INDUSTRIAL MONETARY POLICY*

Emmanuel Farhi and Jean Tirole

September 23, 2019

(This preliminary draft has not been revised/completed since Emmanuel Farhi passed away. It will undergo revision this spring. The core sections are sections 2 and 5)

Abstract

This paper is about "industrial monetary policy": liquidity support policies through which authorities shape the location and continuation of economic activity on their soil, with consequences for banks' international specialization, place of incorporation, charter of affiliates and supervisory regime. We study imperfect banking competition in a two-country environment. Banks' country-specific investment decisions depend on their prospect to receive liquidity support; the latter in turn hinges on the amount of "leakage" associated with liquidity assistance: a country's loan may in part benefit the other country. The implications of leakage depend on a number of factors such as the type of presence in the country (subsidiary vs. branch) and the ability of countries to reach a Coasian bargain. We look at how these institutional details impact banking competition and diversification. We also look at the strategies that central banks can deploy to leverage their ability to commit liquidity support. For example, the model rationalizes central-bank swap lines as attempts by central banks to boost foreign demand for domestic assets by committing to bringing assistance to foreign financial institutions (via foreign central banks) in case of currency shortage.

1 Introduction

Countries are eager to attract and maintain economic activity on their soil. A large literature correspondingly studies how this desire shapes protectionist policies (from export and plant-creation subsidies to import tariffs) and trade agreements. This literature focuses on industry and has by and large ignored the banking system. To be certain, some insights gleaned in this literature also apply to finance. But there are also cross-border banking specificities, such as the key role of public liquidity provision and the presence of supervisors. This project aims at extending the trade literature to the banking system and thereby at shedding light on some ongoing debates.

A case in point is the European banking market. Commentators bemoan the strong home bias of the banks, even of the biggest ones. Clearly a European banking passport does not guarantee a European presence. Of course inertia (the dominance of home banks in their turf prior to banking liberalization)

*Extremely preliminary and incomplete draft prepared for the BCL-TSE conference on "The Future of the International Monetary System", Luxembourg, September 17-18, 2019. We are grateful to the participants as well as to our discussant, Xavier Vives for helpful comments. Please do not circulate.

partly accounts for this strong country specialization. This paper focuses on another source of specialization: the greater ability to access liquidity when specializing.[1]

Section 2 first describes the model. There are two countries, two imperfectly competitive banks, and three dates: a date 0 at which banks choose how much and where to invest, a date 1 at which they may require liquidity support, and a date 2 at which long term (private and social) benefits of these investments are reaped (date 2 stands for the "future"). Banks initially are not credit constrained when they "acquire" (say, SME) customers at date 0. Acquiring customers is a costly activity, all the more so if they compete intensively for these customers. This investment is not necessarily one-shot, as at date 1 the bank may have to reinvest in the funded projects so as to enable them to continue. At that stage, customers are captive[2]. To capture public liquidity provision in a stark and simple way, we assume that there is no store of value[3]; that is, we abstract from the standard liquidity-underinvestment[4] market failure. Because there are no stores of value at date 0, only the state can supply the required date-1 liquidity. Until Section 5, we assume that the states do not commit to liquidity provision; rather they supply the liquidity in a time-consistent manner. Countries supply liquidity because they care about the continuation of activity at home.

Section 2 assumes that money is fungible: the countries cannot ensure that the money they supply at date 1 will be used domestically: Banks allocate their date-1 funds internationally as is optimal for them. This creates a leakage (some of the funds are channeled abroad) and a free-riding problem (at date 1, a country benefits from the liquidity provided by the other country). Section 2 shows that under reasonable conditions, the only equilibria in this otherwise symmetric model are asymmetric equilibria in which the two banks specialize in a different country: each bank wants to be the national champion of one country so as to be able to count on its support in case of distress. The degree of specialization may vary from partial to complete. As a result, banking competition is too weak.

International date-1 coordination of liquidity provision then brings two benefits: better support for the banks at date 1, and increased competition at date 0. Such "Coasian bargains" however require informational commonality (say, about the willingness to rescue the banks) as well as the availability of public funds in both countries. If either condition is violated, Coasian bargaining breaks down and the insights of Section 2 carry over, as shown in Section 3. But a new insight emerges concerning the benefit of ILOLR (international lending of last resort): pre-arranged lines of credit between countries generate a better allocation of support to economies at date 1 and in turn more banking competition at date 0.

[1]While public liquidity provision has been the object of much scrutiny, its translation to the international context has received much less attention. Two policy developments suggest that such attention is warranted. The swap lines extended by the Fed in 2008 and the more formal arrangements offered by China to boost the renminbi in international transactions suggest that international liquidity provision can be used strategically. Simultaneously, concern has been expressed at the ability for multinational banks to secure sufficient support, and plans are drawn in Europe to facilitate banks' recovery and resolution. It is also often argued that European banks are not diversified enough and that both competition and financial stability might be promoted through pan-European banking. The model sheds light on these developments.

[2]One may have in mind the standard learning-by-lending argument. The incumbent lender over time knows more about the borrower than alternative lenders and will underbid the new lender whenever profitable, leaving the latter with an adversely selected sample of negative-value customers, with the outcome being an ex-post monopoly position for the historical lender (see Section 9.4 in Tirole 2006 for an exposition of the standard argument).

[3]More generally, there is an insufficient amount of stores of value, at least in some states of nature.

[4]Or investment in the wrong kind of liquidity.

Section 4 relaxes the perfect fungibility assumption. We assume that the country that regulates a bank can at least partly ringfence the use of cash at date 1, with a ringfencing parameter going from 0 (perfect fungibility) to 1 (perfect ringfencing). We show that banks want to incorporate in (and thereby be supervised by) the country in which they have their strongest presence. Ringfencing has a benefit and a cost: in the absence of Coasian bargains, it makes the home country more eager to exert its responsibility; but it also creates a misallocation of liquidity within the bank.

Section 5 looks at date-0 public policies. A bank may want to attract banking capital by pledging to act as a lender of last resort (LOLR). This we call "industrial monetary policy". LOLR differs from the provision of liquidity considered hitherto, in that it requires a commitment, while the provision of liquidity studied in Sections 2 through 4 is ex-post voluntary; put differently, LOLR involves going beyond what the country would naturally do at date 1. We show how a conditional form of LOLR enables countries to attract investments onto their own soil, while an unconditional one is often self-defeating. We also show that exchange rate appreciations are an unavoidable byproduct of successful industrial monetary policies. Exchange rate appreciations, in turn, are a limiting factor for industrial monetary policies by endogenously making them costlier to operate.

Related literature *Branches vs. subsidiaries*. Section 4 relates to the large law and economics literature on the difference of regulatory and governance environments for subsidiaries and branches[5]. On the institutional front, a branch in the host country exposes the parent bank to liabilities in case of branch distress and therefore to higher[6] risk than a subsidiary, which has its own capital, board of directors and for which limited liability protects the parent bank. Modes of supervision also differ (the following is only the broad picture, as practice in the matter is somewhat heterogeneous). In all cases, the home supervisor supervises the entire banking group, including the affiliate (whether a subsidiary or a bank); the supervisor can limit the bank's range of activities and locations[7]. While the branch must obey the host country's regulations, it is most often not supervised by that country[8]. A subsidiary is by contrast supervised by both countries (indeed the host country is the lead supervisor for the locally incorporated subsidiary). There is a consensus that, whether for governance or regulatory reasons, the bank can more easily relocate liquidity across borders in the case of a branch. And subsidiaries require more capital and liquidity than a branch[9].

[5]Useful reviews are provided in Danisewicz et al (2017) and Fiechter et al (2011).

[6]Of course the parent bank has "its name on the door" and so may feel compelled to rescue its subsidiary despite the absence of legal obligation to do so. This reputation risk makes the distinction not as strong as it might appear.

[7]See Fiechter et al (2011).

[8]Note, though, that the host country may have responsibility for supervising the branch's liquidity position, as is the case within the European Union or under the Basel Concordat.

[9]They also facilitate the writing of living wills. Cross-border bank resolutions are known to be particularly tricky. Bolton and Oehmke (2019) look at the role of bailinable securities (loss-absorbing capital) to prevent bankruptcy in a multinational banking context (our model by contrast focuses on public liquidity support once these securities have been bailed in- adding bailinable securities- e.g. along the lines of Dewatripont-Tirole (2019)- to our model would be doable provided we added date-2 pledgeable income). A single point of entry for bank resolution is efficient when countries can commit to cooperate at the crisis stage (the equivalent of a date-1 Coasian bargain in our model). Multiple points of entry by contrast may be advantageous when no such commitment is feasible and resolution will involve large asymmetries in transfers. Calzolari and Loranth (2011) study the non-cooperative decisions of multiple regulators of a multinational bank. A bank at date 0 invests in projects in both countries using local deposits. The regulator (regulators in the case of a subsidiary) decide at date 1 whether to liquidate the

The branch vs. subsidiary choice is guided by various factors, some unrelated to the analysis of this paper. Differentials between corporate tax rates is an obvious one[10]. Another is the affiliate's source of funding –retail vs. wholesale-; retail deposit funding makes the subsidiary regime more likely, if only because the host country- which then will be in charge of deposit insurance- will often demand to supervise the affiliate.

The theoretical literature on the choice between the two is scant. Dell'Ariccia and Marquez (2010) show that this choice should be influenced by the type of host country risk; in case of (uninsurable) economic shock, the limited parent-affiliate liability afforded by the subsidiary structure pleads for the latter as it limits the propagation of shocks; by contrast the branch structure allows faster repatriation and protects the bank against expropriation by the host country[11]. Dell'Ariccia and Marquez predict that subsidiaries will take on more risk and will be larger. Cerutti et al (2007) find empirical evidence in support of this theory. More generally, the empirical literature is a bit more extensive. There is evidence in favor of the presumed-above impact of corporate tax rates and source of funding.

Transmission of shocks through a cross-border banking system. Beyond the general literature on the cross-country propagation of shocks through the financial system[12], the banking literature points at a stronger propagation of shocks in the home country to the host country when parent banks operate through branches in the host country and they are short of tier-1 capital[13].

Regulatory competition. The 1988 Basel Accord aimed at avoiding a regulatory race to the bottom and establish a level-playing field in terms of capital requirements. Morrison and White (2009) revisit the costs and benefits of a level-playing field. They assume that regulators in different countries are differentially apt at curbing bank risk taking. An inexperienced regulator must offset his lack of competency by asking for higher capital charges, even for healthy banks which would be safe even with lower capital requirements. When banks are mobile, talented-regulator countries exert negative externalities on untalented-regulator ones: healthy banks want to migrate to the former (non-insured depositors still trust the banks located there despite low capital requirements), leaving an adversely selected sample to the latter. While a level-playing field eliminates this cherry-picking externality, it also penalizes countries with a talented regulator, as capital requirements must adjust to the lowest common denominator (i.e. high capital requirements, not the lowest common denominator envisioned in the Basel debate). Overall, the level-playing field has ambiguous welfare effects.

While Morrison and White study regulatory competition among countries, in Carletti et al (2016)'s principal-agent problem, a centralized supervisor (e.g., the ECB) has full control rights over banks, but relies on local supervisors to collect the information necessary to act. Local supervisors are assumed to be less inclined to intervene relative to a centralized supervisor. Because the local supervisors do not control the use of information under a centralized structure, they collect less information than in a

bank's country operations/project or let it continue, on the basis of a signal on the likely date-2 return. Regulators stand for the interests of depositors. The paper stresses the externalities in liquidation decisions.

[10]A branch is particularly appealing for the bank in a high-tax country.

[11]Through forced holdings of government bonds, forced lending to government-connected borrowers, capital controls, etc.

[12]E.g. Giannetti-Laeven (2012).

[13]See Danisewicz et al (2017).

decentralized structure in which they would have the control rights. The centralization of supervision then has an ambiguous welfare impact despite the improvement in the objective function of the decision-maker.

Competition and banking. In a closed economy framework, the literature has highlighted other industrial organization trade-offs than those emphasized here. Most prominent here is the debate (reviewed in Vives 2011) concerning a possible trade-off between competition and financial stability. The standard "charter value" argument states that a bank has less incentive to take the risk of failure if it expects to be profitable in the future; a reduction in competition therefore reduces risk. This charter value argument suggests either adjusting regulation (more supervision, higher capital and liquidity requirements) when the bank is in a more competitive environment or loosening the competition policy rules. There are other effects too: First, high banking concentration may make the banks too-big-to-fail, inducing them to take on more risk. Second, for wholesale deposits, the higher interest rates generated by competition may exacerbate bank runs. We refer to Vives' paper for the policy implications of these theories.

Finally, an analogy can be drawn between a commitment to supply liquidity with the traditional commitment to supply an add-on at a low price in the future (e.g. Shepard 1987, Farrell-Gallini 1988).

2 Model

2.1 Description

There are four players: two countries, A and B (indexed by superscripts k, l or m), and two cross-border banks, 1 and 2 (indexed by subscripts i, j). Players do not discount the future.

- *Date 0*: We capture imperfect competition by assuming that banks pick their number of clients in each country in a Cournot manner. The unit cost of customer acquisition in country k is $c(q_1^k + q_2^k) \equiv c(q^k)$. This unit cost function satisfies $c'(q) > 0$ and $qc''(q) + c'(q) > 0$ (these assumptions will guarantee that investments within a country are strategic substitutes).[14]

  Let $q_i \equiv \sum_m q_i^m$ stand for bank i's size, and $\sigma_i^k \equiv \frac{q_i^k}{q_i}$ denote the relative presence of bank i in country k. $\sigma_i \equiv \max_{m\in\{A,B\}} \sigma_i^m$ is a measure of bank i's country specialization. Bank i is (fully) diversified if $\sigma_i = \frac{1}{2}$.

  The banks' date-0 establishment choices are commonly observable. The simplest interpretation of "client acquisition" is that the banks acquire "projects" in the country, which will be our terminology from now on.

- *Date 1*: In each country, projects are hit by liquidity shocks. The distribution of a bank's liquidity shock, $F(\rho) \sim [0, +\infty)$, is the same in both countries and is common knowledge. These shocks are

[14] As an illustration, suppose that each borrower at date 0 requires an investment of 1. A borrower has endowment e that is distributed according to $G(e)$ on $[0, \infty)$. For simplicity assume that this endowment is not observable by the banks. The aggregate supply of loans q^k determines a cutoff $e^k = G^{-1}(1 - q^k)$ and a cost $c(q^k) \equiv 1 - e^k$. For instance, for a uniform distribution of borrower endowment on [0,1], $c(q^k) \equiv q^k$.

to be understood as net of any date-1 revenue; we do not allow net revenues to be strictly positive only for notational simplicity [15].

Countries face costs of public funds $\{\lambda^k\}$ and simultaneously select bank-specific liquidity support[16] $\{T_i^k \geq 0\}$. So bank i receives $T_i = T_i^A + T_i^B$. We will let $\kappa_i^k \leq q_i^k$ denote the continuation scales.

- *Date 2*: Banks enjoy their private benefits, $[\sum_m \kappa_i^m]b$ for bank i. Country k receives social benefit $[\sum_i \kappa_i^k]\beta$.

Objective functions

Whether transfers are ringfenced (as in Section 4) or not (as is the case here), banks allocate the available money within a given country to those projects that require the smallest reinvestment. Let ρ_i^kdenote bank i's cutoff in country k[17]: $\kappa_i^k = F(\rho_i^k)q_i^k$. Bank i's utility is then equal to the expected continuation benefit minus the cost of acquisition:

$$U_i = [\sum_m F(\rho_i^m)q_i^m]b - [\sum_m c(q^m)q_i^m]$$

Countries do not necessarily care about the banks, but, as we have seen, they internalize the continuation of economic activity on their soil. This feature is- in our model- what makes banks "banks"[18] . Country k's welfare comprises two terms: the benefit of the economic activity net of the transfers needed to maintain it; and the rent $S^k$of date-0 project owners. The latter is given by[19]:

$$S^k(q^k) = q^k c(q^k) - \int_0^{q^k} c(x)dx = \int_0^{q^k} xc'(x)dx$$

The intertemporal welfare of country k is the sum of the date-0 and date-1 welfares:

$$W^k = S^k(q^k) + \sum_i [F(\rho_i^k)q_i^k\beta - \lambda^k T_i^k]$$

Targeting/ringfencing of liquidity

[15] Strictly positive net revenues for some projects could easily be accommodated as they would be used to cover other projects' liquidity shocks. See Subsection 2.3.2.

[16] In the model these are pure bailouts as we have assumed that there is no pledgeable income that the bank can return at date 2. With (say, a random) date-2 income, this liquidity support would take the more familiar form of a risky collateralized loan to the banks. More on this later.

[17] That is, projects that require reinvestment $\rho \leq \rho_i^k$are continued.

[18] This desire to bail out entities whose activity is highly valued by the state extends beyond banking; and the theory developed below would apply as well to such sensitive activities. But bailouts are particularly prominent in the banking sector, and so there is little abuse of terminology.

[19] In the example given in footnote 13,

$$S^k(q^k) = \int_{G^{-1}(1-q^k)}^{\infty} (e - e^k)dG(e)$$

At this stage we assume that money is fungible: countries cannot target their liquidity assistance to reinvestment within the country. This implies that banks allocate funds as they see optimal: For all k

$$\rho_i^k = \rho_i^*$$

Discussion of modeling choices

1. *Occasional liquidity shocks*. The banks in this model are in need of cash at date 1 with probability 1. But the same results apply to a situation in which the need for cash arises with an arbitrary probability in $[0,1]$[20].

2. *Date-1 revenue and date-2 pledgeable income*. Nothing would be altered if the banks produced income at date 1 and/or pledgeable income at date 2 in case of project continuation. We will later show how to incorporate date-1 income into the analysis. To the extent that the date-2 pledgeable income is bailinable[21], it plays the same role as a date-1 revenue, except that the revenue is contingent on continuation. In the date-2 pledgeable income case, the analysis directly carries through, replacing "liquidity shocks" by "net liquidity shocks".

3. *Correlation of shocks*. Due to risk neutrality, the model admits two interpretations. The one developed above has a continuum of independent projects whose realized shock distribution is, by the law of large numbers, identical to the distribution of shocks $F(\rho)$ for an arbitrary project. Alternatively, the projects sponsored by bank i all face the same shock ρ drawn from $F(\rho)$. In this correlated-shocks interpretation, $F(\rho_i^*)$ is to be interpreted as the probability that all projects continue, rather than as the fraction of surviving projects.

4. *Capital requirements*. Because we want to focus on liquidity shortages in the simplest manner, we assumed that the banks face no date-0 solvency constraint. We will later relax this assumption.

2.2 Single-country benchmarks

Suppose that banks can invest in only one country (so there is no leakage of liquidity support). The country's cost of public funds is λ. Its optimal liquidity support to bank i is given by:

$$\lambda\rho_i^* = \beta$$

A monopoly bank invests q^M such that:

$$F(\beta/\lambda)b = c(q^M) + c'(q^M)q^M$$

[20] The focus then is on the state in which the banks need cash.

[21] See Dewatripont-Tirole (2018) for an analysis of optimal bailinability.

A duopoly in banking results in total (Cournot) activity q^Cgiven by:

$$F(\beta/\lambda)b = c(q^C) + c'(q^C)\frac{q^C}{2}$$

As usual, $q^C > q^M > \frac{q^C}{2}$. Liquidity support naturally decreases with the shadow cost of public funds λ and increases with the country's willingness to pay to preserve economic activity, β.

2.3 Date-1 liquidity provision equilibrium

2.3.1 Countries' incentives under full fungibility

Let us consider two countries and assume for the moment that the two countries face identical costs of public funds: for all k, $\lambda^k = 1$.

At date 1, bank i receives transfers from both countries, in total amount $T_i \equiv T_i^A + T_i^B$. It efficiently allocates this liquidity to the least-cost projects, so as to maximize the date-2 value. Let $M^-(\rho_i^*)$ denote the expectation of ρ conditional on $\rho \le \rho_i^*$, where ρ_i^* is bank i's cutoff for continuation. The date-1 budget constraint writes:

$$F(\rho_i^*)M^-(\rho_i^*)q_i = T_i$$

Furthermore

$$\kappa_i^k = F(\rho_i^*)q_i^k$$

Country k solves

$$\max\{\beta\kappa_i^k - T_i^k\} = \max\{\beta F(\rho_i^*)q_i^k - T_i^k\}.$$

And

$$\frac{\partial(\beta\kappa_i^k - T_i^k)}{\partial T_i^k} = \frac{\beta\sigma_i^k}{\rho_i^*} - 1$$

This implies that, unless $\sigma_i = 1/2$, only the home country (country k such that $\sigma_i^k \equiv \sigma_i > 1/2$) brings liquidity to the bank. The cutoff is given by

$$\rho_i^* = \beta\sigma_i$$

If $\sigma_i = 1/2$, we assume that each country contributes for half of the liquidity provision and so[22] $\rho_i^* = \beta/2$.

The bank's continuation scale is therefore $F(\beta\sigma_i)$ where, recall, σ_i denotes bank i's degree of specialization. The continuation scale is higher, the lower the probability of leakage (where leakage can be measured by the fraction, $1 - \sigma_i$, that benefits the other country). There is free riding between the two countries unless the bank is specialized, i.e. not cross-border ($\sigma_i = 1$). The leakage associated with the inability to ringfence induces the home country to bring too little liquidity to the bank, from the point of view of the other country (and of course from the point of view of the bank).

[22]There are actually a continuum of equilibria, all yielding the same date-1 continuation scale, and therefore the same behavior at date 0: any $\{T_i^A, T_i^B\}$such that $T_i^A + T_i^B = F(\beta/2)M^-(\beta/2)q_i$ is an equilibrium of the liquidity provision stage.

2.3.2 Extension: adding a date-1 revenue

Let bank i receive date-1 revenue rq_i where $r \geq 0$ is the per-unit revenue. In the absence of public liquidity provision, the bank sets cutoff ρ_0^* such that $F(\rho_0^*)M^-(\rho_0^*)q_i = rq_i$, provided that the bank is eager enough to continue ($\rho_0^* \leq b$). Two cases are then possible:

1. *Moderate revenue.* If $\rho_0^* < \rho_i^*$, the continuation scale is unchanged, $\rho_i^* = \beta\sigma_i$. The state provides additional liquidity $[F(\rho_i^*)M^-(\rho_i^*) - r]q_i$, conditional on the bank's revenue being reinvested. Note that the date-1 revenue does not benefit the bank[23]. Rather it serves to reduce the public outlay. This suggests that (i) were the date-1 revenue subject to moral hazard, careful monitoring of activities that determine this revenue should be undertaken; and (ii) the natural supervisor is the country with the largest presence, as this country will end up footing the bill.

2. *High revenue.* If $\rho_0^* > \rho_i^*$, there is no need for public liquidity provision, and also [*conjecture*] no specialization.

2.3.3 Extension: asymmetric liquidity shocks

Suppose that bank i 's distribution of shocks is country contingent. Let $F^k(\rho)$ denote the distribution in country k, with density $f^k(\rho)$. Generalizing the previous analysis and defining the likelihood ratio as $l(\rho) \equiv f^k(\rho)/f^l(\rho)$ we have

$$\frac{\partial(\beta\kappa_i^k - T_i^k)}{\partial T_i^k} = \frac{\beta}{\rho_i^*}\frac{f^k(\rho_i^*)q_i^k}{\sum_m f^m(\rho_i^*)q_i^m} - 1 = [\frac{\beta}{\rho_i^*}][\frac{l(\rho_i^*)\sigma_i^k}{l(\rho_i^*)\sigma_i^k + \sigma_i^l}] - 1$$

where the cutoff is given by:

$$\sum_m \int_0^{\rho_i^*} \rho q_i^m dF^m(\rho) = T_i$$

A country's incentive to rescue a bank now depends not only on the relative presence of the bank in the country, but also on the relative densities around the cutoff shock.

Example (exponential distributions). Suppose that $F^k(\rho) = 1 - e^{-(\rho - \rho_0^k)}$ on $[\rho_0^k, +\infty)$. Then $\rho_0^l < \rho_0^k$ implies that country l is the "low-shock country". Incentives to supply liquidity to bank i are given by:

$$\frac{\partial(\beta\kappa_i^k - T_i^k)}{\partial T_i^k} = \frac{\beta}{\rho_i^*}\frac{e^{\rho_0^k}q_i^k}{\sum_m e^{\rho_0^m}q_i^m} - 1$$

The low-shock country is, ceteris paribus, less eager to supply liquidity. So it may be the case that liquidity support be brought (solely) by country l even though $\sigma_i^l < \frac{1}{2}$.

[23] This would not be the case if either the bank had some bargaining power or there were states of nature without liquidity needs (or with minor ones).

More generally we need to make some assumption as to where in the shock distribution the cutoff lies. It is reasonable to assume that uncovered liquidity shocks are tail events (high ρ shocks). If so, country k is the "high-shock country" if the distributions are ranked in terms of the likelihood ratio, such that $l(\rho) \equiv f^k(\rho)/f^l(\rho)$ is increasing in ρ.

2.4 Date-0 competition

Bank i solves:

$$\max_{\{q_i^A, q_i^B\}} \{F(\beta(\max_{k\in\{A,B\}}(\frac{q_i^k}{q_i^A+q_i^B}))(q_i^A+q_i^B)b - \sum_{k\in\{A,B\}} c(q_i^k+q_j^k)q_i^k\}$$

This yields first-order condition with respect to q_i^k:

If $0 < q_i^k < q_i^l$ (if $q_i^k = 0$, we have a weak inequality)

$$F(\beta(\frac{q_i^l}{q_i^A+q_i^B}))b - c(q^k) - c'(q^k)q_i^k - f(\beta(\frac{q_i^l}{q_i^A+q_i^B}))\frac{q_i^l}{q_i^A+q_i^B}\beta b = 0 \tag{1}$$

If $q_i^k > q_i^l \geq 0$

$$F(\beta(\frac{q_i^k}{q_i^A+q_i^B}))b - c(q^k) - c'(q^k)q_i^k + f(\beta(\frac{q_i^k}{q_i^A+q_i^B}))\frac{q_i^l}{q_i^A+q_i^B}\beta b = 0 \tag{2}$$

Conditions (1) and (2) are the standard Cournot conditions except for the last terms on the RHSs (in the density f), which reflects the concern about receiving liquidity support.

Thus a symmetric, balanced outcome, in which banks invest equally in each country cannot exist: Because the bank can reduce or increase its presence in any given country, the two first-order conditions (1) and (2) would have to be satisfied, which is impossible.

2.5 Equilibrium analysis

Symmetric, partial specialization equilibrium

We first look for an equilibrium in which the two banks choose to specialize in different countries, with degree of specialization $\sigma \in (\frac{1}{2}, 1)$.

It is instructive to consider a bank's choice of specialization in say country k, given a fixed size q_i:

$$max_{\{\sigma_i\}}[F(\beta\sigma_i)b - c(\sigma_i q_i + q_j^k)\sigma_i - c((1-\sigma_i)q_i + q_j^l)(1-\sigma_i)]q_i$$

In a "symmetric"[24] equilibrium, for which we omit bank and country indices, the first-order condition with respect to σ_i yields:

[24] It is symmetric in magnitudes, but, as we have seen, banks specialize in different countries.

$$f(\beta\sigma)b\beta = c'(q)q(2\sigma - 1)$$

Furthermore, a sufficient (but by no means necessary) for the second-order condition with respect to σ_i to be satisfied is $f'' \le 0$. [*This is an incomplete analysis of the SOC.*]

Let q denote the total volume in a given country. Conditions (1) and (2) can be rewritten as

$$\begin{aligned} F(\beta\sigma)b - c(q) - c'(q)(1-\sigma)q - f(\beta\sigma)\sigma\beta b &= 0 \\ F(\beta\sigma)b - c(q) - c'(q)\sigma q + f(\beta\sigma)(1-\sigma)\beta b &= 0. \end{aligned}$$

Adding and subtracting these two conditions yields the condition obtained above together with a new condition:

$$f(\beta\sigma)b\beta = c'(q)q(2\sigma - 1)$$

$$F(\beta\sigma)b = c(q) + c'(q)q[\sigma^2 + (1-\sigma)^2].$$

For $\sigma > \frac{1}{2}$, $\sigma^2 + (1-\sigma)^2 > \frac{1}{2}$: the marginal cost of investment is higher under specialization than when banks diversify their portfolio, because an increase in the bank's size has a larger inframarginal effect on the cost of acquisition in the market in which the bank is more present.

This in turn implies that

$$F(\beta\sigma)b = \left(\sigma - \frac{1}{2}\right) f(\beta\sigma)\beta b + H\left(\frac{f(\beta\sigma)\beta b}{2\left(\sigma - \frac{1}{2}\right)}\right) \tag{3}$$

where H is an increasing function (defined implicitly by $H(X) = c(q) + c'(q)\frac{q}{2}$ when $X = c'(q)q$). For instance for $c(q) = q$ (see footnote 14), $H(X) = \frac{3}{2}X$; and more generally $H' \ge 1$ if and only if $c' \ge c''q$.

A *full specialization equilibrium* in which banks both stay in their home country and do not attempt to invade the other's territory has banks operate at scale q^M and requires that the following condition be satisfied:

$$\frac{F(\beta)}{f(\beta)\beta} \le \frac{c'(q^M)q^M + c(q^M)}{c'(q^M)q^M}$$

The RHS of this inequality increases with the ratio of the average cost $c(q)/q$ over marginal cost $c'(q)$.

$c(q) = q^\eta$ acquisition cost. When the acquisition cost is a power function with $\eta > 0$ (which includes the linear case $c(q) = q$), $H(X) = (\frac{1}{2} + \frac{1}{\eta})X$ and (3) can be rewritten as

$$\frac{F(\beta\sigma)}{f(\beta\sigma)\beta\sigma} = \frac{\sigma^2 - \sigma + \frac{1}{2}(1 + \frac{1}{\eta})}{\sigma^2 - (\sigma/2)} \tag{4}$$

Let us assume that $F(X)/[f(X)X]$ is non-decreasing in X. Then, the LHS of this equation is non-decreasing in σ, while the RHS is (always) decreasing in σ on $[1/2, 1]$. Thus condition (4) has a unique solution. And this solution is a corner solution of full specialization if and only if $\frac{F(\beta)}{f(\beta)\beta} \leq 1 + \frac{1}{\eta}$.

It is also interesting to investigate the consequences of a shift θ in the distribution (the distribution writes $F(\rho-\theta)$), assuming a monotone hazard rate (F/f increasing). A higher θ can be interpreted as more turbulent times. With this interpretation, *more turbulent times lead to banking renationalization* (a higher specialization). This is easily understood: banks face a trade-off between specializing more to secure more liquidity support from their home country and conquering the more lucrative[25] foreign market. The first concern looms larger when shocks become more likely.

Specialization in the same country?

Can an equilibrium with full specialization in the same country exist? Suppose that banks specialize in country A, say. Conditions (1) and (2) must then be satisfied simultaneously in country A, in which the Cournot equilibrium delivers per-country quantities q^C given by

$$F(\beta)b = c(q^C) + c'(q^C)\frac{q^C}{2}$$

Suppose instead that a bank moves its investment $q^C/2$ to the uncovered country[26]. The bank obtains the same benefit, $F(\beta)b\frac{q^C}{2}$,and reduces its acquisition cost from $c(q^C)\frac{q^C}{2}$to $c(\frac{q^C}{2})\frac{q^C}{2}$. Thus an equilibrium in which both banks specialize in the same country does not exist. The reason for this is that entry into a unserved market is more profitable than entry in a competitive market.

3 Coasian bargains and their breakdowns

3.1 Date-1 cross-country deals

Suppose that the two countries bargain at date 1 (say, they share the gains from trade). The countries jointly provide a level of support to bank i that satisfies $\rho_i^* = \beta$. This in turn implies a date-0 investment level given by $q^C$where, recall, $F(\beta)b = c(q^C) + c'(q^C)\frac{q^C}{2}$. Clearly, the Coasian bargain ex post solves the free-rider problem and, as we will show shortly, ex ante delivers more competition. Overall a higher welfare is reached.

To show that competition is stronger under a Coasian bargain, note that bank's size q in the absence of Coasian bargain is given by

$$c(q) + [\sigma^2 + (1-\sigma)^2]qc'(q) = F(\beta\sigma)$$

This is to be compared with a similar equation in the Coasian bargain case:

[25] In the sense that gaining market share is less costly, as an expansion implies an increase in the acquisition cost that impacts a smaller number of inframarginal units.

[26] This is not an optimal strategy in reaction to the other bank's strategy, but here we only aim at proving that the presumed equilibrium is not one.

$$c(q) + \frac{1}{2}qc'(q) = F(\beta)$$

So overall, *there is more banking activity under a Coasian bargain for two reasons: a stronger liquidity support and a smaller market power*.

3.2 Breakdowns of the Coasian bargain and their implications

As noted in the introduction, Coasian bargains require informational commonality (say, about the willingness of each country, β^k, to rescue the banks) as well as the availability of public funds in both countries. If either condition is violated, Coasian bargaining breaks down. The two causes of Coasian breakdown offer similar insights and we will here content ourselves with the case of different shadow costs of public funds. We will do so in a stark manner by assuming that at date 1, one country has cash ($\lambda^k = 1$) while the other is broke or has reached its indebtedness limit imposed by a treaty or by financial markets($\lambda^l = \infty$). Which country will have money at date 1 is not known at date 0, and each country is equally likely to be that country. The implicit assumption of negative correlation of course works against a Coasian bargain.

We again look for a symmetric equilibrium in which banks specialize in different countries (this includes as a limit case the situation in which they diversify maximally, i.e. $\sigma_i = 1/2$ for all i). In such an equilibrium (say bank i specializes on country k), the allocation of activity between the two countries solves:

$$max_{\{\sigma_i, q_i\}}[\frac{F(\beta\sigma_i) + F(\beta(1-\sigma_i))}{2}b - c(\sigma_i q_i + q_j^k)\sigma_i - c((1-\sigma_i)q_i + q_j^l)(1-\sigma_i)]q_i$$

yielding first-order conditions

$$\frac{f(\beta\sigma) - f(\beta(1-\sigma))}{2}b\beta = c'(q)q(2\sigma - 1)$$

$$\frac{F(\beta\sigma) + F(\beta(1-\sigma))}{2}b = c(q) + c'(q)q[\sigma^2 + (1-\sigma)^2].$$

Whether or not the banks want to specialize depends finely on the shock distribution. And for a given amount of specialization, banks invest less than under the exogenous assumption that countries cannot strike Coasian bargains but have available public funds.

Binary shock distribution: a fraction x of projects face shock ρ while the remaining fraction face shock 0. Then bank i will be able to continue full scale under full diversification if and only if $\beta/2 \geq \rho$; the equilibrium is then the same as under a Coasian bargain. By contrast if $\beta/2 < \rho < \beta$,

- There exists a threshold $x^* \in (0,1)$ such that for $x > x^*$, banks specialize and pick $\sigma = \rho/\beta$ and total scale $q \equiv q^*(x)$ given by $c(q) + c'(q)q[\sigma^2 + (1-\sigma)^2] = b(1 - \frac{x}{2})$.

- There exists a threshold $x^{**} \in (0,1)$ such that for $x < x^{**}$, banks diversify maximally ($\sigma_i = 1/2$ for all i) and total scale is given by $q \equiv q^{**}(x)$ given by $c(q) + c'(q)\frac{q}{2} = (1-x)b$.

These thresholds are defined by:

$$max_{\{q_i^k, q_i^l\}}[(1-x^*)b - \frac{c(q_i^k + (1-\frac{\rho}{\beta})q^*(x^*)) + c(q_i^l + \frac{\rho}{\beta}q^*(x^*))}{2}]q_i = [(1-\frac{x^*}{2})b - c(q^*(x^*))]q^*(x^*)$$

$$max_{\{q_i\}}[(1-\frac{x^{**}}{2})b - c(\frac{\rho}{\beta}q_i + \frac{q^{**}(x^{**})}{2})\frac{\rho}{\beta} - c((1-\frac{\rho}{\beta})q_i + \frac{q^{**}(x^{**})}{2})(1-\frac{\rho}{\beta})]q_i = [(1-x^{**})b - c(q^{**}(x^{**}))]q^{**}(x^{**}).$$

[*To do: existence and multiplicity. I.e.* $x^* \gtrless x^{**}$*?*]

4 Supervision, subsidiaries and branches

[*This section is particularly preliminary, and its modeling may change*]

We so far have not introduced ex-ante supervision. As noted earlier, doing so can follow the standard lines; e.g. we could introduce date-0 moral hazard; banks could then make a choice affecting its date-1 revenue or equivalently its date-1 illiquidity. Our interest here lies with the implication of regulation on the liquidity provided to a global bank, and we thus rather focus on the implications of supervision on the allocation of liquidity within the group. We here return to the no-Coasian-bargain world.

We caricature reality by capturing the easier reallocation of liquidity in the branch system in the following way:

- In the case of a branch, the home supervisor is the unique supervisor, which enables them to direct more than a fair fraction of liquidity to the supervisor's country.
- In the case of a subsidiary, the host country is the lead supervisor for the subsidiary and can ringfence the liquidity support by the host country and (when we later add date-1 returns) the date-1 revenue earned in the host country, just as the supervisor in the home country can do the same for any form of liquidity originating in the home country.

4.1 Single supervisor: the branch case

We first assume that a bank is regulated by a single supervisor, who supervises the banking group on a consolidated basis. Following standard terminology, we call the supervisor's country the "home country". The bank's operations in the other country (the "host country") are run by a branch. We make the following

Assumption (regulation and ringfencing). When country k regulates bank i, the fraction of bank i's total liquidity T_i that is used by the bank in country k is given by the following reinvestment function:

$$L_i^k = [\sigma_i^k + \alpha(1-\sigma_i^k)]T_i$$

The parameter α in [0,1] is the ringfencing parameter; the case $\alpha = 0$ corresponds to perfect fungibility, the case $\alpha = 1$ describes perfect ringfencing. This formulation of ringfencing is only one of several assumptions with similar consequences that we could entertain. For example, the ringfencing parameter could apply only to the transfer made by country k and to revenues earned in country k.

Suppose that the home country k (and only country k) brings liquidity to the bank; its ex-post utility is then $\beta F(\rho_i^k)q_i^k - T_i^k$, where $[\int_0^{\rho_i^k} \rho dF(\rho)]q_i^k = L_i^k$. Unless the solution is a corner solution ($T_i^k = 0$), the threshold ρ_i^k in country k is then given by:

$$\rho_i^k = \beta[\sigma_i^k + \alpha(1-\sigma_i^k)] = \beta s_i^k$$

The cutoff in the host country is then μ_i^l where

$$\frac{s_i^k}{s_i^l} = \frac{\int_0^{\rho_i^k} \rho dF(\rho)}{\int_0^{\mu_i^l} \rho dF(\rho)} \frac{\sigma_i^k}{\sigma_i^l} \Longleftrightarrow 1 + \frac{\alpha}{(1-\alpha)\sigma_i^k} = \frac{\int_0^{\rho_i^k} \rho dF(\rho)}{\int_0^{\mu_i^l} \rho dF(\rho)}.$$

Only country k brings liquidity if and only if $\mu_i^l > \beta s_i^l \geq \beta(1-\alpha)\sigma_i^l$, or

$$1 + \frac{\alpha}{(1-\alpha)\sigma_i^k} \leq \frac{\int_0^{\beta s_i^k} \rho dF(\rho)}{\int_0^{\beta s_i^l} \rho dF(\rho)}.$$

As ringfencing becomes more potent (α increases), the LHS of this inequality (which is equal $\left[s_i^k/\sigma_i^k\right]/\left[s_i^l/\sigma_i^l\right]$) increases, suggesting that the increased leakage makes country l less eager to bring liquidity; however the RHS also increases with α, as few projects continue in country l and so the marginal cost of rescuing projects in that country is small.

Example (power law distribution). Let $F(\rho) = \rho^v$ on $[0,1]$ with $v > 0$. The inequality then writes (assuming interior solutions for the cutoffs):

$$\left(\frac{\sigma_i^k}{\sigma_i^l}\right)^{v+1} \left[1 + \frac{\alpha}{(1-\alpha)\sigma_i^k}\right] \geq 1.$$

This inequality is satisfied at $\alpha = 0$ provided that $\sigma_i^k \geq 1/2$ and a fortiori for any $\alpha \in [0,1]$.

Next, assume that the host country l (and only country l) brings liquidity to the bank. Its ex-post utility is then $\beta F(\rho_i^l)q_i^l - T_i^l$, where $[\int_0^{\rho_i^l} \rho dF(\rho)]q_i^l = (1-\alpha)\sigma_i^l T_i^l$. In that case and unless the solution is a corner solution ($T_i^l = 0$), the threshold ρ_i^l in country l is then given by:

$$\rho_i^l = \beta(1-\alpha)\sigma_i^l = \beta s_i^l$$

The cutoff in the home country is then μ_i^k where

$$\frac{s_i^k}{s_i^l} = \frac{\int_0^{\mu_i^k} \rho dF(\rho)}{\int_0^{\rho_i^l} \rho dF(\rho)} \frac{\sigma_i^k}{\sigma_i^l} \Longleftrightarrow 1 + \frac{\alpha}{(1-\alpha)\sigma_i^k} = \frac{\int_0^{\mu_i^k} \rho dF(\rho)}{\int_0^{\rho_i^l} \rho dF(\rho)}$$

[*Liquidity support game: Existence? Multiplicity? More work is needed here*]

Ringfencing has two opposite consequences: First, it implies a *misallocation of the bank's resources* among the projects in the two countries; valuable projects are stopped in the host-country/cash-poor establishment (where "poor" is relative to presence), that would have been pursued had they been located in the home-country/cash-rich one. Second, ringfencing *alters liquidity support*; it unambiguously increases liquidity support if regulation takes place in the country with the highest bank presence; by contrast it tends to reduce liquidity support if regulation takes place in the low-presence country, unless the establishments in the two countries have similar sizes.

Another interesting question relates to preferences with respect to the location of the supervisor. In practice, both the bank and countries have an impact on the location of supervision. The bank chooses where to incorporate, thereby designating a "home supervisor". But the host country may decide to also supervise the local operations of the bank[27]. For the moment, we ignore the latter and focus on the bank's choice of incorporation. For the purpose of this analysis, we assume that the date-0 incorporation decision is simultaneous with, or posterior to the choice of investment; we thus avoid commitment effects attached to the incorporation decision.

To analyze the banks' preferences, it suffices to look at liquidity provision for a given presence in the two countries. Suppose that $\sigma_i^k \geq 1/2$. Let U_i^k and U_i^l denote bank i's utility when incorporating in countries k and l, respectively. That is,

$$U_i^k = [\sigma_i^k F(\beta[\sigma_i^k + \alpha(1-\sigma_i^k)]) + \sigma_i^l F(\mu_i^l)] q_i b - [\sum_m c(q^m) q_i^m]$$

and (*not sure about following equation*)

$$U_i^l = [\sigma_i^l F(\beta(1-\alpha)\sigma_i^l]) + \sigma_i^k F(\mu_i^k)] q_i b - [\sum_m c(q^m) q_i^m]$$

Conjecture: $U_i^k > U_i^l$ *. The intuition is that supervision in the country with the larger establishment size brings about a higher liquidity support. But some condition on F may be needed for that. Furthermore the overall concavity of the program requires some attention, although I don't expect special difficulties here.*

[27] It must then assume responsibility for deposit insurance for the host establishment's retail depositors.

4.2 Subsidiaries

The host country is the lead supervisor for the subsidiary, and therefore has more control over its dispatching of funds. The host country may demand that the bank establishes a subsidiary, giving it some (counter) control over the allocation of liquidity, perhaps even reestablishing the balanced level of leakage (the perfect fungibility benchmark). There is then a trade-off between the level of transfer and the efficiency of the allocation of this transfer; the extra supervisory resources that must then be committed are also relevant.

[*To be worked on*]

5 Industrial monetary policy

Liquidity support interventions studied so far have been ex-post (i.e. time-consistent) interventions. In principle, countries could try to attract banks at date 0 by promising domestic LOLR services. Let us return to the no-ringfencing case for analytical simplicity. We add a prior stage ("stage-1") at which countries may commit to liquidity support. The issue is whether they do this conditionally (contingent on the absolute or relative presence in the country) or unconditionally.

5.1 A fully worked out case

Suppose that there is a single bank (so we drop the subscripts) and two countries. Only country A has cash to bring liquidity (in that sense, country A is an "Hegemon"); but how much liquidity it is prepared to bring depends on how diversified the bank is.

The shock structure is binary. A fraction x of projects face shock ρ while the remaining fraction face shock 0. We assume that $\beta/2 < \rho < \beta$ so that the bank will have to downsize at date 1 if it fully diversifies. Let $\sigma > \frac{1}{2}$ be defined by $\sigma\beta = \rho$.

Finally let us assume a linear cost structure ($c(q) = q$). Let U^I (for "insured") and U^D (for "diversified") denote the bank's utility when it chooses to specialize to $\sigma = \frac{\rho}{\beta}$ and to diversify fully at $\sigma = \frac{1}{2}$:

$$U^I = max_q\{bq - c(\sigma q)\sigma q - c((1-\sigma)q)(1-\sigma)q\}$$

and

$$U^D = max_q\{2[(1-x)b\frac{q}{2} - c(\frac{q}{2})\frac{q}{2}]\}$$

In the linear cost case ($c(q) = q$),

$$q^I = \frac{b}{2[\sigma^2 + (1-\sigma)^2]}$$

and

$$q^D = (1-x)b$$

Suppose that the bank would want to diversify in the absence of LOLR ($U^D > U^I$):

$$(1-x)^2 > \frac{1}{2[\sigma^2 + (1-\sigma)^2]}$$

Country A's welfare is then equal to $S(\frac{q^D}{2}) + \beta(1-x)\frac{q^D}{2}$. Will the country with cash want to grant LOLR to the bank?

Unconditional and free-of-charge liquidity support Suppose first that country A commits to liquidity support T . The bank then keeps diversifying. Let $\xi = min\{1-x+\frac{T}{\rho q}, 1\}$ denote the fraction of activity that continues at date 1.

(i) For $T < x\rho[(1-x)b]$, the bank solves

$$max_q\{(1-x+\frac{T}{\rho q})bq - c(\frac{q}{2})q\} = max_q\{(1-x)bq - c(\frac{q}{2})q + \frac{Tb}{\rho}\}$$

yielding

$$q = q^D = (1-x)b$$

Country A's welfare is now $S(\frac{q^D}{2}) + \beta[(1-x) + \frac{T}{\rho q^D}]\frac{q^D}{2} - T$. Country A's welfare loss is:

$$\Delta W^A = T(\frac{\beta}{2\rho} - 1)$$

Such interventions only benefit the bank and reduce welfare: LOLR interventions that reduce date-1 downsizing without changing the date-0 scale cannot improve welfare since, if socially desirable, they could be performed at date 1 anyway.

(ii) For $T \in [x\rho(1-x)b, x\rho b]$, the bank optimally chooses a size that leads to continuation with probability 1:

$$q = \frac{T}{\rho x},$$

and welfare,

$$W = S\left(\frac{T}{2\rho x}\right) + \left[\frac{\beta}{\rho}\left(1 - \frac{x}{2}\right) - 1\right]T,$$

is convex in T. So, the optimum does not lie in the interior of this intermediate region.

(iii) For $T \geq x\rho b$, then

$$q = b.$$

The welfare gain (or loss) at $T = x\rho b$ [28]is:

$$\Delta W^A = S(\frac{b}{2}) - S(\frac{(1-x)b}{2}) + \rho b x[\frac{\beta}{\rho}(1 - \frac{x}{2}) - 1]$$

Therefore, there can be a welfare gain from large unconditional liquidity support if $\frac{\beta}{\rho}(1 - \frac{x}{2}) > 1$, i.e. if x is not too large. The source of the gains is two-fold: first, banks acquire more clients, which generates more inframarginal surplus; second, banks continue more often, which, given their larger scale, can also potentially generate more social benefits (note a potential complementarity here).

Optimal intervention Now consider a contract between Country A and the bank specifying in the two countries a presence $\{q^m\}_{m\in\{A,B\}}$, a continuation scale $\{\xi^m\}_{m\in\{A,B\}} \in [1-x, 1]$, a liquidity allocation $\{T^m\}_{m\in\{A,B\}}$, and a date-0 transfer between the bank and country A, so as to maximize the joint surplus of the two players:

$$U + W^A = S(q^A) + \xi^A \beta q^A + \sum_m [(\xi^m b - c(q^m) - (\xi^m - (1-x))\rho]q^m].$$

This yields $\xi^B = 1$ if $b \geq \rho$ and $\xi^B = 0$ otherwise. Similarly, $\xi^A = 1$ if $b + \beta \geq \rho$ and $\xi^A = 0$ otherwise. As for the quantities, we have:

$$(b+\beta)\xi^A = c(q^A) + [\xi^A - (1-x)]\rho$$
$$b\xi^B = c(q^B) + c'(q^B)q^B + [\xi^B - (1-x)]\rho.$$

Output is greater in the Hegemon ($q^A > q^B$) for three reasons: (i) country A values investment on its soil ($\beta > 0$); (ii) country A values inframarginal rents on its soil ($c(q) < c(q) + c'(q)q$); and (iii) If $b + \beta > \rho > b$, investment in country A is more valuable than investment in country B, as it is optimal to continue it fully in country A but not in country B ($\xi^A = 1 > \xi^B = 1 - x$).

We could do the same computations, but *with fungibility.* Something we did not look at is whether the above assumes that ringfencing is feasible (it certainly seems to). A priori the bank is indifferent between rescuing a troubled project in country A and in country B, so maybe ringfencing is not needed; but this is very knife edged: a small noise around ρ for the troubled projects means that it is more reasonable to assume that ξ^m is the same in both countries.

5.2 Exchange rate appreciation in the special case

Now we introduce a date-1 exchange rate. We show that exchange rate appreciations are an unavoidable byproduct of successful industrial monetary policies. Exchange rate appreciations, in turn, are a limiting factor for industrial monetary policies by endogenously making them costlier to operate.

[28]Any transfer beyond this level is wasteful.

Assume that consumers in each country k have identical preferences $E[c_0^{k,A} + c_0^{k,B} + u(c_1^{k,A}, c_1^{k,B}) + c_2^{k,A} + c_2^{k,B}]$,where $c_t^{k,m}$ is the consumption of country k of good produced in country m at date t. Assume that investment in country i requires reinvestment in the goods produced in this country. Denote by l the endowment of goods in country i, which we assumed are also owned by consumers of country i. Then the exchange rate e of country A at date 1 is the relative price of good B vs. good A. We focus on the equilibrium with LOLR. We refer the reader to the appendix for an analysis of the equilibrium in the absence of LOLR.

With Cobb-Douglas preferences $u(c_1^{k,A}, c_1^{k,B}) = 2(c_1^{k,A} c_1^{k,B})^{\frac{1}{2}}$, the date-1 exchange rate is given by equating the demand for good A with the supply of good A net of taxes levied to finance the bank's continuation in both countries:

$$\frac{l - [\xi^A - (1-x)]\rho q^A + e[l - [\xi^B - (1-x)]\rho q^B]}{2} = l - [\xi^A - (1-x)]\rho q^A$$

which can be rewritten as:

$$e = \frac{l - [\xi^A - (1-x)]\rho q^A}{l - [\xi^B - (1-x)]\rho q^B}$$

The exchange rate of country A is more appreciated (e lower), the higher is q^A, the lower is q^B, the higher is ξ^A, and the lower is ξ^B:

$$\frac{\partial e}{\partial \xi^A} = e\frac{-\rho q^A}{l - [\xi^A - (1-x)]\rho q^A} < 0 \qquad \frac{\partial e}{\partial \xi^B} = e\frac{\rho q^B}{l - [\xi^B - (1-x)]\rho q^B} > 0$$

$$\frac{\partial e}{\partial q^A} = \frac{-[\xi^A - (1-x)]\rho}{l - [\xi^A - (1-x)]\rho q^A} < 0 \qquad \frac{\partial e}{\partial \xi^B} = e\frac{[\xi^B - (1-x)]\rho}{l - [\xi^B - (1-x)]\rho q^B} > 0.$$

The joint surplus of the bank and country A is now given by:

$$U + W^A = S(q^A) + \xi^A \beta q^A + \sum_m [\xi^m b - c(q^m)]q^m + \frac{l - [\xi^A - (1-x)]\rho q^A - e[\xi^B - (1-x)]\rho q^B}{e^{\frac{1}{2}}}$$

This expression is decreasing in e:

$$\frac{\partial (U + W^A)}{\partial e} = -\frac{1}{2e}\frac{l - [\xi^A - (1-x)]\rho q^A + e[\xi^B - (1-x)]\rho q^B}{e^{\frac{1}{2}}}$$

The first-order conditions are

$$\beta + b = \frac{\rho}{e^{\frac{1}{2}}} - \frac{1}{q^A}\frac{\partial (U + W^A)}{\partial e}\frac{\partial e}{\partial \xi^A}$$

$$b = \rho e^{\frac{1}{2}} - \frac{1}{q^B}\frac{\partial (U + W^A)}{\partial e}\frac{\partial e}{\partial \xi^B}$$

$$(b + \beta)\xi^A = c(q^A) + [\xi^A - (1-x)]\frac{\rho}{e^{\frac{1}{2}}} - \frac{\partial (U + W^A)}{\partial e}\frac{\partial e}{\partial q^A}$$

$$b\xi^B = c(q^B) + c'(q^B)q^B + [\xi^B - (1-x)]\rho e^{\frac{1}{2}} - \frac{\partial (U + W^A)}{\partial e}\frac{\partial e}{\partial q^B}.$$

At the optimum, the date-1 exchange rate is appreciated ($e < 1$). The desire of country A to expand bank activities more in country A than in country B leads to more liquidity injections in country A at date 1, which in turn increases the demand for country A's currency and appreciates country A's exchange rate. As for banking activities, there are new forces: liquidity injections in A (B) are more (less) costly because the exchange rate of country A is appreciated at date 1 (this pushes towards lower q^A, higher q^B, lower ξ^A, higher ξ^B); liquidity injections in A (B) appreciate (depreciate) the country A exchange rate and help (hurt) country A's terms of trade manipulation (this pushes towards higher q^A, lower q^B, higher ξ^A, lower ξ^B). The first force captures exchange rate appreciations as a limiting factor for industrial monetary policies.

5.3 Conjectures on the extension of the basic model

[*This subsection too is highly tentative.*] At date 0, utility is transferable between banks (which have cash) and the countries, and so we assume that a country can charge banks for access to LOLR services. For simplicity, we assume that bank i has stronger presence in country k and that country k can offer LOLR service to only bank i (and similarly for bank j and country l) [*Note: an alternative is that LOLR deals are secret.*] The goal of such an agreement is to maximize the joint surplus

$$W^k + U_i = [F(\rho_j^*)\beta q_j^k + F(\rho_i^*)[\beta - M^-(\rho_i^*)]q_i^k + S^k(q^k) - F(\rho_i^*)M^-(\rho_i^*)q_i^l] + [F(\rho_i^*)(q_i^k + q_i^l)b - [\sum_m c(q^m)q_i^m]]$$

Unconditional LOLR Suppose, first, that the pledged liquidity support offered by country k is simply a level T_i^k and that the LOLR agreement cannot specify anything relative to the size of establishments. Keeping quantities fixed, there are indeed gains from trade and therefore scope for LOLR, as the optimal support would be given by $\rho_i^* = \beta\sigma_i^k + b$. However a new form of leakage appears: there is no longer a reason for the bank to specialize. Pledging unconditional liquidity support is a failed industrial policy in this environment.

Conjecture: Under some conditions, it is not worth granting LOLR (another take on the same point is that supervision & ringfencing is complementary with LOLR) . This is clearly the case for limited levels of LOLR, i.e. levels $T_i^k = F(\rho_i^*)M^-(\rho_i^*)q_i^* + \varepsilon$, where stars refer to the equilibrium of Section 2. The gain in terms of insurance is modest, but guaranteed support triggers a massive reallocation of activity benefiting the foreign country.

Conditional LOLR Let us now assume that country k can offer LOLR service to bank i, that specifies not only some liquidity support, but also a presence in each country. This is equivalent to specifying a vector $\{\rho_i^*, q_i^k, q_i^l\}$.

Conjecture: there are three benefits of LOLR for the bank-country coalition (some of these benefits are akin to protectionism, though, and it is not clear that such policies make the world a better place- to be studied) :

- *Insurance*

- *Increase in the presence of country k*
- *Reduction in the presence in country l (inducing the bank to internalize some if the externality of leakage)*

6 Extensions

References

[1] Bolton, P. and M. Oehmke (2019) "Bank Resolution and the Structure of Global Banks," *Review of Financial Studies*, 32(6): 2384–2421.

[2] Calzolari, G. and G. Loranth (2011) "Regulation of Multinational Banks: A Theoretical Inquiry," *Journal of Financial Intermediation*, 20: 178–198.

[3] Cerutti, E., Dell'Ariccia, G. and S. Martínez Pería (2007) "How Banks Go Abroad: Branches or Subsidiaries?" *Journal of Banking and Finance*, 31: 1669–92.

[4] Corsetti, G., Guimaraes, B. and N. Roubini (2006) "International Lending of Last Resort and Moral Hazard: a Model of IMF's Catalytic Finance," *Journal of Monetary Economics*, 53: 441–471.

[5] Danisewicz, P., Reinhardt, D. and R. Sowerbutts (2017) "On a Tight Leash: Does Bank Organizational Structure Matter for Macroprudential Spillovers?" *Journal of International Economics*, 109: 174–194.

[6] Dell'Ariccia, G. and R. Marquez (2010) "Risk and the Corporate Structure of Banks," *Journal of Finance*, 65: 1075–96.

[7] Dewatripont, M. and J. Tirole (2019) "Liquidity Regulation, Bail-ins and Bailouts," mimeo.

[8] Farhi, E. and J. Tirole (2012) "Collective Moral Hazard, Maturity Mismatch and Systemic Bailouts," *American Economic Review*, 102: 60–93.

[9] Farhi, E. and J. Tirole (2018) "Deadly Embrace: Sovereign and Financial Balance Sheets Doom Loops," *The Review of Economic Studies*, 85(3): 1781–1823.

[10] Farhi, E. and J. Tirole (2021) "Shadow Banking and the Four Pillars of Traditional Financial Intermediation," *The Review of Economic Studies*.

[11] Farrel, J. and N. Gallini (1988) "Second-Sourcing as a Commitment: Monopoly Incentives to Attract Competition," *Quarterly Journal of Economics*, 103: 673–694.

[12] Fiechter, J., Otker-Robe, I., Ilyna, A., Hsu, M., Santos, A., and Surti, J. (2011) "Subsidiaries or Branches: Does One Size Fit All?" IMF Staff Discussion Note, March.

[13] Giannetti, M. and L. Laeven (2012) "The Flight Home Effect: Evidence from the Syndicated Loan Market during Financial Crises," *Journal of Financial Economics*, 104: 23–43.

[14] Morrison, A. and L. White (2009) "Level Playing Fields in International Financial Regulation," *Journal of Finance*, 64:1099–1142.

[15] Rochet, J.C. and X. Vives (2004) "Coordination Failures and the Lender of Last Resort: Was Bagehot Right after All?" *Journal of the European Economic Association*, 2:1116–1147.

[16] Schoenmaker, D. (2015) "The New Banking Union Landscape in Europe: Consolidation Ahead?" *The Journal of Financial Perspectives*, 3 (2), 189–201.

[17] Schoenmaker, D. (2018) "Resolution of international banks: Can smaller countries cope?" *International Finance*, 21 (1), 39–54.

[18] Schoenmaker, D. and W.B. Wagner (2013) "Cross-border Banking in Europe and Financial Stability," *International Finance*, 16 (1), 1–22.

[19] Schoenmaker, D. (2013) *Governance of International Banking: The Financial Trilemma*, New York: Oxford University Press.

[20] Shepard, A. (1987) "Licensing to Enhance Demand for New Technologies," *Rand Journal of Economics*, 18: 360–368.

[21] Tirole, J. (2003) "Inefficient Foreign Borrowing: A Dual-and Common-Agency Perspective," *American Economic Review*, 93(5): 1678–1702.

[22] Tirole, J. (2015) "Country Solidarity in Sovereign Crises," *American Economic Review*, 105(8): 2333–2363.

[23] Tooze, A. (2018) "The Forgotten History of the Financial Crisis," *Foreign Affairs*, September/October, 199–210.

[24] Valiante, D. (2016) "Europe's Untapped Capital Market," Vox EU, March 13.

[25] Vives, X. (2011) "Competition Policy in Banking," *Oxford Review of Economic Policy*, 27: 479–497.

[26] Vives, X. (2016) *Competition and Stability in Banking: The Role of Regulation and Competition Policy*, Princeton University Press

Appendix

Exchange rate in the special case without LOLR. We examine the equilibrium in the absence of LOLR. How does the bank split liquidity support at date 1? For simplicity, we assume that the liquidity is given to the bank in a way that neutralizes changes in the exchange rate brought about by changes in the split (this can be done by making the liquidity support contingent on the exchange rate, for example via an appropriate currency composition). This ensures that the bank does not seek to manipulate the exchange rate when it decides its split, and chooses the same cutoff for all projects. There are two possible equilibria: I (insured) and D (diversified). The equilibrium depends on which of these equilibria yields higher utility to the bank.

In the first possible equilibrium, the bank is specialized in country A, country A's exchange rate is appreciated $e < 1$, and country A provides liquidity support. Country A provides liquidity (and then $\xi^A = \xi^B = \xi$) up to the point where

$$\beta q^A - \frac{\rho}{e^{\frac{1}{2}}} q^A - \rho e^{\frac{1}{2}} q^B - \frac{1}{2e} \frac{l - [\xi - (1-x)]\rho q^A - e[\xi - (1-x)]\rho q^B}{e^{\frac{1}{2}}} \frac{\partial e}{\partial \xi} = 0$$

or at a corner ($\xi = 1$ or $\xi = 1 - x$) if the condition holds as an inequality ($\geq$ or $\leq$), where

$$e = \frac{l - [\xi - (1-x)]\rho q^A}{l - [\xi - (1-x)]\rho q^B}$$

$$\frac{\partial e}{\partial \xi} = -\frac{\rho (q^A - q^B) l}{[l - [\xi - (1-x)]\rho q^B]^2}.$$

Let $\xi(q^A, q^B)$ be the solution. At date 0, if there is a single bank, its solves[29]

$$U^I = max_{\{q^A, q^B\}} \{b \xi(q^A, q^B)(q^A + q^B) - c(q^A) q^A - c(q^B) q^B\}$$

Specializing increases liquidity support, but appreciates the exchange the exchange rate, which triggers the two offsetting forces described above.

In the second possible equilibrium, the bank diversifies, and $e = 1$. Its utility is

$$U^D = max_q \{2[(1-x) b \frac{q}{2} - c(\frac{q}{2}) \frac{q}{2}]\}$$

and

$$q^D = (1-x) b$$

exactly as above.

[29]For example, suppose that the equilibrium is such that $\xi = 1$. This means that

$$U^I = max_{\{q^A, q^B\}} \{b(q^A + q^B) - c(q^A) q^A - c(q^B) q^B\}$$

s.t.

$$\beta \frac{q^A}{q^A + q^B} - \frac{\rho}{e^{\frac{1}{2}}} \frac{q^A}{q^A + q^B} - \rho e^{\frac{1}{2}} \frac{q^B}{q^A + q^B} + \frac{1}{2e} \frac{l - x\rho q^A - ex\rho q^B}{e^{\frac{1}{2}}} \frac{\rho (q^A - q^B) l}{(l - x\rho q^B)^2} = 0$$

where

$$e = \frac{l - x\rho q^A}{l - x\rho q^B}$$