{-i}\right)$$

there are there two cases to look at:

When $R_2^i \leq \beta$, then banks from region $-i$ are willing to buy assets A^{-i} even if the return R_1^i is below one. And when the return R_1^i is below one, banks from region i are indeed willing to borrow as much as possible from banks from region $-i$. Moreover given that $m^i\left(1 - A^i\right) \leq 1 + L^{-i}$, the amount of borrowing from banks of region i determines the equilibrium and we have $L^i = A^{-i} = m^i\left(1 - A^i\right)$, $\beta R_1^i = R_2^i$ and $R_1^i \leq 1$. Solving the equations $L^i = m^i\left(1 - L^{-i}\right)$ and $L^{-i} = m^{-i}\left(1 - L^i\right)$ then yields the amount claims issued at the equilibrium (8).

Conversely, if $R_2^i > \beta$, then the return R_1^i needs to be strictly above one for banks from region $-i$ to buy assets A^{-i}. But when the return R_1^i is above one, banks from region i do not issue any liability because it is too costly, $L^i = 0$. The equilibrium therefore takes place with no assets nor liabilities $A^{-i} = L^i = 0$, and any return R_1^i which satisfies $\beta < \beta R_1^i \leq R_2^i$ is consistent with this equillibrium.

Let us now show that the equilibrium on the market for ex post funding is such that $R_2^i = R_2^{-i} = \max\left(r^i; r^{-i}\right)$. Given that the demand and supply for ex post funding are piece-wise inelastic, the ex post funding costs $\left(R_2^i; R_2^{-i}\right)$ are equal to 1 or equal to $\max\left(r^i; r^{-i}\right)$. So let us assume that $R_2^i = 1$ and show that this cannot happen. When $R_2^i = 1$, following what has been established above, banks from region i do not issue any liabilities, i.e. $L^i = 0$. But if $L^i = 0$, then using (6), the cost of ex post funding cost R_2^i is indeed equal to one if and only if $\lambda^i + \left(1 - \beta R_1^{-i}\right) L^{-i} < 0$ which cannot hold because $\lambda^i > 0$ and $L^{-i} > 0$. The equilibrium of the market for ex post funding is necessarily such that $R_2^i = R_2^{-i} = r$ and that liabilities issued ex ante satisfy (9). And to the extent that $r \leq \beta$, the returns on such liabilities satisfy (7).

Appendix: Proof of lemma 3.

Let us first show that if region c is the core then the condition $\lambda^c > \lambda^p$ necessarily holds. If region c is the core, then policymakers in the core choose to maximize bank ex ante borrowing: $L^c = \lambda^c + (1 - r_n) L^p$ while ex ante borrowing by bank from the periphery necessarily satisfies $L^p \leq \lambda^p + (1 - r_n) L^c$. Moreover the condition $\frac{\lambda^c}{L^c} > \frac{\lambda^p}{L^p}$, under which region c is the core implies that ex ante borrowing by bank from the periphery necessarily satisfies $L^p > \frac{\lambda^p}{\lambda^c} L^c$. Using the expression for L^c, it is straightforward to show that the two inequalities $L^p \leq \lambda^p + (1 - r_n) L^c$ and $L^p > \frac{\lambda^p}{\lambda^c} L^c$, are not compatible unless $\lambda^c > \lambda^p$. Hence if region c is the core, then the inequality $\lambda^c > \lambda^p$ necessarily holds.

Conversely, if $\lambda^c > \lambda^p$, let us assume that region p is the core and show that this is impossible. If region p is the core, optimal policy in the "core" consists in maximising ex ante borrowing by banks: $L^p = \lambda^p + (1 - r_n) L^c$ while ex ante borrowing by banks from the periphery satisfied $L^c \leq \lambda^c + (1 - r_n) L^p$. In addition for region p to be the "core" we must have $L^c > (\lambda^c / \lambda^p) .L^p$. Using the expression for L^p, a necessary condition for the two inequalities $L^c \leq \lambda^c + (1 - r_n) L^p$ and $L^c > (\lambda^c / \lambda^p) .L^p$ to hold together is $(\lambda^p)^2 > (\lambda^c)^2 + (1 - r_n) \lambda^p \lambda^c$, which is not compatible with the working assumption that $\lambda^c > \lambda^p$. As a result, when $\lambda^c > \lambda^p$ then region c is necessarily the core.

Appendix: Allowing for state-contingent lending conditions.

The model assumes that policymakers announce at date 0 the return they propose on their respective deposit facilities between date 1 and 2, therefore setting lending conditions before uncertainty is resolved. This section proposes to relax this assumption and show that the main intuition of the model still goes through. In particular, the trade-off for policymakers in the periphery, between lending conditions and controlling bank ex ante borrowing still holds.

For this, I follow Farhi and Tirole (2012), assuming that the core, which sets lending conditions R_2 between date 1 and 2, undergoes a cost $\frac{\delta}{2} (R_2 - r^*)^2$ where r^* can be thought of as a natural rate. In addition, the natural rate r^* decreases with ex ante borrowing from banks from the core, i.e. $\partial r^* / \partial L^c < 0$.Turning to the periphery, consistent with the main framework, it has no direct control over lending conditions, which it can only influence through changes in ex ante borrowing choices. Last as a simplification, I assume that there is a lower bound on lending conditions, denoted r_m (with $r_m < \beta$). Denoting R_2^c (resp. R_2^p) the lending conditions when banks from the core (resp. from the periphery) are distressed, the problem in the non-cooperative game consists for the core, in choosing the returns R_2^c and R_2^p to solve:

$$\max_{R_2^c;R_2^p} \pi^c = \left(1 + L^c - \frac{1}{\beta} R_2^c L^c\right) R_2^p + \left(1 - R_2^c\right)\left(1 - \lambda^c\right) - \frac{\delta}{2}\left(R_2^c - r^*\left(L^c\right)\right)^2 - \frac{\delta}{2}\left(R_2^p - r^*\left(L^c\right)\right)^2$$

$$\text{s.t. } R_2^p; R_2^p \geq r_m$$

Using the first order conditions and assuming the lower bound r_m is such that for any L^c, we have $r^*\left(L^c\right) - \frac{1-\lambda^c}{\delta} < r_m < r^*\left(L^c\right)$, optimal ex post lending conditions then write as

$$R_2^c = r_m \text{ and } R_2^p = r^*\left(L^c\right) + \frac{\beta + \left(\beta - r_m\right) L^c}{\beta\delta}$$

$$R_2^c = r^*\left(L^c\right) - \frac{1-\lambda^c}{\delta} - \frac{L^c}{\delta\beta} R_2^p \text{ and } R_2^p = r^*\left(L^c\right) + \frac{1 + L^c}{\delta} - \frac{L^c}{\delta\beta} R_2^c$$

Consistent with a basic intuition, policymakers in the core choose to set easy lending conditions when domestic banks are distressed but tighter lending conditions when domestic banks are intact, i.e. $R_2^c < R_2^p$. Moreover, lending conditions when the periphery is distressed ease when banks in the core have borrowed more ex ante when

$$\frac{\partial r^*}{\partial L^c} + \frac{\beta - r_m}{\beta\delta} < 0$$

Then turning to regulatory policy, assuming the core and the periphery choose such policy non-cooperatively, the core chooses to maximise domestic banks ex ante borrowing when

$$\frac{d\pi^c}{dL^c} = \frac{\partial \pi^c}{\partial L^c} + \frac{\partial \pi^c}{\partial R_2^p} \frac{\partial R_2^{p\,c}}{\partial L^c} + \frac{\partial \pi^c}{\partial R_2^c} \frac{\partial R_2^c}{\partial L^c} > 0$$

Given that $\partial R_2^c / \partial L^c = 0$ and $\partial \pi^c / \partial R_2^p = 0$, this condition simplifies as

$$\frac{\beta - r_m}{\beta\delta} r^*\left(L^c\right) + \left[\frac{\partial r^*}{\partial L^c} + \frac{\beta - r_m}{\beta\delta}\right] \frac{\beta + \left(\beta - r_m\right) L^c}{\beta\delta} - \left(r^*\left(L^c\right) - r_m\right) \frac{\partial r^*}{\partial L^c} > 0$$

Conversely, in the periphery, policymakers face a meaningful trade-off: If domestic banks borrow more ex ante, then banks in the core have to borrow less, which implies tighter lending conditions when periphery banks are in distress. Banks' expected profits in the periphery write as

$$\pi^p = \left(1 + L^p - \frac{1}{\beta} R_2^p L^p\right) R_2^c + (1 - R_2^p)(1 - \lambda^p)$$

Then given that $\partial R_2^c / \partial L^c = 0$, expected profits of periphery banks increase with ex ante borrowing if and only if

$$\beta - R_2^p > \frac{\partial L^c}{\partial L^p} \frac{\partial R_2^p}{\partial L^c} \left[\frac{1 - \lambda^p}{r_m} + \frac{L^p}{\beta}\right]$$

Assuming R_2^p is linear in L^c, the left-hand side of the inequality is decreasing in L^p while the right-hand side is increasing in L^p. As a result there is a level of ex ante borrowing for periphery banks that maximises expected profitsm which satisfies

$$L^p = \frac{\beta}{1+\beta} \left[\frac{1}{m^c} \frac{\beta - \left(R + \frac{1}{\delta}\right)}{r^* - \frac{\beta - r_m}{\beta\delta}} + \frac{r_m - (1 - \lambda^p)}{r_m}\right]$$

and this optimal level of ex ante borrowing is an interior solution when

$$\frac{1}{m^c} \frac{\beta - \left(R + \frac{1}{\delta}\right)}{r^* - \frac{\beta - r_m}{\beta\delta}} < \left[\frac{1+\beta}{\beta} - \frac{1}{r_m}\right] \lambda^p$$

In other words, in the non-cooperative equilibrium, the core maximises domestic bank ex ante borrowing while the periphery limits domestic bank ex ante borrowing, because policymakers in the periphery trade-off the benefits of higher ex ante borrowing against the cost of tighter lending conditions when domestic banks end up in distress. Policymakers in the periphery therefore limit domestic banks ex ante borrowing to insulate the economy from tight lending conditions ex post.

Appendix: Considering the case of debt roll-over.

The model assumes that claims issued by banks ex ante are like equity claims insofar as they are subject to default when banks are in distress. In this section we propose to extend the model so that banks still have to honour such claims when they fall into distress. In practise, claims on distressed banks can be rolled-over at conditions similar to those prevailing on the market for ex post funding and paid back from reinvestment proceeds. Let us then show that that the situation where banks from both regions borrow from each other is the only possible decentralised equilibrium when the parameters satisfy $m^c > \lambda^c$ and $m^p > \lambda^p$.

To do so,consider a bank from region $i = \{c; p\}$ borrowing L^i and lending A^i at date 0 earns $1 - A^i + \left(1 - R_1^i\right) L^i$ at end of date 1 if intact. Moreover the claims A^i on banks from the other region which were supposed to be paid back with a return R_1^{-i} are rolled over at a rate R_2^{-i} given that banks from the other region are distressed. As a result, the intact bank from region i reaps $A^i R_1^{-i} R_2^{-i}$ at date 2, in addition to the product $\left(1 - A^i + \left(1 - R_1^i\right) L^i\right) R_2^{-i}$ coming from funds lent on the market for ex post funding. Conversely, when the bank from region i is distressed, it earns nothing at date 1 but can draw on the claims $\beta R_1^{-i} A^i$ it holds on banks from the other region while it can also borrow D^i on the market for ex post funding. Still once output from reinvestment is realized at date 2, the bank has to pay back not only $R_2^i D^i$ but also $R_2^i R_1^i L^i$ which corresponds to the liabilities issued ex ante that have been rolled-over at date 1. Expected profits for a bank from region i borrowing L^i and lending A^i at date 0 therefore write as

$$\pi^i = \left(1 - \left(1 - R_1^{-i}\right) A^i + \left(1 - R_1^i\right) L^i\right) R_2^{-i} + \beta R_1^{-i} A^i + D^i - R_2^i \left(D^i + R_1^i L^i\right)$$

Assuming $R_2^i \leq 1$, ex post borrowing D^i is still equal to $1 - \lambda^i$, and optimal ex ante lending and borrowing for banks from region i writes as

$$L^i = \mathbf{1}\left[R_1^i \leq \frac{R_2^{-i}}{R_2^{-i} + R_2^i}\right] m^i \left(1 - A^i\right) \text{ and } A^i = \mathbf{1}\left[R_1^{-i} \geq \frac{R_2^{-i}}{R_2^{-i} + \beta}\right] \left(1 + L^{-i}\right) \tag{37}$$

There are then four different situations to look at.

1. If banks do not borrow ex ante, i.e. $L^c = A^p = 0$ and $L^p = A^c = 0$, then, using (37), this situation is an equilibrium if and only if the returns R_1^c and R_1^p satisfy

$$\frac{R_2^p}{R_2^p + R_2^c} < R_1^c < \frac{R_2^c}{R_2^c + \beta} \text{ and } \frac{R_2^c}{R_2^p + R_2^c} < R_1^p < \frac{R_2^p}{R_2^p + \beta}$$

For these two sets of inequalities to hold, the necessary conditions $\beta R_2^p < (R_2^c)^2$ and $R_2^c \beta < (R_2^p)^2$ must be satisfied. In addition when banks do not borrow, then the market for ex post funding is in excess supply. Hence following the previous appendix, policymakers in the core set lending conditions R_2^c and R_2^p to solve:

$$\max_{R_2^c; R_2^p} R_2^p + (1 - R_2^c) D^c - \frac{\delta}{2} \left(R_2^p - r(L^c)\right)^2 - \frac{\delta}{2} \left(R_2^c - r(L^c)\right)^2$$

$$\text{s.t. } R_2^c; R_2^p \geq r_m$$

Then assuming the lower bound r_m binds for R_2^c, i.e. for any L^c, $r_m \geq r(L^c) - \frac{1-\lambda^c}{\delta}$, optimal ex post lending conditions satisfy

$$R_2^c = r_m \text{ and } R_2^p = r(L^c) + \frac{1}{\delta}$$

Yet given that we have $r_m < r(L^c) < \beta$, the necessary condition $\beta R_2^p < (R_2^c)^2$ cannot hold and this situation cannot be an equilibrium.

2. If only banks from the periphery borrow ex ante, i.e. $L^c = A^p = 0$ and $L^p = A^c = m^p$, then using (37), this situation is an equilibrium if and only if the returns R_1^c and R_1^p satisfy

$$\frac{R_2^p}{R_2^p + R_2^c} < R_1^c < \frac{R_2^c}{R_2^c + \beta} \text{ and } \frac{R_2^p}{R_2^p + \beta} = R_1^p \leq \frac{R_2^c}{R_2^p + R_2^c}$$

For these two sets of inequalities to hold, the necessary conditions $R_2^p < \min\left\{\frac{1}{\beta}(R_2^c)^2; \sqrt{\beta R_2^c}\right\}$ must be satisfied. Then if $m^p > \lambda^p$, we have $R_2^p = 1$ and this situation cannot be an equilibrium since the condition $R_2^p < \sqrt{\beta R_2^c}$ does not hold.

3. If only banks from the core borrow ex ante, i.e. $L^p = A^c = 0$ and $L^c = A^p = m^c$, then using (37), this situation is an equilibrium if and only if the returns R_1^c and R_1^p satisfy

$$\frac{R_2^c}{R_2^p + R_2^c} < R_1^p < \frac{R_2^p}{R_2^p + \beta} \text{ and } \frac{R_2^c}{R_2^c + \beta} = R_1^c \leq \frac{R_2^p}{R_2^p + R_2^c}$$

For these two sets of inequalities to hold, the necessary conditions $R_2^c < \min\left\{\frac{1}{\beta}\left(R_2^p\right)^2; \sqrt{\beta R_2^p}\right\}$ must be satisfied. Then if $m^c > \lambda^c$, we have $R_2^c = 1$ and this situation cannot be an equilibrium since the condition $R_2^c < \sqrt{\beta R_2^p}$ does not hold.

4. Last, if both banks in the core and in the periphery borrow from each other, then we have $L^p = A^c = m^p\left(1 - L^c\right)$ and $L^c = A^p = m^c\left(1 - L^p\right)$ and this situation is an equilibrium if and only if the returns R_1^c and R_1^p satisfy

$$\frac{R_2^p}{R_2^p + \beta} = R_1^p \leq \frac{R_2^c}{R_2^p + R_2^c} \text{ and } \frac{R_2^c}{R_2^c + \beta} = R_1^c \leq \frac{R_2^p}{R_2^p + R_2^c}$$

And necessary conditions for these two set of inequalities to hold write as $\left(R_2^p\right)^2 \leq R_2^c\beta$ and $\left(R_2^c\right)^2 \leq R_2^p\beta$. In addition when banks in the core and in the periphery borrow, then the market for ex post funding is in excess supply if and only if

$$L^c \leq \lambda^c + \left(1 - \frac{\beta R_2^p}{R_2^p + \beta}\right) L^p \text{ and } L^p \leq \lambda^p + \left(1 - \frac{\beta R_2^c}{R_2^c + \beta}\right) L^c \tag{38}$$

Under these conditions, and assuming the lower bound r_m binds for R_2^i, i.e. for any L^c, $r_m \geq r\left(L^c\right) - \frac{1-\lambda^c}{\delta}$, ex post lending conditions then satisfy

$$R_2^c = r_m \text{ and } R_2^p = r\left(L^c\right) + \frac{1}{\delta}\left[1 + \frac{\beta L^c}{r_m + \beta}\right]$$

Hence provided the necessary conditions (38) and $\frac{1}{\beta}\left(R_2^c\right)^2 \leq R_2^p \leq \sqrt{R_2^c\beta}$ are satisfied, the situation where banks from both regions borrow ex ante is the only possible equilibrium.

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