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Carlos Cañón Salazar,[1] Misa Tanaka[2] and John Thanassoulis[3]

Abstract

We develop a game-theoretic model in which financial regulators compete to attract internationally mobile banks by setting the level of regulatory stringency to meet both financial stability and growth objectives. We show that competitive deregulation will not arise if the relatively growth-focused regulator becomes even more growth focused, but it becomes more likely if the relatively stability-focused regulator becomes more growth focused. We also demonstrate that domestic nonregulatory inducements to retain banks (eg tax, labour laws) create an externality on the global equilibrium of regulatory stringency chosen by financial regulators with a growth objective.

Key words: Financial regulation, global financial markets, growth, competitiveness.

JEL classification: G18, G28, F43, L50.

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(1) Bank of England. Email: carlos.canonsalazar@bankofengland.co.uk
(2) Bank of England. Email: misa.tanaka@bankofengland.co.uk
(3) Warwick Business School, University of Warwick and CEPR and UK Competition and Markets Authority. Email: john.thanassoulis@wbs.ac.uk

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Bank of England, Threadneedle Street, London, EC2R 8AH
Email: enquiries@bankofengland.co.uk

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1. Introduction

Three out of the four top financial centres, other than New York, are currently overseen by a financial regulator which has an explicit objective to enhance the competitiveness of its financial centre and so increase the nation's growth.[1] For most of the last decade (2013-2023), the Monetary Authority of Singapore (MAS) has been the most growth focused of the leading financial centres, followed by the Hong Kong Monetary Authority (HKMA), according to our textual analysis of their annual reports (See Section 7 and especially Figure 7). The MAS has a development objective of growing Singapore into an internationally competitive financial centre, and has quantitative targets for financial sector real value added and productivity, as well as net job creation in financial services and the FinTech sector.[2] Similarly, the HKMA has as one of its key functions to "*help maintain Hong Kong's status as an international financial centre, including the maintenance and development of Hong Kong's financial infrastructure*", and dedicates a chapter of its annual report to this objective.[3] More recently, the UK's Prudential Regulation Authority (PRA) acquired a secondary objective on competitiveness and growth in 2023, which is reflected in an uptick in our textual measure of growth focus.[4] This secondary objective requires the PRA to seek to enhance the competitiveness of the UK's financial system and so increase UK growth over the medium to long-term, as long as doing so is compatible with the safety and soundness of financial institutions.

Yet there is little research on how the inclusion of growth and competitiveness into

[1] According to the Global Financial Centre Index (Z/Yen and CDI, 2024), New York is ranked as the top financial centre as of 2024, followed by London, Hong Kong and Singapore.

[2] See "Monetary Authority of Singapore (Amendment) Bill 2017" - Second Reading Speech by Mr Ong Ye Kung, Minister for Education (Higher Education and Skills) and Second Minister for Defence, on behalf of Mr Tharman Shanmugaratnam, Deputy Prime Minister and Minister-in-charge of the Monetary Authority of Singapore, on 4 July 2017 (mas.gov.sg), and Financial Services Industry Transformation Map at MAS launches Financial Services Industry Transformation Map 2025.

[3] See Hong Kong Monetary Authority - Annual Report (hkma.gov.hk)

[4] see: Our secondary objectives — Bank of England

regulators' objectives influences their policies, and how these will in turn influence the financial institutions' choice of where to locate their headquarters, subsidiaries and banking activities. We study this question. Using a game-theoretic model, this paper examines how financial regulators' pursuit of growth objectives influences equilibrium financial stability and regulatory stringency across jurisdictions.

In our two-country model, each regulator sets the level of regulatory stringency to maximise its objective, which consists of a 'stability objective' to minimise the expected cost of bank failures, and a 'growth objective' to maximise the gross value added from financial intermediation.[5] Regulatory stringency in our model captures the full package of regulations, supervisory requirements and the manner of their enforcement. A higher level of regulatory stringency lowers the probability of bank failure but increases the operational costs for banks. We assume that, while some banks are committed to operating in a specific country, others are internationally mobile and thus optimise their locations, e.g. of their headquarters, subsidiaries, and specific activities. The geographic flexibility of a bank is private information to the bank. Internationally mobile banks choose to operate from the country that offers a level of regulatory stringency which maximises their expected profits. In this work we refer to banks to capture banking groups, subsidiaries, or specific banking activities (e.g. capital provision via loans, equity, debt, or other security). The level of regulatory stringency thus affects growth both via the number of internationally mobile banks attracted to the country, and the expected gross value added generated by all banks operating in the country.[6]

[5]We use 'banks' as a shorthand, but our analysis is applicable to a more general situation in which financial regulators compete to attract financial firms to their jurisdictions.

[6]We acknowledge that there could be additional channels via which financial regulation could affect growth, e.g. by influencing the ability of domestic and foreign financial firms to trade across the border, and by incentivising them to allocate capital efficiently so as to enhance the productivity in the non-financial sector. We also note that there could be situations where promotion of financial stability and growth go hand-in-hand, but we do not consider such a case where all parties agree that a regulatory approach is in everyone's interest as these are good ideas and are analytically uninteresting.

Our analysis focuses on a general case in which the two regulators have different weights on growth and stability in their objective functions. We label throughout regulator 2 as more growth focused than regulator 1, i.e. regulator 2 has a higher weight on growth in its objective function than regulator 1. Our first result is to characterise the nature of the competitive equilibrium between the two regulators. If regulator 2 places a sufficiently high weight on growth relative to regulator 1, then a pure strategy equilibrium exists. Both regulators optimally set the regulatory stringency at their respective 'closed-economy optimal' levels, i.e. the levels which they would choose if they did not have to consider attracting mobile banks to their country. As the stability-focused regulator 1 expects growth-focused regulator 2 to aggressively compete for mobile banks, regulator 1 willingly cedes the internationally mobile banking market to its rival. (Proposition 1). Thus, all the internationally mobile banks locate in the growth-focused jurisdiction in equilibrium.

However, the pure strategy breaks down and a mixed-strategy equilibrium arises if regulator 1's weight on growth in its objective function is close enough to that of regulator 2 (Theorem 1). The form of the mixed strategies is new. Both regulators must decide whether they will seek to win internationally mobile banks, or instead focus on maximising the net benefits produced by the banks tied to the domestic market. If they decide not to compete, then the regulators set their closed-economy optimal levels of stringency. But if they decide to compete, then competitive deregulation arises, whereby the regulators choose the levels of stringency from a continuous distribution which stretches down to levels below their closed-economy optimal levels. We show that this lower bound is set by the stability-focused regulator, i.e. the extent to which it chooses to compete with the growth-focused regulator. We also demonstrate that the competition between the two regulators does not lead to a 'race-to-the-bottom': we define this as a situation in which at least one regulator offers the level of regulatory stringency that maximises banks' profits. A race-to-the-bottom is ruled out as regulators internalise the externality from bank failures and thus always prefer a level of stringency which is higher than the level preferred by banks.

We then examine the comparative statics properties of the mixed strategy equilibrium by analysing how global regulatory stringency is affected if one of the two regulators is given a more growth-focused objective. We show that the outcome will differ depending on which regulator is made more growth focused.

We demonstrate that competitive deregulation will not arise if regulator 2, the comparatively more growth focused regulator, becomes even more growth focused. As regulator 2 becomes more likely to compete more aggressively, the benefit of competing for regulator 1 declines. Thus, regulator 1 competes less aggressively, and raises its regulatory stringency in a first-order-stochastic-dominant manner (Proposition 2). In turn this leads to regulator 2 'winning' more mobile banks, and this is achieved without any reduction in the lower-bound of the range of regulatory stringency offered by the two regulators.

Matters are different, however, if the relatively more stability focused regulator, regulator 1, has its focus on growth strengthened. In this case we show (Proposition 3) that both regulators will compete more aggressively for mobile banks so both become more likely to set low levels of regulatory stringency. In all cases regulatory stringency does not drop 'to the bottom', i.e. to the levels preferred by banks. So competitive deregulation is always limited even without explicit international coordination.

Finally, we examine how the equilibrium regulatory stringency changes if the proportion of internationally mobile banks (or recall we include here the proportion of internationally mobile banking activities) were to increase. Such a change is the natural outcome of domestic policies (such as tax and labour laws) which are outside the scope of financial regulation. We find that such an increase in the willingness of banks to move internationally causes the regulatory stringency offered by the growth-focused regulator to decline, as it becomes relatively more important to secure the international mobile banks. The stability-focused regulator also becomes more willing to lower regulatory stringency to attract the larger pool of mobile banks, and this causes the global lower bound of regulatory stringency to decline. However, the effect on the average regulatory levels offered by the stability focused regulator is ambiguous. This result implies that the enaction of a growth objective creates an externality between global financial regulation and broader social and economic policy which affects the willingness of banks to move internationally.

The rest of the paper is organised as follows. Section 2 reviews the relevant literature. Section 3 outlines our two-country model. Section 4 derives the conditions in which pure strategy and mixed strategy equilibria arise when regulator 2 is more growth focused than regulator 1. Section 5 examines the comparative statics properties of the mixed strategy equilibrium in response to one regulator becoming more growth focused. Section 6 examines the impact of a reduced number of banks committed to each country on the mixed strategy equilibrium. Section 7 explores some of the policy implications of the study using textual analysis to rank the growth focus of the leading financial centres empirically before concluding.

2. Literature Review

We contribute to the theoretical literature which studies financial regulation when regulators are in some form of competition with each other. Dell'Ariccia and Marquez, 2006 is perhaps the first work which formalised the concern of a race-to-the-bottom. In their two country model, regulators set the monitoring effort which banks headquartered in their jurisdiction must exert. This work took the approach, not shared by us or others, that banks can be active without constraint in either country and can apply the home level of regulation to their activities in both countries. As a result a bank incorporating in a jurisdiction with the lowest level of regulation, and competing globally, has an advantage.

Bahaj and Malherbe, 2024 builds on Dell'Ariccia and Marquez, 2006 by refocusing the analysis on the competition for scarce bank equity capital. Dropping the assumption in Dell'Ariccia and Marquez, 2006 that banks could compete freely across borders, Bahaj and Malherbe, 2024 require banks to meet local capital adequacy rules. This helps to limit the race-to-the-bottom effect between regulators. Bahaj and Malherbe, 2024 use their model to argue that an increase in the capital requirement in a country does not necessarily generate outflow of bank equity capital. This analysis is complementary to ours as we consider a setting in which banks have to choose where to headquarter or locate specific activities, and regulators compete for these by setting the level of overall regulatory stringency.

An important contribution of our work is to study settings in which regulators have different objectives. We have noted that recently some jurisdictions have altered the objectives of their regulator to explicitly target growth, while others have not.[7] This aspect of our analysis builds on the literature started by Morrison and White, 2009 who study the effects of some regulators being naturally more skilled than others. We share with Morrison and White, 2009 the feature that banks must choose where to headquarter (or locate its activities) and so regulators compete. In Morrison and White, 2009 banks prefer skilled regulators and this has externalities on the financial regulations chosen by the less skilled jurisdictions. Our analysis differs as we suppose regulators are equally skilled but have different objectives, and thus offer a level of regulatory stringency to banks to optimise over their growth and stability objectives.

More broadly there is a rich research stream which considers the implications

[7]At section 7 we present evidence, using textual analysis of annual reports from local financial regulators, that countries differ in their preference for growth. We also discuss its evolution during the last decade.

of multiple regulators in different jurisdictions. Colliard, 2019 studies the optimal supervisory architecture in an environment where supervision is a joint responsibility between central supervisors – who have some visibility of cross-border externalities – and local supervisors who know the regulated entity better. Calzolari, Colliard, and Lóránth, 2018 studies the strategic game between a multinational bank active in multiple countries and the monitoring incentives of the different national regulators. Here free-riding between regulators is at issue and can sometimes be mitigated by the presence of a multinational supervisor.[8] Farhi and Tirole, 2024 model the intra-supervisor game after a liquidity shock. They note that as bailout money is fungible supervisors will be reluctant to bail out a bank which is active in multiple jurisdictions as their funds will help support projects in other countries, and they can hope to free-ride on other countries' bailouts. As a result banks endogenously prefer to concentrate their footprint in just one country. Korinek, 2016 takes a second fundamental welfare theorem approach and argues that if one country implements fiscal or monetary policy restrictions, then welfare maximisation may require a second country to take an offsetting position. Similar conclusions are reached by Buck and Schliephake, 2013 and Gersbach, Haller, and Papageorgiou, 2020. Our work differs from this wider approach by studying the decision banks make as to where to incorporate and locate their activities, and the competition between regulators to win these when they have both stability and growth objectives.

3. Model

We first introduce the banks and the regulatory technology. Subsequently, we describe the regulators' objective functions reflecting the desire for both growth and financial stability. Finally, we establish the global economy optimal benchmark against which we can judge the effects of competition.

[8] See also Faia and Weder, 2016, and Bolton and Oehmke, 2018.

3.1. Banks and the regulatory technology

There are two countries labelled $i = \{1, 2\}$, and three time periods, $T = 0, 1, 2$. There is a measure 1 of risk-neutral banks. We use bank as a shorthand to denote the headquarters of a banking group, subsidiary, or specific banking activity (e.g. capital provision via some security). Our model bears any such interpretation.[9] A proportion B_i of the banks are committed to remain in country i and are thus immobile. The identity of these immobile banks is not observable. This assumption captures that all banks and financial institutions can threaten to locate to a foreign country, but for some this may be a bluff.[10] The remaining banks (measure $1 - B_1 - B_2$) are internationally mobile and are willing to locate in either country.

Banks bring skills to intermediate international finance: they are able to raise capital from risk-neutral, uninformed international capital providers, then identify and provide capital to projects run by risk-neutral entrepreneurs in the country in which they locate. At $T = 0$, each bank approaches each of the regulators in country $i \in \{1, 2\}$ and asks what level of regulatory stringency t_i the regulator proposes to impose on the bank should it locate to the country. The regulator privately offers a level of regulatory stringency to each bank. The level of stringency t_i captures the reduction in bank profits which would be caused by this level of stringency as compared to the bank's preferred level of regulatory stringency. This stringency measure is an expansive representation of all the impositions placed on the bank by the regulator. The offered level of stringency can be the same for all banks or can differ between them. The stringency measure t_i will of course include the capital

[9] Thus, our analysis captures a situation where each bank in country i decides how much of its activities can be moved abroad.

[10] For example it may be that a sufficient number of the executive team is unwilling to relocate their families to the other country so as to make the threat of relocation empty. Immobile banks can equivalently be thought of as those banks which are committed to operating in a given country due to its attractiveness on dimensions other than financial regulation (e.g. taxes, labour laws and infrastructure). Farhi and Tirole, 2024 show banks may face strong incentives to concentrate their footprint in just one country.

adequacy and liquidity requirements, but also the wider costs of complying with all regulations. These could, for example, include the amount of information requested by the regulator, any restrictions imposed on the bank's business model, business approval processes such as those for getting internal risk models underpinning capital requirements accepted, and any fee which funds the regulator and must be paid for the license to operate.[11] As we discuss later, the level of t_i influences the locational choice of mobile banks, but it does not influence the measure of immobile banks tied to each country, B_i.

A higher level of regulatory stringency t_i increases the cost to banks but reduces the probability of failure of their projects, and thus the probability of bank failure, denoted as $g(t_i)$. The function $g(\cdot)$ can be interpreted as the regulatory technology, which we assume is common across the two countries. Thus, we do not assume that one country has more skilled regulators than another. We assume that the level of regulatory stringency is range-bound, such that $t_i \in [0, \bar{t}]$. The lower bound, $t_i = 0$, is the profit-maximising level of regulatory stringency for banks, i.e. the minimum level of regulatory stringency below which even the regulated banks would not want to go.[12] In what follows, we define a 'race-to-the-bottom' as a situation in which at least one regulator sets the stringency level at $t_i = 0$ in order to attract banks. The upper bound $t_i = \bar{t}$, indexes the level of regulatory stringency at which banks will become perfectly safe. As the regulators share the same technology the stringency

[11]For example the UK has outlined a number of ways in which it has sought to reduce the burden of regulatory stringency after it was given a secondary objective on competitiveness and growth in PRA Report to the UK Parliament, 30 July 2024. These include streamlined rules for risk calculations in particular with respect to counterparties, more leniency on internal models, a more relaxed approach to branching, and the removal of some restrictions on the way banks and financial institutions choose to pay their staff (removal of the bonus cap). See Woods, 2024 for PRA's proposed future plans for regulatory changes, which include a reduction in the bonus deferral period.

[12]Banks would prefer not to locate in a country which sets regulatory stringency below this level as they consider that this would create an environment which is too risky and unstable. Thus, there is no trade-off between growth and financial stability when $t < 0$: we will not examine this parameter range as it is not analytically interesting, and regulators which care about externalities from bank failures will never set the regulatory stringency in this parameter range.

bounds are common across the jurisdictions.

The actual range of t_i that the regulator in country i will choose to offer to banks will be endogenously determined in equilibrium. It will depend on the objective function of the regulators, as we will discuss below. To solve for the equilibrium, we make a number of assumptions about the regulatory technology:

Assumption 1.

$$g' < 0 \ , g'' > 0 \ , \ g(0) = c \in (0,1), \ \exists \ \bar{t} \ s.t. \ \lim_{t_i \to \bar{t}} g(\bar{t}) = g'(\bar{t}) = 0.$$

The first two parts of Assumption 1 imply that the more stringent the regulation, the lower will be the probability that any given bank in that country will fail, whilst the marginal benefit of additional regulatory stringency decreases. The third part implies that if the regulatory stringency is at the lower bound (which is preferred by the banks), then the probability of bank failure lies between 0 and 1. The final part implies that banks become perfectly safe at the upper bound of regulatory stringency, $\bar{t}$.

At time $T = 1$, internationally mobile banks decide which country's offer to accept. Though banks are transnational, their choice of headquarters for given business lines or subsidiaries is often significant for politicians who desire growth. Securing the location of a corporate headquarters is important for the level and stability of profits booked (and jobs kept) in a country (Dischinger, Knoll, and Riedel, 2014). Politicians are willing to underwrite significant subsidies to attract headquarter functions – such as Maryland offering $8.5 billion to Amazon in subsidies and tax deals to try to secure the location of Amazon's second HQ.[13] After mobile banks choose the country to operate in, they are matched with a potential project and its controlling entrepreneur, and intermediate capital from international capital providers to the

[13]See Amazon HQ2's 50,000 jobs will cost New York and Virginia $4.2 billion.

project. We assume that entrepreneurs and projects are in elastic supply so that as the number of banks in the country increases it remains possible for each bank to be matched with a productive entrepreneur.[14] We assume that each bank can oversee one project run by an entrepreneur, and each project requires one unit of investment.

At time $T = 2$ each bank's project generates $(1 + R)$ if it succeeds, while it fails with probability $g(t_i)$ and yields zero return. Note that the probability of success depends upon the quality of regulation capturing that good regulation supports appropriate project risk management, monitoring and generates a stable market environment facilitating entrepreneurs' projects to succeed.[15] In the case of success the project returns are divided between the entrepreneurs, banks and capital providers. All parties receive zero when the project fails. We assume that banks have the skill to generate the same return R from their entrepreneur's project regardless of which country they choose to locate in.

We denote the payoff of entrepreneurs, banks and capital providers as P_E, P_B, and P_C, respectively. We assume that international capital providers are in excess supply and have no bargaining power. The real interest rate they earn is normalised to 0. Thus, we have

$$P_C \cdot (1 - g(t_i)) = 1 \;\Rightarrow\; P_C = \frac{1}{1 - g(t_i)}.$$

At time $T = 1$, entrepreneurs and banks bargain over how to share the remaining

[14] The entrepreneurs could be from the domestic country, or could have come to the country from abroad in order to receive the bank's funding. See Davies and Killeen, 2017 which found that the financial development of a country increases the probability of that country being chosen as the location of a newly incorporated foreign affiliates in the non-bank financial sector. Bruno and Hauswald, 2014 also finds evidence that domestic lending by foreign banks alleviates financial constraints and increases real growth net of competitive reaction of local banks.

[15] In principle the economy in country i might be more conducive to business than in country j so that $R_i \geq R_j$. Allowing for this would add some complication to the analysis, but it would not affect our results. We simplify by setting aside exogenous differences in the quality of the commercial environment across the countries: $R_1 = R_2 = R$.

returns from the project when it is successful. We denote the entrepreneurs' share of the remaining return as $\gamma \in (0,1)$, which reflects their bargaining power. For simplicity, we assume γ is common across the two countries. Thus, the payoffs for the entrepreneurs and the banks in country i when the funded project is successful satisfy:

$$\left.\begin{array}{c} P_E + P_B = 1 + R - P_C \\ P_E : P_B \ = \ \gamma : 1-\gamma \end{array}\right\} \Rightarrow \left\{\begin{array}{c} P_E = \gamma\left[1 + R - \frac{1}{1-g(t_i)}\right] \\ P_B = (1-\gamma)\left[1 + R - \frac{1}{1-g(t_i)}\right] \end{array}\right. .$$

Entrepreneur's profits. From the above, the expected profit of an entrepreneur who is funded in country i is given by:

$$\Pi_E(t_i) = P_E \cdot (1 - g(t_i)) = \gamma\left[R - g(t_i)(1+R)\right]$$

Note that $g'(t_i) < 0 \Rightarrow \Pi_E'(t_i) > 0$. Thus, conditional on receiving bank funding, the entrepreneurs' payoff is increasing in the regulatory stringency, t_i. This reflects that well regulated banks will monitor their entrepreneurs more closely such that the probability of project success increases.

We assume that the project has a positive net present value at all considered regulatory levels, $\Pi_E(t_i) > 0$ for all t_i. This is delivered by:

Assumption 2.

$$R - g(0)(1+R) > 0. \tag{1}$$

Assumption 2 is guaranteed if $c(= g(0))$, the probability of bank failure, is not too large.

Banks' profits. From the above, the expected profits of banks which chose to locate in country i are given by:

$$\Pi_B(t_i) = P_B \cdot (1 - g(t_i)) - t_i = (1-\gamma)\left[R - g(t_i)(1+R)\right] - t_i$$

We make two assumptions on banks' expected profits. The first is that we assume that banks prefer low regulatory stringency to high regulatory stringency in the considered range, so that $\Pi'_B(t_i) < 0$ for all $t_i \in [0, \bar{t}]$. This is guaranteed if

Assumption 3.

$$1 > -g'(t_i) \cdot (1 + R)(1 - \gamma) \ \forall t. \tag{2}$$

This preference of banks for low regulation is equivalent to an assumption that the entrepreneur's bargaining power γ is large: this is consistent with a competitive credit market.

The second assumption is that the bank is willing to operate even if the regulator is maximally focused on safety and soundness. This occurs if $\Pi_B(\bar{t}) > 0$ i.e.:

Assumption 4.

$$\bar{t} < (1 - \gamma)R. \tag{3}$$

3.2. The regulators' objective function

Before solving our model we first define the closed-economy regulatory objective function in which regulators do not seek to attract mobile banks. We define regulator i's 'closed-economy' objective function as follows:

$$W(\alpha_i) := \alpha_i \underbrace{(\Pi_E + \Pi_B)}_{\text{Surplus from financial intermediation}} -(1 - \alpha_i) \underbrace{Lg(t_i)}_{\text{Bank failure externality}} \tag{4}$$

In equation (4) L captures the negative externalities generated by a bank failure: this includes the cost of bank resolution and reputational damage incurred by the regulator. The sum of the profits of entrepreneurs and bankers captures the total surplus (or gross value added) created by financial intermediation.[16] More stringent

[16]The government may want the financial regulator to care about the gross value added produced by financial intermediation as it is likely correlated with tax receipts and employment in related sectors.

regulation (a higher t) can reduce the overall surplus from financial intermediation while it also reduces the expected cost of bank failures. The parameter $\alpha_i \in [0,1]$ is a critical part of our model. This parameter captures regulator i's preference over the two objectives of maximising total surplus from financial intermediation and minimising the expected cost of bank failures. For simplicity, we refer to the first component of the regulator's objective function as the 'growth objective', and the latter part as the 'stability objective'. A high α_i implies greater growth focus: if $\alpha_i = 0$ then the regulator is focused exclusively on the stability objective, whereas $\alpha_i = 1$ implies that the regulator is focused exclusively on growth.[17] As regulators' objectives are typically determined by the domestic political process, we assume α_i is exogenous.

This closed-economy objective function simplifies to

$$W(t_i;\alpha_i) = \alpha_i \left(R - g(t_i)(1+R) - t_i\right) - (1-\alpha_i)Lg(t_i) \tag{5}$$

Given Assumption 1 that $g(\cdot)$ is convex, $W(\cdot;\alpha_i)$ is concave with respect to t_i:

$$g'' > 0 \Rightarrow \; W_{tt} < 0 \tag{6}$$

where the subscripts denote derivatives. Each country therefore has an optimal closed-economy level of regulatory stringency, $t^*(\alpha_i)$ which is a function of the regulator's preference.

We introduce an additional assumption that the regulator's preferred closed-economy level of regulatory stringency exceeds the banks' preferred minimal level of

[17] This reduced-form objective function does not explicitly capture the possibility of a hierarchical objective, in which the growth objective is made explicitly secondary to the stability objective, e.g. in the case of the UK's Prudential Regulation Authority (PRA) and Financial Conduct Authority (FCA). This formulation is used for analytical tractability, as it is often used to describe a central bank's objective in the monetary policy literature.

stringency, $t = 0$. This is delivered by assuming that $W_t(0;\alpha_i) > 0 \ \forall \ \alpha_i \ \in \ [0,1]$, and this is guaranteed by

Assumption 5.

$$-g'(0)(1+R) - 1 > 0 \tag{7}$$

It is useful to note that the objective function W is strictly positive at the highest level of regulatory stringency, i.e. $W(\bar{t};\alpha_i) = \alpha_i(R-\bar{t}) > 0 \ \forall \alpha_i > 0$.[18]

If regulator i is exclusively focused on safety and soundness ($\alpha_i = 0$) then the closed-economy objective function is increasing in t_i, and it has a finite maximum at $\bar{t}$. On the other hand, if regulator i cares about growth ($\alpha_i > 0$), then there is an interior optimum, $t^*(\alpha_i) < \bar{t}$.[19] It follows that

$$W(t^*(\alpha_i);\alpha_i) > W(\bar{t};\alpha_i) > 0 \ \text{ if } \alpha_i \in (0,1]. \tag{8}$$

So the closed-economy objective function is positive at the optimal choice of regulatory stringency.

We conclude the model with two useful results characterising the nature of the closed-economy optimal level of regulatory stringency.

Claim 1. *The closed-economy objective function evaluated at $t^*(\alpha_i)$ is increasing in the regulator's focus on growth.*

$$\frac{d}{d\alpha_i} W(t^*(\alpha_i);\alpha_i) > 0$$

Proof. All omitted proofs are contained in Appendix A. ■

Claim 1 is an application of the envelope theorem. If the regulator is endowed with a greater focus on growth ($\alpha_i \uparrow$), then that causes the regulator to place more

[18] This is guaranteed by assumption 4: $R > \frac{\bar{t}}{1-\gamma} > \bar{t}$.
[19] Follows as $W_t(\bar{t};\alpha_i) = -\alpha_i < 0$, by assumption 1.

weight on the expected surplus created by the bank-entrepreneur pairs, and less weight on the negative externalities which arise in the event of a bank failure. As the surplus of the bank-entrepreneur pairs is positive, whereas the externality of bank failure is negative, a greater focus on the former explains the result.

Second, observe that the first-best level of regulatory stringency which regulator i would set in a closed economy, $t^*(\alpha_i)$, is defined implicitly by the first-order condition:

$$W_t(t^*(\alpha_i); \alpha_i) = 0 \tag{9}$$

as W is concave in t (see (6)). This closed-economy optimal level of regulatory stringency has the following characteristics:

Claim 2. *The first best level of regulatory stringency in a closed economy declines in growth focus:*

$$\frac{dt^*(\alpha_i)}{d\alpha_i} < 0,$$

and it does not respond to the mass of immobile banks:

$$\frac{dt^*(\alpha_i)}{dB_i} = 0 \tag{10}$$

Claim 2 is proved by differentiating the implicit definition of the closed-economy optimal regulatory stringency, $t^*(\alpha_i)$, given in (9). In a closed economy the regulator does not need to worry about incentivising banks to locate in-country, and so the independence with respect to B_i captured in (10) is expected. At the closed-economy optimal level of regulatory stringency, the regulator maximises the net benefit per bank-entrepreneur pair, by balancing the need to maximise the surplus created from financial intermediation (which declines with regulatory stringency) against the need to minimise the negative externalities from bank failures (which also declines with regulatory stringency in the range considered, $t \in [0, \bar{t}]$). A greater focus on growth (i.e. a higher α_i) raises the salience of the surplus created by the bank-entrepreneur pairs as against the negative externality, and so results in a decline in the optimal closed-economy level of regulation.

We complete the model by extending the regulators' objective function to the open economy setting to analyse how regulators adjust the level of regulatory stringency t in order to attract internationally mobile banks. In what follows, we define 'competitive deregulation' as a situation in which at least one regulator sets t below their domestic closed-economy optimum , $t^*(\alpha_i)$. We denote the expected payoff for regulator i from choosing t_i in an open economy as:

$$\mathcal{E}(t_i;\alpha_i) := \underbrace{\mu(t_i;t_j)}_{\text{[expected number of banks in country } i\text{]}} \cdot \underbrace{W(t_i;\alpha_i)}_{\text{[net benefit per bank]}} . \tag{11}$$

The objective function (11) follows naturally as $W(t_i;\alpha_i)$ captures the benefit internalised by the regulator per bank attracted to the country. How this value should reflect the balance between the surplus of the bank-entrepreneur versus any negative externalities from a bank failure is captured by α_i and is exogenously set for the regulator. The function $\mu(\cdot)$ then captures the number of banks attracted to the country – an endogenous variable.

In what follows, we assume that regulator 1 is more stability focused, while regulator 2 is more growth focused, such that:

$$\alpha_1 < \alpha_2.$$

Recall from Claim 2 that the above assumption implies that the closed-economy optimal regulatory stringency is lower for the growth-focused regulator 2, such that:

$$t^*(\alpha_2) < t^*(\alpha_1). \tag{12}$$

Finally we focus on the setting in which the externalities from a bank failure are sufficiently large:

Assumption 6.

$$L \geq \max \left\{ 0 \ , \ 1 + R + \underbrace{\frac{1}{g'(0)}}_{(<0)} \right\} . \tag{13}$$

Assumption 6 will ensure that $W_{t\alpha} < 0$, i.e. the marginal benefit for regulators of increasing t is decreasing in their growth focus, α.

It is possible to solve a simpler symmetric version of our model in which the regulators are restricted to have the same objective function (i.e. $\alpha_1 = \alpha_2$). We do not report the results here, however, as in our view the more relevant setting is one in which each country has made independent decisions as to the appropriate objective function for its financial regulators. We solve this general version of our model below.

3.3. Globally optimal equilibrium benchmark

We conclude the model description by characterising the globally optimal equilibrium, which we define as the one which sets regulatory stringency levels to maximise the sum of welfare of the two countries whilst leaving mobile banks to choose their location freely. The joint welfare is given by $\mathcal{E}(t_1;\alpha_1)+\mathcal{E}(t_2;\alpha_2)$. We know from Claim 1 that $W(t^*(\alpha_1);\alpha_1) < W(t^*(\alpha_2);\alpha_2)$ as $\alpha_1 < \alpha_2$. It follows that if each regulator were to set its closed-economy optimal level of regulatory stringency, (i.e. regulator 1 sets $t^*(\alpha_1)$ and regulator 2 sets $t^*(\alpha_2)$) then the joint welfare is maximised when the growth-focused regulator 2 gets all the mobile banks – but as $t^*(\alpha_2) < t^*(\alpha_1)$ this is delivered by the market mechanism. It follows that both countries setting their closed-economy optimal levels of stringency maximises global welfare. Thus, in the globally optimal equilibrium, expected welfare of regulator 1 will be:

$$\mathcal{E}^c(t^*(\alpha_1), \alpha_1) = B_1 W(t^*(\alpha_1); \alpha_1) \tag{14}$$

where the superscript ^{c} denotes the collusion required between the regulators. The expected welfare of regulator 2 in this case will be:

$$\mathcal{E}^c(t^*(\alpha_2), \alpha_2) = (1 - B_1)W(t^*(\alpha_2); \alpha_2). \tag{15}$$

4. Equilibrium Solution

We now solve the model presented in Section 3.

We begin with maximum generality and suppose that each regulator i adopts a mixed strategy over $t \in [t_i^{down}, t_i^{up}] \subseteq [0, \bar{t}]$ for $i \in \{1, 2\}$. A pure strategy equilibrium occurs if the support collapses to a singleton. Denote the mixing distribution function $F_i(t; \mathcal{A}, \mathcal{B})$ for regulator i, and where $\mathcal{A} = \{\alpha_1, \alpha_2\} \in \mathbb{R}_+^2$ and $\mathcal{B} = \{B_1, B_2\} \in [0, 1]^2$.

4.1. Pure strategy equilibrium – passive competition

Our first result is to establish the necessary and sufficient conditions for a pure strategy equilibrium in regulatory stringency to exist. In the pure strategy equilibrium, both regulators set the regulatory stringency at the closed-economy optimal levels and thus there is no welfare loss relative to the globally otpimal equilibrium.

Proposition 1. *A pure strategy equilibrium exists if and only if*

$$B_1 W(t^*(\alpha_1); \alpha_1) > (1 - B_2)W(t^*(\alpha_2); \alpha_1). \tag{16}$$

The pure strategy equilibrium has each regulator setting their closed-economy optimal level of regulatory stringency, $t^*(\alpha_i)$ $i \in \{1, 2\}$, defined implicitly by (9).

Proof. All omitted proofs are contained in Appendix A. ■

To show that condition (16) is sufficient for a pure strategy equilibrium to exist, the proof of Proposition 1 establishes strategies sustaining a pure strategy equilibrium directly. We suppose that each regulator selects its closed-economy level of regulatory stringency $t^*(\alpha_i)$. Given (12), the growth-focused regulator 2 sets a lower level of regulatory stringency than the rival regulator 1 and so would win all of the internationally mobile banks. The most promising deviation for regulator 1 is to just undercut regulator 2's level of stringency. By doing so, regulator 1 would win all of the internationally mobile banks at the minimum possible reduction of its regulatory stringency. Condition (16) guarantees that this deviation is not desirable for regulator 1 and so the equilibrium is sustained.

The main task in Proposition 1 is to prove that condition (16) is necessary for a pure strategy equilibrium to exist. To achieve this we argue by contradiction and suppose that a pure strategy equilibrium exists whilst (16) is not satisfied. We then establish that the only possible form for a pure strategy equilibrium is if both regulators set their preferred closed-economy levels of regulatory stringency. This is achieved by arguing that any other pair of strategies offers a beneficial deviation for one of the regulators. It then follows that condition (16) is necessary for an equilibrium to exist.

Note that a pure strategy equilibrium arises either when the number of mobile banks is small (B_1 and B_2 are large), or when regulator 2 is much more growth focused than regulator 1 (α_2 is much larger than α_1). In such cases, the stability-focused regulator 1 chooses not to compete with the growth-focused regulator 2 because it is not worth incurring the cost of the increased probability of bank failures. Thus, regulator 1 simply sets its closed-economy optimal $t^*(\alpha_1)$. Because regulator 1 does not actively compete, regulator 2 can also set its closed-economy optimal $t^*(\alpha_2)$, and gets all the mobile bankers. Thus, no competitive deregulation arises in this case, and both regulators achieve the welfare levels as in the globally optimal equilibrium.

4.2. Mixed strategy equilibrium – active competition

If (16) does not hold then any equilibrium will be in mixed strategies. A mixed strategy arises because regulators cannot observe the level of regulatory stringency offered by the rival regulator to banks, and thus try to outguess the other in deciding what level of stringency to offer. Thus, in equilibrium, regulators offer t from within a given range, with each level of stringency offered with some probability. We turn to the form of such an equilibrium now. We denote the probability with which regulator i sets $t^*(\alpha_i)$, its closed-economy optimal level, in the mixed strategy equilibrium as ρ_i. We establish the following result.

Theorem 1. *A mixed strategy equilibrium must have regulator i placing a mass ρ_i on $t^*(\alpha_i)$ and otherwise mixing on $[t_*, t^*(\alpha_2))$. Regulator 2 places strictly positive mass on $t^*(\alpha_2)$: $\rho_2 > 0$. There are no gaps in the range $[t_*, t^*(\alpha_2))$. There is no measure in the range $(t^*(\alpha_2), t^*(\alpha_1))$.*

The support of the mixing distributions described in Theorem 1 is depicted in Figure 1.

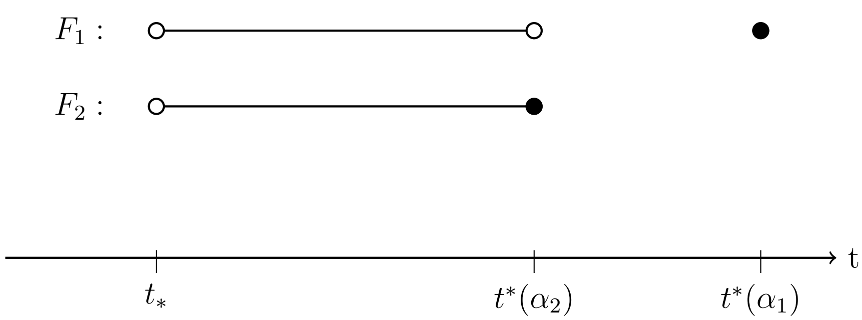

Figure 1: The support of the mixing distribution established in Theorem 1
Notes: Solid circles represent mass points. Straight lines indicate the support of a continuous distribution. The regulators mix over the entirety of the depicted support.

To prove Theorem 1 we establish a number of claims which characterise key properties of the mixed strategy equilibrium. These claims are each proved in the Appendix. Together these claims deliver the proof of Theorem 1.

Claim 3. *Let $k = \arg\max(t_1^{up}, t_2^{up})$ then $t_k^{up} = t^*(\alpha_k)$.*

Claim 3 notes that if a regulator sets the highest level of stringency then it will not win any internationally mobile banks. In this case the regulator optimally sets its preferred closed-economy level of regulation $t^*(\alpha_i)$ that maximises the welfare generated by banks which are committed to staying in the country.

Claim 4. *There cannot be any measure at stringency levels in the range* $(t^*(\alpha_2), t^*(\alpha_1))$.

Claim 4 establishes that neither regulator can ever find it optimal to set a level of regulatory stringency below that level preferred by the stability-focused regulator 1, but above the level preferred by the growth-focused regulator 2. This is established by noting that for regulator 2 any level of regulatory stringency in this range is strictly dominated by setting its preferred closed-economy level, $t^*(\alpha_2)$; the welfare per bank is higher and the reduction in the level of stringency will attract more internationally mobile banks. It follows that only regulator 1. the stability focused regulator could offer regulation in the range $(t^*(\alpha_2), t^*(\alpha_1))$. But then the result follows from the logic of Claim 3. Intuitively, regulator 1 has no incentive to set the stringency level in the range $(t^*(\alpha_2), t^*(\alpha_1))$ given that regulator 2 will not go above $t^*(\alpha_2)$, as this will not win any internationally mobile banks and thus will only lower welfare relative to setting $t^*(\alpha_1)$, the closed-economy optimal level.

We have established that regulator 1 can have some mass at $t^*(\alpha_1)$, but otherwise both regulators mix over $t \leq t^*(\alpha_2)$.

Claim 5. *In a mixing equilibrium the two regulators adopt the same lower bound in a mixed strategy equilibrium,* $t_1^{down} = t_2^{down} := t_* < t^*(\alpha_2)$.

Claim 5 is established by contradiction. If one regulator offered a level of regulatory stringency strictly below its rival, then it has a desirable deviation to raise the level of stringency towards its closed-economy optimal level of regulation. Such a small change increases the benefit per bank, without altering the likelihood of winning all of the internationally mobile banks.

We can therefore refer to the support of the mixing distribution as $[t_*, t^*(\alpha_2)] \cup t^*(\alpha_1)$.

Claim 6. *There is no gap in the support of the mixed strategy of the two regulators in the region* $t \in (t_*, t^*(\alpha_2))$.

The proof of Claim 6 is established by contradiction. If there was a gap then at least one of the regulators will have an incentive to raise its offer of regulatory stringency from the bottom to the top of the gap. Once again this increases the benefit for the regulator by raising the level of regulatory stringency closer to its closed-economy optimal without altering the probability of winning the internationally mobile banks.

Claim 7. *There is no mass point in* $[t_*, t^*(\alpha_2))$.

Claim 7 is proved by demonstrating that if either regulator had a mass point in the range then there exists a beneficial deviation in which one regulator collects mass from above the mass point of its rival and instead just undercuts the rival's mass point. This strictly increases the probability of attracting all internationally mobile banks whilst only altering the benefit per bank by a very small amount.

Claim 8. *Regulator 2 must have a mass point at* $t^*(\alpha_2)$, *while regulator 1 can have a mass point only at* $t^*(\alpha_1)$.

Regulator 1 , the stability-focused regulator, must in equilibrium be willing to mix across the two levels of stringency $\{t^*(\alpha_2), t^*(\alpha_1)\}$. If regulator 2 did not have a mass point at $t^*(\alpha_2)$ then regulator 1 would always be undercut whichever of these two levels of stringency she offered. But for the equilibrium to hold, regulator 1 would need to be indifferent between the two different levels of stringency, both of which yield no international banks. This is a contradiction.

Claims 3–8 combine to prove Theorem 1.

4.3. Explicit representation of mixing probabilities

Having established the generic form of the mixed strategy equilibrium in Figure 1 and Theorem 1 we can now determine the explicit mixing probabilities. This is an essential step towards understanding the comparative static effects of changes in the regulators' objective functions – such as the strengthening of the growth focus for one or other of the regulators.

Regulator 1 must be indifferent between setting $t \in \{t_*, t^*(\alpha_1)\}$: i.e. regulator 1 must be indifferent between setting t_* and capturing all the mobile banks, and setting $t^*(\alpha_1)$ and having immobile banks only:[20]

$$(1 - B_2)W(t_*; \alpha_1) = B_1 W(t^*(\alpha_1); \alpha_1) \tag{17}$$

Note that it is regulator 1's indifference condition, given by (17), which implicitly defines t_*, the bottom of the mixing support for both regulators. The lower bound is $t_* > 0$, and so exceeds the optimal level of regulatory stringency from the banks' point of view, if the externality L is sufficiently large, or if α_1 (the stability focused regulator) is not too growth focused.[21]

To understand why this must be so, note that if both regulators offered their closed-economy optimal levels of regulatory stringency, then the growth-focused regulator 2 would be happy as it would secure all the mobile banks. It is therefore the stability-focused regulator 1 which chooses whether and how much to compete, and so it sets the lower bound of regulatory stringency resulting from the competition.[22]

Regulator 1 must also be indifferent between setting $t \in \{t^*(\alpha_2), t^*(\alpha_1)\}$:[23]

$$[B_1 + \rho_2(1 - B_1 - B_2)]W(t^*(\alpha_2); \alpha_1) = B_1 W(t^*(\alpha_1); \alpha_1) \tag{18}$$

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[20]Note that if one regulator selects t_*, it captures all the mobile banks as there is no mass point at t_* (Claim 7) and thus there is zero probability that the other regulator will choose exactly the same level of regulatory stringency.

[21]We have that $W(t^*(\alpha_1); \alpha_1) > 0$ by (8) and we also note that $\partial W/\partial t > 0$ for $t < t^*$ by the concavity of $W(\cdot)$ established in (6). A sufficient condition for $t_* > 0$ is therefore if $W(0; \alpha_1) < 0$ which holds, using (5), if L is large enough or if

$$\alpha_1 < \frac{1}{1 + \frac{(R - c(1+R))}{cL}}.$$

[22]Of course such an action by the stability-focused regulator 1 can be met with a response from the growth-focused regulator 2, and this is why we generate the mixed strategy equilibrium studied here.

[23]Formally regulator 1 sets $t = \lim_{\varepsilon \downarrow 0}(t^*(\alpha_2) - \varepsilon)$ as regulator 1 sets $t \in (t_*, t^*(\alpha_2))$. It follows that regulator 1 would win all the mobile banks in the event that regulator 2 is at its mass point $t^*(\alpha_2)$ and regulator 1 has just undercut regulator 2.

which yields the mass ρ_2 regulator 2 places on its closed-economy optimal level, $t^*(\alpha_2)$.

Regulator 1 must be indifferent between $t \in (t_*, t^*(\alpha_2))$ and $t^*(\alpha_1)$. This yields:

$$\begin{aligned} &\left[B_1 + (1 - B_1 - B_2)(1 - F_2(t))\right] W(t;\alpha_1) = B_1 W(t^*(\alpha_1);\alpha_1) \\ &\qquad \Rightarrow F_2(t;\alpha_1,\alpha_2) = \frac{1}{1 - B_2 - B_1}\left[1 - B_2 - B_1 \frac{W(t^*(\alpha_1);\alpha_1)}{W(t;\alpha_1)}\right] \end{aligned} \tag{19}$$

Equation (19) therefore establishes the distribution function for regulator 2 across its support.

In turn, in equilibrium regulator 2 must be indifferent between setting $t \in \{t_*, t^*(\alpha_2)\}$. This requirement yields:

$$(1 - B_1)W(t_*;\alpha_2) = \left[B_2 + \rho_1(1 - B_1 - B_2)\right] W(t^*(\alpha_2);\alpha_2) \tag{20}$$

which gives the mass ρ_1 which regulator 1 places on its closed-economy optimum, $t^*(\alpha_1)$.[24]

And finally regulator 2 must be indifferent between $t \in (t_*, t^*(\alpha_2))$ and t_*. This yields:

$$\begin{aligned} &\left[B_2 + (1 - B_1 - B_2)(1 - F_1(t))\right] W(t;\alpha_2) = (1 - B_1)W(t_*;\alpha_2) \\ &\qquad \Rightarrow F_1(t;\alpha_1,\alpha_2) = \frac{1 - B_1}{1 - B_2 - B_1}\left[1 - \frac{W(t_*;\alpha_2)}{W(t;\alpha_2)}\right] \end{aligned} \tag{21}$$

Equation (21) therefore delivers the distribution function that regulator 1 uses in equilibrium.

All the parameters of the equilibrium are established by equations (17)–(21). It is possible to simplify the characterisation of the mass points $\{\rho_1, \rho_2\}$ by observing

[24] Note that in the range $(t_*, t^*(\alpha_2))$ regulator 1 has no mass points and so both regulators setting the exact same level of stringency is an event of zero measure, and so can be set aside without loss.

that:

$$\rho_1 = 1 - F_1(t^*(\alpha_2)) \tag{22}$$

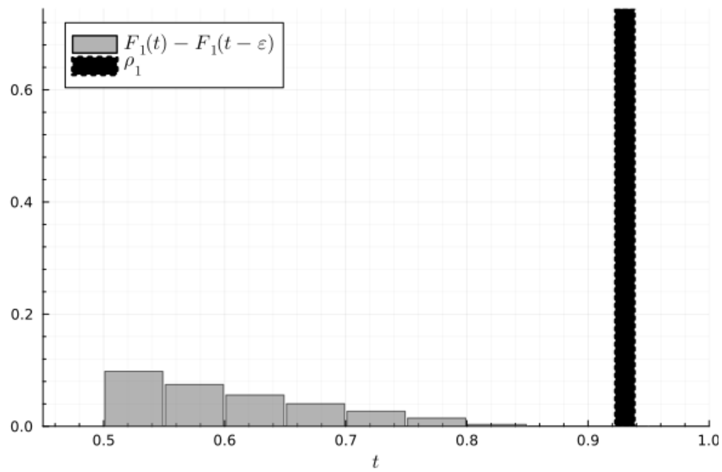
$$\rho_2 = 1 - F_2(t^*(\alpha_2)) \tag{23}$$

The fact that the argument in equations (22) and (23) is $t^*(\alpha_2)$ in both cases is not a typo. For both regulators, the measure placed on their respective mass points is equal to all the measure of the mixing distributions which lies at or above the upper bound of the mixing range. This upper bound of the mixing range is $t^*(\alpha_2)$ for both regulators.

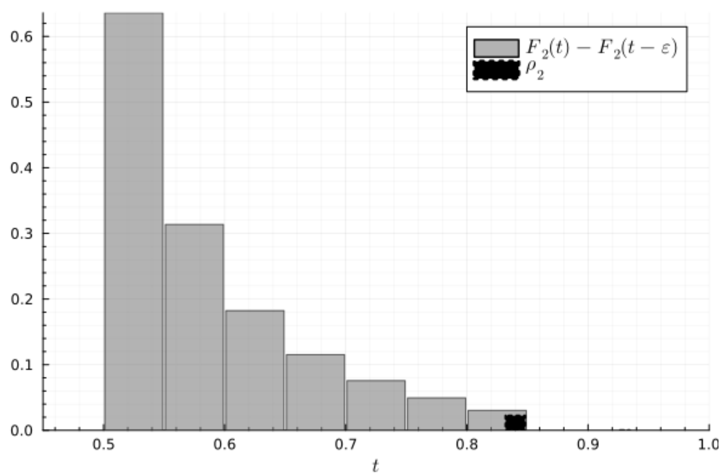
Thus, competitive deregulation may arise in the mixed strategy equilibrium, whereby at least one of the regulators sets the level of regulatory stringency below the closed-economy optimum with some probability. But in general, it does not lead to a 'race-to-the-bottom', because neither regulator will set the stringency levels below t_* which is above the banks' preferred level ($t = 0$). This point is illustrated in Figures 2a and 2b, which simulate the probability density functions of the regulators' mixing distributions through a set of histograms. Histograms are necessary as the mixing distributions include a mix of a mass point with a region in which the regulators use continuous distributions – as we depicted in Figure 1. It is noticeable that in the continuous part of the distribution, the weight on the lower levels of stringency is increasing. Hence, if the regulators choose to compete to secure a bank which might be internationally mobile then they gravitate towards regulatory stringency levels which are towards the bottom of their support. This effect is strongest for the growth-focused regulator, 2. If the gap in the objective functions should grow large enough – the spread $\alpha_2 - \alpha_1$ large – then Proposition 1 applies which is captured by both regulators increasing the weight they assign to their mass points, until these weights become equal to 1 delivering a pure strategy equilibrium.

Figure 2: Mixing Equilibrium

(a) Histogram of regulator 1 (stability-focused) PDF including mass ρ_1



(b) Histogram of regulator 2 (growth -focused) PDF including mass ρ_2



Note: The graphs show a histogram of the probability density functions of the two regulators. Each column gives the value of $F_i(t+\varepsilon) - F_i(t)$ with columns of width $\varepsilon = 0.05$. Functions $F_1(t), \rho_1$ are determined by equations (21), and (22), while $F_2(t), \rho_2$ from equations (19), (23). To perform the numerical simulations we assume that the regulatory technology $g(t) = c\,(1 - t/\bar{t})^2$ for $t \in [0, \bar{t}]$ and $c = 0.5$. Both figures use parameters $\bar{t} = 1, R = 3, L = 1.5 + R + (1/c), \alpha_1 = 0.3, \alpha_2 = 0.6, B_1 = B_2 = 0.3$. For these parameters, $(t^*(\alpha_1), t^*(\alpha_2)) = (0.84, 0.93)$. Julia simulation code available at link.

We now examine the welfare implications of the mixed strategy equilibrium. From (19) and (21), we know that the expected payoff of regulator 1 in the mixed strategy equilibrium is given by:[25]

$$\mathcal{E}^m(t^*(\alpha_1), \alpha_1) = B_1 W(t^*(\alpha_1); \alpha_1) = \mathcal{E}^c(t^*(\alpha_1), \alpha_1) \tag{24}$$

[25]Equation (24) follows as regulators must be indifferent between all the levels of regulatory stringency in the support of their mixing functions.

And the expected welfare of regulator 2 will be:

$$\mathcal{E}^m(t_*, \alpha_2) = (1 - B_1)W(t_*; \alpha_2) < \mathcal{E}^c(t^*(\alpha_2), \alpha_2) \tag{25}$$

Thus, the stability-focused regulator 1 is no worse off than in the globally optimal equilibrium, whereas the growth-focused regulator 2 is worse off. Intuitively, regulator 1 will engage in competition with regulator 2 only to the extent that it is no worse off than setting its closed-economy optimal $t^*(\alpha_1)$ and only retaining immobile banks. But regulator 2 may be forced to reduce t below its closed-economy optimal $t^*(\alpha_2)$ to attract all the mobile banks when regulator 1 starts competing for them. Thus, regulator 2 is worse off than in the globally optimal equilibrium.

5. The impact of the growth objective

In this section we study how regulatory stringency and the international location choices of banks change if one of the regulators should have its objective function adjusted to increase the importance of growth. We will show that the effect on the mixed strategy equilibrium depends crucially on which of the two regulators become more growth focused.

5.1. If the growth-focused regulator is made even more growth focused

In this subsection we describe the effects on the mixed strategy equilibrium when the growth-focused regulator 2 becomes even more growth focused (i.e. α_2 increases). We first present the result. We then describe the method of proof and explain the intuition underlying the results. We conclude the section with a discussion of the policy implications.

Proposition 2. *If the growth focused regulator* 2 *becomes even more growth focused* ($\alpha_2 \uparrow$)*, then:*

1. *The lower bound of the mixing distribution (which is common to both regulators) is unaffected:*

$$\frac{\partial t_*}{\partial \alpha_2} \equiv 0$$

2. *The regulatory stringency offered by the stability-focused regulator 1 adjusts as follows:*

   (a) *The measure regulator* 1 *places on the upper bound* $(t^*(\alpha_1))$ *rises:* $\partial \rho_1 / \partial \alpha_2 > 0$.

   (b) *The mixing distribution moves to higher levels of regulatory stringency in a FOSD manner:* $\partial F_1(t; \alpha_1, \alpha_2)/\partial \alpha_2 < 0$.

3. *The regulatory stringency offered by the growth-focused regulator (2) adjusts as follows:*

   (a) *The upper bound of the distribution declines:* $\partial t^*(\alpha_2)/\partial \alpha_2 < 0$.

   (b) *The measure on the upper bound rises:* $\partial \rho_2 / \partial \alpha_2 > 0$.

   (c) *The mixing distribution is unaffected:* $\partial F_2(t; \alpha_1, \alpha_2)/\partial \alpha_2 = 0$.

The comparative statics results captured in Proposition 2 are depicted graphically in Figure 3, where we assume that the weight on regulator 2's objective function is raised from $\underline{\alpha}_2$ (dotted line) to $\overline{\alpha}_2$ (solid line).

Part 1 of Proposition 2 follows mathematically from the fact that the definition of the (common) lower bound of the mixing distributions is established in (17) and it does not depend upon the value of α_2, only on the value of α_1.

The fact that the degree of growth focus of regulator 2 does not affect the lower bound of the mixing distribution t_* may seem surprising. However, the intuition is readily explained. The lower bound of the mixing distributions t_* is strictly below the closed-economy optimal of both regulators and represents the maximum reduction in regulatory stringency that regulator 1 is willing to accept in exchange for winning all of the internationally mobile banks. This trade-off is not affected by the objectives

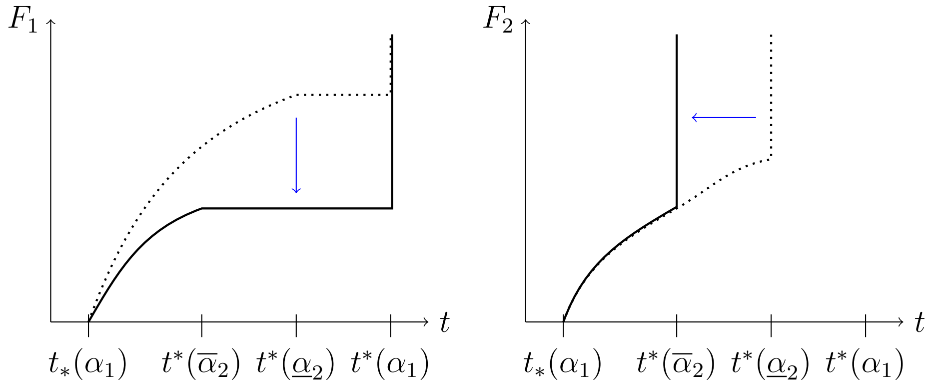


Figure 3: The mixing distributions of regulator 1 and regulator 2 as regulator 2 becomes more growth focused
Notes: The dotted line represents the distribution under $\underline{\alpha}_2$ while the solid line represents the distribution under $\overline{\alpha}_2$ when regulator 2 becomes more growth focused.

of regulator 2, with one exception. If regulator 2 should become so growth focused that its closed-economy optimal $t^*(\alpha_2)$ is below the lowest-level that regulator 1 is willing to go in order to win all the internationally mobile banks, then the mixed strategy breaks down and we revert to the pure strategy equilibrium. This outcome is explained in Proposition 1.

Part 2 of Proposition 2 captures that regulator 1 becomes less willing to undercut regulator 2 as the latter becomes even more growth focused. The method of proof is to use the explicit definition for the distribution function of regulator 1, given in (21) and implicitly differentiate with respect to α_2.

The intuition for the result is as follows. If regulator 2 becomes even more growth focused, then regulator 1 anticipates a more aggressive approach from its rival. Given that this reduces the probability of beating regulator 2, regulator 1 becomes less inclined to compete for mobile banks. It follows that if regulator 2 becomes even more growth focused then the mass that regulator 1 places on its upper bound, which coincides with its closed-economy optimal $t^*(\alpha_1)$, increases. We can therefore see that the mixed strategy equilibrium begins to approach the pure strategy equilibrium captured in Proposition 1.

Turning to regulator 2, if regulator 2 becomes more growth focused, then the upper bound of its regulatory stringency $t^*(\alpha_2)$ declines mechanically to reflect the new, higher level of α_2. The regulator has been given a greater focus on growth by hypothesis, and so the level of regulatory stringency which yields the closed-economy optimal declines as the surplus of bank-entrepreneur pairs is weighted more highly compared to the negative externalities which would arise from a bank failure.

Proposition 2 demonstrates that the mass with which this upper bound is offered increases while the distribution with which lower stringencies are offered is unchanged. The proof that the distribution of regulatory stringencies offered by regulator 2 below its closed-economy optimal is unchanged follows from the fact that the regulator 2's mixing distribution is determined so that regulator 1 is indifferent about mixing across the support of the regulatory stringencies it might offer. As α_1 has not changed, the cost-benefit trade-off facing regulator 1 between having a low level of stringency and winning all international banks versus offering the closed-economy optimal and not attracting them has not changed. The required distribution of regulator 2 is not then changed as it is already at a level which makes regulator 1 indifferent about the range of possible stringencies which it might set.

As regulator 1 is less aggressive and increases the stringency it offers, while regulator 2 weakly lowers the stringency it offers, then we expect regulator 2 to be more successful in winning international banks. This is indeed the case:

Corollary 1. *If the growth focused regulator* 2 *becomes even more growth focused* ($\alpha_2 \uparrow$) *then regulator* 2 *wins a greater share of international banks.*

The structure of the density functions allows for some further insight. Suppose that regulator 2 has its growth focus raised from $\underline{\alpha}_2$ to $\overline{\alpha}_2$. Define $F^{(2)}(t; \alpha_2)$ to be the cumulative distribution for the lowest stringency offered to a mobile banker when regulator 2's growth objective is α_2.[26] Consider any stringency level $\tilde{t} < t^*(\overline{\alpha}_2)$:

$$F^{(2)}(\tilde{t}; \alpha_2) = 1 - (1 - F_1(\tilde{t}; \alpha_2))(1 - F_2(\tilde{t}; \alpha_2)) \tag{26}$$
$$\Rightarrow \frac{\partial F^{(2)}(\tilde{t}; \alpha_2)}{\alpha_2} =_{\text{sign}} \frac{\partial F_1(\tilde{t}; \alpha_2)}{\partial \alpha_2} < 0$$

Therefore after regulator 2 becomes more growth focused, the probability of a bank receiving a very low level of regulatory stringency *declines*.

However, the probability that the best offer which a bank will receive will be a stringency level strictly above $t^*(\overline{\alpha}_2)$, which is lower than $t^*(\underline{\alpha}_2)$, drops to zero. Hence the highest levels of stringency are removed from the set of outcomes.[27]

Thus, as regulator 2 becomes more growth focused, it becomes more likely to offer its (lower) closed-economy optimal level of regulatory stringency. If regulator 2 becomes significantly more focused on growth than regulator 1, then Proposition 1 applies and we move to a pure strategy equilibrium in which both regulators set their regulatory stringency at their closed-economy optimal levels.

Policy Implications

If the political process in country 2, which is already relatively more growth-focused than country 1, should increase regulator 2's focus on growth further then we find the following implications:

- Regulator 2's closed-economy optimal level of regulatory stringency declines.
- But competitive deregulation becomes *less* likely, as both regulators become more likely to set their regulatory stringency at their closed-economy optimal levels.

[26]I.e. the minimum of the two independent offers t_1 and t_2 from the two jurisdictions.

[27]In the limit of country 2 becoming very growth focused then the mixed strategy equilibrium breaks down and country 2 wins all the internationally mobile banks.

- It does not lead to a race-to-the-bottom in terms of regulatory stringency. The lowest level at which the regulators are willing to reduce the regulatory stringency remains unchanged and above zero, as it is set by the stability-focused regulator.
- Internationally mobile banks see a reduction in the variance of regulation that they are offered. The probability of a bank being offered regulatory stringency at the lowest or highest levels of the support declines.

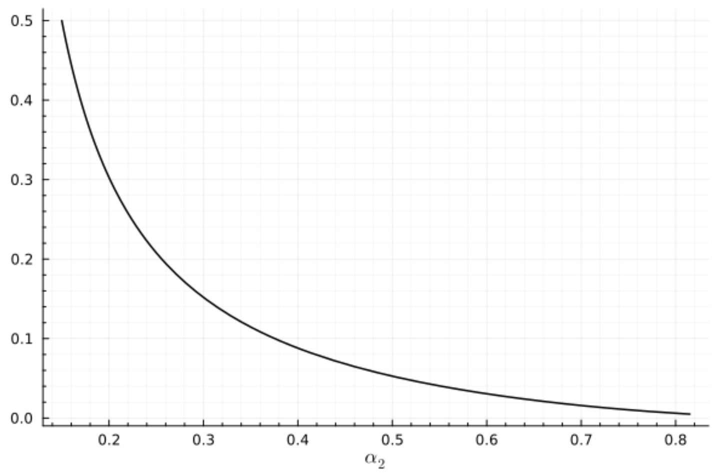
Some policymakers have been concerned that an increase in the focus towards growth, such as that created by the UK regulator's growth objective, will inevitably lead to a race-to-the-bottom in terms of regulations, although the UK's PRA denied this as a possibility.[28] Proposition 2 shows that competitive deregulation becomes less likely as the growth-focused regulator becomes even more growth-focused, and the race-to-the-bottom will not arise.

Figures 4a and 4b describe the impact of higher levels of growth-preference for regulator 2 on key market characteristics. Panel (a) shows that the probability of regulator 1 winning all mobile banks decreases monotonically as α_2 increases. (This reflects Corollary 1.). If the growth focus of regulator 2 becomes great enough then Proposition 1 is triggered – a pure strategy equilibrium holds. And so regulator 1 fails to win any internationally mobile banks. Panel (b) shows that, in the parameter range in which regulator 1 is competitive and has a non-zero probability of winning an internationally mobile bank, then the expected level of regulatory stringency which will apply to internationally mobile banks is not monotonic in the regulator 2's growth focus. This is because there are two opposing effects operating on regulator 1. On the one hand, as α_2 increases so will the regulatory stringency set by regulator 1,

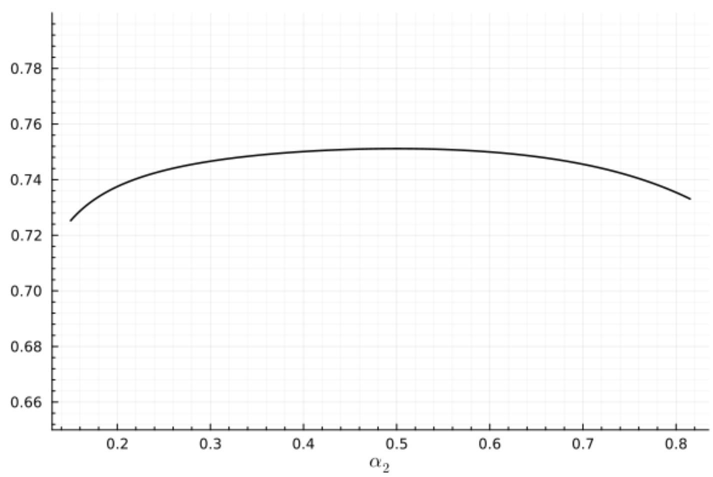
[28] See for example *Luxembourg finance minister pleads with UK against a race to the bottom with EU*, The Times, 28 Nov 2022. Available here. For the UK PRA's position, see Woods, 2022 and Saporta, 2022.

Figure 4: The impact of growth-focused country becoming even more growth focused

(a) Regulator 1's probability of winning versus α_2



(b) Expected Stringency for internationally mobile banks versus α_2



Note: The probability that regulator 1 wins a given internationally mobile bank is

$$\omega_1 := \int_{t=t_*}^{t^*(\alpha_2)} f_1(t)[1 - F_2(t)]dt,$$

and is plotted in Panel (a). While the expected best regulatory stringency offered by the two regulators is established using (27) as

$$E_{F^{(2)}}(t) = \int_{t_*}^{t^*(\alpha_2} t\frac{\partial F^{(2)}}{\partial t}(t)dt = t_* + \int_{t_*}^{t^*(\alpha_2)} (1 - F_1(t))(1 - F_2(t))dt$$

using an integration by parts, and is plotted in Panel (b). To perform the numerical simulations we assume that the regulatory technology $g(t) = c\,(1 - t/\bar{t})^2$ for $t \in [0, \bar{t}]$ and $c = 0.5$. Both figures use parameters $\bar{t} = 1, R = 3, L = 1.5 + R + (1/c), \alpha_1 = 0.15, B_1 = B_2 = 0.3$. Functions $F_1(t), \rho_1$ is determined by equations (21), (22), and $F_2(t), \rho_2$ from equations (19), (23). Julia simulation code available at link.

as we described in Proposition 2. On the other hand, the upper bound of the mixing support for both regulators will decrease and this will act to decrease the best offered level of regulatory stringency. The larger the gap between α_2 and α_1, the more the latter effect, which works through the growth-focused regulator, dominates. This is shown in panel (b) of Figure 4.

5.2. If the stability-focused regulator is made more growth focused

In this subsection we consider the implications of the relatively more stability-focused regulator (i.e. regulator 1) having its objective function changed to increase the prioritisation given to growth. Thus, we examine the comparative statics of the mixed strategy equilibrium with respect to α_1. We continue to assume that, of the two regulators, regulator 1 remains relatively more focused on stability ($\alpha_1 < \alpha_2$).

As in Section 5.1 we first present the result. Then we describe the manner in which the result is proved and explain the intuition. The subsection concludes with a discussion of the relevant policy implications for this case.

Proposition 3. *If the stability focused regulator* 1 *becomes more growth focused* ($\alpha_1 \uparrow$) *whilst* $\alpha_1 < \alpha_2$ *then:*

1. *The lower bound of the mixing distribution (which is common to both regulators) declines:* $\partial t_* / \partial \alpha_1 < 0$.

2. *The regulatory stringency offered by the stability-focused regulator* (1) *adjusts as follows:*

    (a) *The upper bound of the distribution declines:* $\partial t^*(\alpha_1)/\partial \alpha_1 < 0$.

    (b) *The mixing distribution moves mass downwards towards lower stringency:* $\partial F_1(t; \alpha_1, \alpha_2)/\partial \alpha_1 > 0$.

    (c) *The regulator places a lower mass on its closed economy optimal:* $\partial \rho_1 / \partial \alpha_1 < 0$.

3. *The regulatory stringency offered by the growth-focused regulator* (2) *adjusts as follows:*

(a) *The mixing distribution moves mass downwards:* $\partial F_2(t;\alpha_1,\alpha_2)/\partial\alpha_1 > 0$.

(b) *The regulator 2 places decreasing measure on its closed economy optimum:* $\partial\rho_2/\partial\alpha_1 < 0$.

The results captured in Proposition 3 exploring the effect of regulator 1 becoming more growth focused are depicted graphically in Figure 5.

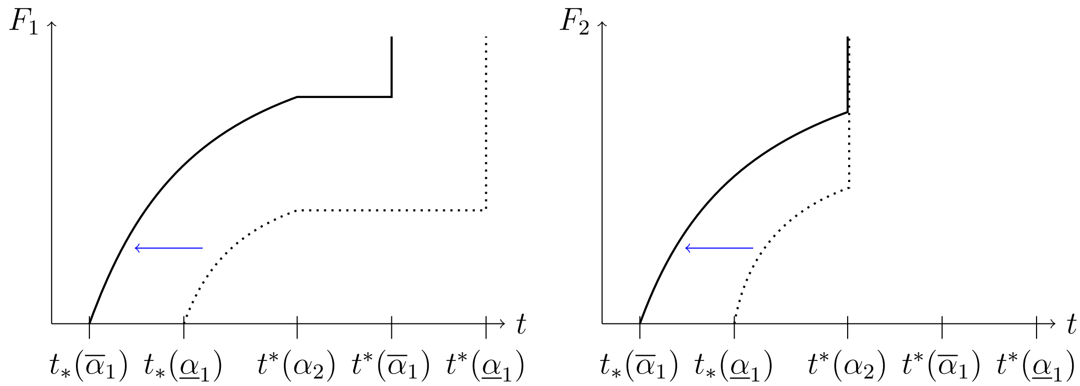


Figure 5: The mixing distributions as regulator 1 pivots to become more growth focused
Notes: The dotted line represents the distribution under $\underline{\alpha}_1$ while the solid line represents the distribution under $\overline{\alpha}_1$ when regulator 1 is more growth focused. That lower levels of regulatory stringency are delivered is evident.

Proposition 3 establishes how competitive deregulation could intensify as the stability-focused regulator becomes more growth focused. Nevertheless, a race-to-the-bottom is avoided as the bottom level of regulatory stringency is bounded above $t = 0$ by the preference of the (relatively) stability-focused regulator. The method of proof of the first result is to differentiate the implicit definition of the lower bound of the mixing distribution which is established above in (17). The intuition is however significantly deeper. When the stability-focused regulator 1 becomes more growth focused, then regulator 1 starts to target lower levels of regulatory stringency to win mobile banks. This is because the value attached to the surplus created by bank-entrepreneur pairs features more prominently in its objective function – a consequence of the increase in the weight α_1. Thus, regulator 1 will reduce the lower-bound of stringency levels $t_*(\alpha_1)$ which it is willing to go to in order to win all the mobile banks. In addition, the regulator 1 moves its mass downwards, as shown in the left-hand-side panel of Figure 5, thus reducing the level of stringency it tends to offer to banks.

The increased growth focus by regulator 1 induces a matching response from regulator 2. As regulator 1 starts competing more aggressively for mobile banks, the (more) growth-focused regulator 2 lowers the regulatory stringency it offers in turn: this is shown graphically in the right-hand-side panel of Figure 5. Thus, both regulators will lower their regulatory stringency when regulator 1 becomes more growth-focused.[29] From (25), we also know that this reduces the expected payoff of regulator 2.

We conclude this discussion by noting that if regulator 1 becomes more growth focused, then the expected level of regulatory stringency declines across both countries, as shown graphically in Figure 5. This follows as both regulators lower their stringency in a first order stochastically dominant manner. Thus, the immobile banks receive lower expected levels of stringency. The mobile banks face a lowest stringency distribution of

$$1 - F^{(2)}(t) = (1 - F_1(t))(1 - F_2(t)) \tag{27}$$

As $\partial F_i(t)/\partial \alpha_1 > 0$ for $i \in \{1, 2\}$, it follows that $\partial F^{(2)}(t)/\partial \alpha_1 > 0$ also.

Figures 6a and 6b describe the impact of increasing the focus on growth which applies to the stability-oriented regulator on a number of market characteristics. Panel (a) shows the probability of regulator 1 winning is close to zero for low levels of α_1, and it monotonically increases with α_1. Therefore increasing regulator 1's growth focus does lead to more international banks being won by regulator 1 in this numerical simulation.[30] Panel (b) depicts the expected level of stringency which

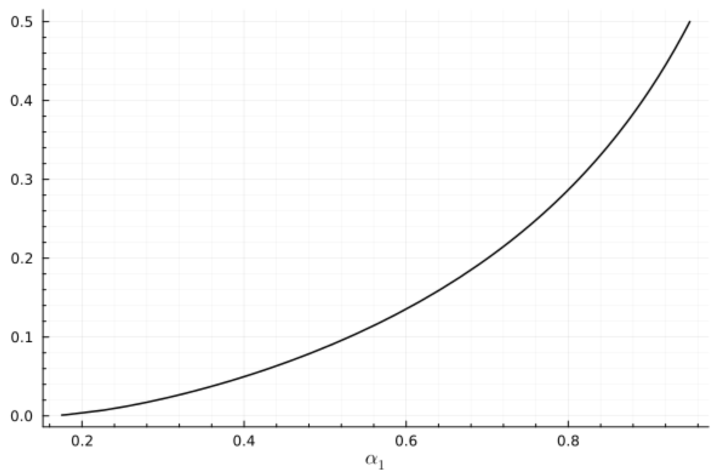
[29]It follows that whether country 1 wins a greater share of mobile banks is ambiguous and depends upon the parameter values.

[30]Though this is not a result; see the text around footnote 29.

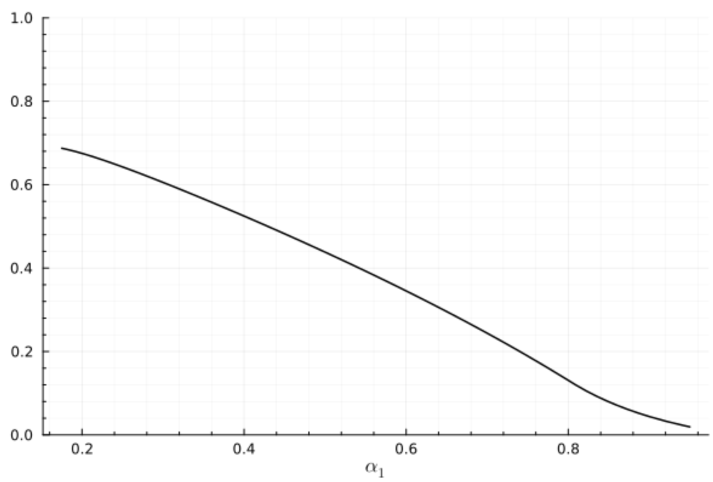
applies to internationally mobile banks, as a function of the growth focus of regulator 1. It shows that as the growth focus of regulator 1 becomes more significant, and approaches that of regulator 2, then the expected level of regulatory stringency for internationally mobile banks declines monotonically, consistent with competitive deregulation predicted by Proposition 3 and explained around equation (27).

Figure 6: The impact of stability-focused regulator becoming more growth focused

(a) Regulator 1's probability of winning against α_1



(b) Expected Stringency for internationally mobile banks against α_1



Note: For panel (a), the probability of regulator 1 winning is $\int_{t_*}^{t^*(\alpha_2)} f_1(t)(1-F_2(t))dt$, and for panel (b), expected stringency is $t_* + \int_{t_*}^{t^*(\alpha_2)}(1-F_1(t))(1-F_2(t))dt$. To perform numerical simulations we assume that the regulatory technology $g(t) = c\,(1-t/\bar{t})^2$ for $t \in [0,\bar{t}]$ and $c = 0.5$. Both figures use parameters $\bar{t} = 1, R = 3, L = 1.5 + R + (1/c), \alpha_2 = 0.95, B_1 = B_2 = 0.3$. Functions $F_1(t), \rho_1$ is determined by equations (21), and (22), while $F_2(t), \rho_2$ from equations (19), (23). Julia simulation code available at link.

Policy Implications

If the political process in country 1, which is relatively more stability-focused than country 2, should increase regulator 1's focus on growth then we find the following implications:

- Regulator 1's closed-economy optimal level of regulatory stringency falls.
- Competitive deregulation intensifies, as the lowest level of regulatory stringency which either regulator may set also falls.
- But a race-to-the-bottom is still avoided as the lowest level of regulatory stringency set by either regulator remains above banks' preferred level ($t = 0$). The lower bound of regulatory stringency is determined by the point at which regulator 1 is indifferent between winning all the mobile banks at a low level of stringency and keeping just the tied banks at the closed-economy optimal level of stringency.
- All banks see an expected reduction in the level of regulatory stringency they are offered.

So the sentiments expressed, for example by the Chairman of Natwest Group in "*Should We Fear Singapore-on-Seine?*" are both real and, in parts, overblown.[31] If a less-growth focused jurisdiction should increase its growth focus then it can drag the level of regulatory stringency downwards across jurisdictions. However, this effect is not without a limit, and so does not give rise to a race-to-the-bottom. The end-point of the race is calibrated by the more stability focused jurisdiction as the lowest it is willing to go for the increased chance of winning the mobile banks.

We therefore conclude that the impact of stability-focused regulator 1 becoming more growth focused is worse both in terms of reducing welfare (of regulator 2) and

[31]Referenced article available at this link.

increasing the risk of bank failures, compared to the impact of the growth-focused regulator 2 becoming even more growth focused.

6. Impact of more internationally mobile banks on regulatory stringency

This section will consider the impact of changes in the measure of internationally mobile banks on global levels of regulatory stringency. The measure of internationally mobile banks would rise if the proportion of banks tied to one of the two countries, B_i, falls. The immobile banks in our model capture bank headquarters, subsidiaries and activities that are committed to staying in a given country due to factors other than the level of regulatory stringency. For example, the Global Financial Centres Index draws on a number of non-regulatory factors in ranking the attractiveness of a financial centre, including political stability, the tax burden, availability of skilled personnel, flexible labour market, and infrastructure. Sharp changes in these factors could potentially alter the number of immobile banks in a given country.

Proposition 4. *If the number of internationally mobile banks rises as a result of the measure of banks tied to either country shrinking (either $B_1 \searrow$ or $B_2 \searrow$) then the two regulators will respond in the following way:*

1. *The (common) lower bound of regulatory stringency, t_*, declines.*
2. *The growth focused regulator 2 offers a lower regulatory stringency in a FOSD manner.*
3. *Regulator 1's response is ambiguous.*

A reduction of immobile banks in either country implies that the number of mobile banks has increased. Thus, regulator 1 now has a stronger incentive to attract mobile banks and so is willing to offer a lower level of regulatory stringency (t_*) in return for winning all of these banks. This follows formally using the indifference condition

(17). This explains why the lower bound of the regulatory stringency in equilibrium declines.

Turn now to the growth-focused regulator 2. This regulator cannot avoid competing with regulator 1 as there is always a positive probability that regulator 1 will seek to undercut regulator 2's preferred level of regulatory stringency and secure the internationally mobile banks – this is apparent from the form of the mixed strategy equilibrium we established in Theorem 1. By hypothesis in Proposition 4 there are more internationally mobile banks. It follows that the gap between the consolation prize of keeping just nationally tied banks versus winning all the internationally mobile banks is now larger. This logic implies that regulator 2 becomes more aggressive as it competes. This explains why regulator 2 increases the probability of offering low levels of regulatory stringency.

An increase in the proportion of internationally mobile banks has an ambiguous effect on the actions of regulator 1. This is because there are two competing forces. On the one hand, regulator 2 is more aggressive making it less worthwhile for regulator 1 to compete. On the other hand, there are now more mobile banks in play, and so the benefit of successfully undercutting regulator 2 rises. Which effect dominates depends on the specific model parameters. This logic explains why a first-order-stochastic-dominance result is not available for regulator 1's response.

It is noteworthy that the existence of growth objectives in the regulators' objective functions creates an externality between global levels of regulatory stringency in equilibrium and non-financial domestic policies which affect the willingness of banks to be internationally mobile. The relevant domestic policies include taxes, labour laws and the broader economic and social institutions, which are matters that are typically outside the purview of a financial regulator. The above result implies that, the more attractive the domestic policies (unrelated to financial regulation), the smaller will be the number of banks in play internationally, and so the urgency of using financial regulatory stringency to attract banks is reduced globally.

7. Conclusions and Policy Discussion

We have developed a game theoretic model of financial regulators competing to attract banks to their jurisdiction, where regulators have objectives to both ensure financial stability and support economic growth. The regulators compete to attract banks in their countries by setting regulatory stringency they will apply to any given bank. Our model applies to the headquarters of whole banking groups, bank subsidiaries, and specific financial activities.

We noted in the Introduction that three of the top four financial centres based on the Global Financial Centres Index (New York, London, Hong Kong and Singapore as of 2024) have explicit growth objectives within their mandates. Using textual analysis of the annual reports published by the regulators of these financial centres, we obtain a proxy measure of the growth focus of these regulators, as this cannot be directly observed. We describe in Appendix B how this allows us to construct a proxy for α for each of these regulators. This proxy for the focus on growth in the regulators' objective function is plotted in Figure 7, with the measure indexed to the level of EU measure in 2013 (indexed as 1).

Based on this measure, the financial regulators of Singapore and Hong Kong appear to have been more growth focused for most of the 2013-23 period relative to those in the US, UK and Europe. The measured preference of UK and European regulators remained broadly similar throughout the decade, although our measure does pick up the uptick in the growth focus of the UK's Prudential Regulation Authority (PRA) after it was given a secondary growth and competitiveness objective in 2023. We note that this is a crude measure, as simple counts of the growth-focused words relative to the stability-focused words in annual reports may not accurately capture regulators' true preference over growth relative to stability. [32]

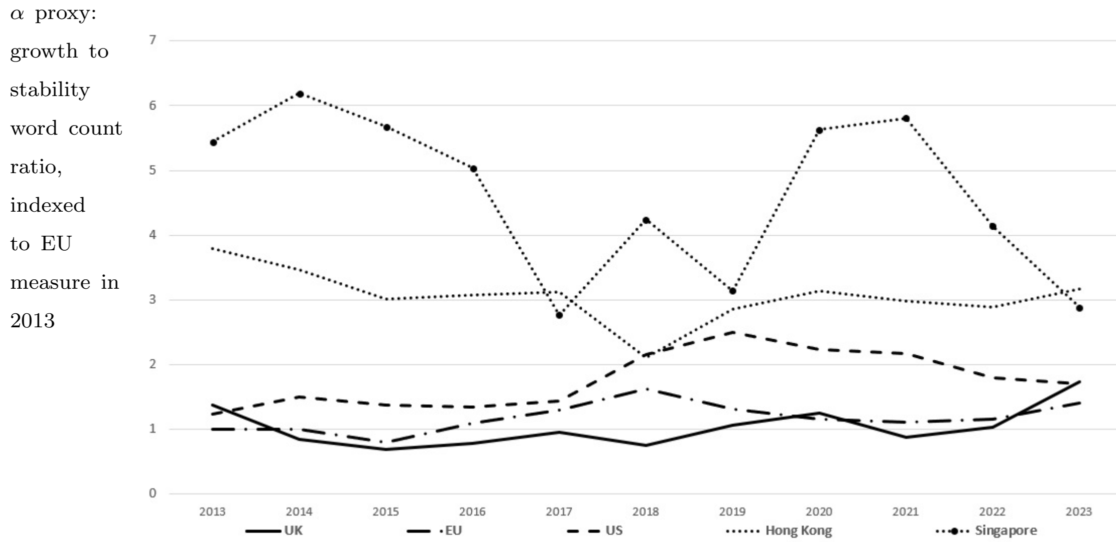


Figure 7: Growth Preference – Cross Country Comparison, 2013-2023

Note: This figure presents a proxy for α which we construct as the ratio between the frequency of growth-related words and the frequency of stability-related words found in the annual reports of the European Union, United Kingdom, United States, Singapore and Hong Kong. The construction of this metric is described in Appendix B. The figure presents the word count ratio relative to that of the EU in 2013 to facilitate comparisons.

Our work sets out a number of analytical results for the impact of giving financial regulators a growth objective, and the impact of strengthening the growth focus of a financial regulator relative to its peers. It is clear from the textual analysis of objectives depicted in Figure 7 that some financial regulators have recently seen a change in the relative focus they place on growth as compared to financial stability.

First, the impact of a growth objective of a financial regulator on the country's regulatory stringency depends on how much foreign regulators care about growth. This result follows from Proposition 1 and Theorem 1 which show that the equilib-

[32] Compared to other countries, the proxy for Singapore is more volatile. Volatility could be explained by several changes in the format of annual reports published by the Monetary Authority of Singapore (MAS). From 2015 to 2016 the length of the report decreased from 144 pages to 85 pages, then from 2016 to 2017 the report changed from a single PDF document to a small slide pack, and from 2017 onwards the report is published as separate individual chapters on the MAS' website. These changes only affected the frequency of words related to stability. Finally, the surge in 2020-2021 coincides with a series of innovation-related policies, e.g. second phase of SGFinDex, enhancements to its Fintech Regulatory Sandbox framework, and the Global CBDC Challenge.

rium of financial regulation depends upon how the objectives given to one regulator compare with the objectives given to the financial regulator in the competing jurisdiction.

Second, giving a growth objective to a financial regulator (or enhancing it) will not lead to competitive deregulation if other regulators are primarily focused on stability. But this becomes a possibility if other regulators are similarly growth-focused. Proposition 2 demonstrated that if a growth-focused regulator has its growth focus reinforced, then other regulators may actually *increase* the levels of financial stringency in response. But when a stability-focused regulator is given a stronger growth focus, Proposition 3 demonstrated that competitive deregulation becomes possible. In general, this will not result in a 'race-to-the-bottom' in which regulators simply offer a level of stringency preferred by banks. Instead, the levels of regulatory stringency remain within controlled, though more permissive, bounds.

Finally, competitive deregulation becomes more likely if more banks become willing to move their headquarters, subsidiaries, or specific activities across jurisdictions in response to differences in the levels of regulatory stringency.

Our analytical results give rise to a number of policy implications. First, setting global regulatory standards would help limit the extent of competitive deregulation, though this will not offer a full solution. In practice, it is not possible to agree on and enforce global standards across all regulatory dimensions for the following reasons: i) many regulations are specific to jurisdictions (e.g. a bonus cap in the EU); ii) some regulatory requirements may not be disclosed (e.g. Pillar 2 capital requirements for banks), and iii) implementation details are hard to agree on (e.g. the amount of data requests).

Second, setting hierarchical objectives, whereby the growth objective is made strictly secondary to the stability objective (e.g. in the case of the UK's PRA), could be another way of limiting the extent to which the domestic regulator engages in competitive deregulation. In the context of our model, making the growth objective secondary would imply that the regulator would trade-off stability against growth only subject to meeting a minimum required standard for stability. To ensure that the stability objective remains strictly primary, regulators could define and monitor a set of quantitative indicators for its primary stability objective.[33]

Finally, the need for financial regulators to use regulatory stringency to attract banks will be reduced if more banks become committed to staying in the country because it is attractive in other dimensions, and vice-versa. Thus, a country-level strategy for enhancing the competitiveness of a financial centre will need to take into account this externality between financial regulations and other government policies (e.g. tax, labour laws, and the wider economic and social institutions).

[33]Given that no single indicator will be perfect, regulators may wish to use a mix of indicators based on market prices (e.g. CDS premia and SRisk (see for example Brownlees and Engle, 2016)), balance sheet measures (e.g. capital, liquidity and leverage ratios), and judgment (e.g. credit ratings, supervisory ratings)

Appendix A. Proofs

Proof of Claim 1. Applying the envelope theorem to (5)

$$
\begin{aligned}
\frac{d}{d\alpha_i}W(t^*(\alpha_i);\alpha_i) &=_{\text{envelope thm}} \frac{\partial}{\partial\alpha_i}W(t^*(\alpha_i);\alpha_i) \\
&= [R - g(t^*)(1+R) - t^*] + g(t^*)L \\
&= \frac{1}{\alpha_i}W(t^*(\alpha_i);\alpha_i) + \frac{1-\alpha_i}{\alpha_i}g(t^*)L + g(t^*)L \\
&> 0
\end{aligned}
$$

as all the terms are individually positive. ■

Proof of Claim 2. Differentiate the first order condition (9)

$$W_{tt}(t^*(\alpha);\alpha)\frac{dt^*(\alpha)}{d\alpha} + W_{t\alpha}(t^*(\alpha);\alpha) = 0$$

Therefore

$$
\begin{aligned}
\frac{dt^*(\alpha)}{d\alpha} &= -\frac{W_{t\alpha}(t^*(\alpha);\alpha)}{W_{tt}(t^*(\alpha);\alpha)} \\
&=_{\text{sign}} W_{t\alpha}(t^*(\alpha);\alpha) = -g'(t^*)(1+R) - 1 + g'(t^*)L \qquad \text{(Appendix A.1)} \\
&= \frac{1}{\alpha}\underbrace{W_t(t^*(\alpha);\alpha)}_{=0} + \frac{1-\alpha}{\alpha}g'(t^*)L + g'(t^*)L \\
&< 0.
\end{aligned}
$$

For the second result, notice $t^*(\alpha)$ does not depend on B. ■

Proof of Proposition 1. For the 'if' direction we construct the equilibrium explicitly. Suppose that each regulator i sets the closed-economy optimal level of regulatory stringency: $t^*(\alpha_i)$. Given (12) regulator 2 will secure all of the mobile bankers and earns the maximum possible – it has no profitable deviation. For regulator 1, the best possible deviation is to just undercut regulator 2: by doing so, regulator 1 will gain more banks but only at the expense of reducing the welfare gain per bank. This is not profitable for regulator 1 if (16) holds. Thus this delivers a pure strategy equilibrium whereby regulator 1 sets $t^*(\alpha_1)$ and regulator 2 sets $t^*(\alpha_2)$. Since $t^*(\alpha_2) < t^*(\alpha_2)$, regulator 2 gains all mobile banks.

For the 'only if' direction we show that if (16) does not hold then a pure strategy equilibrium does not exist. Suppose to the contrary that it does. The regulators cannot set the same level of t, otherwise one would undercut the other and win all the mobile banks. If they set different levels of t, then the regulator with the lower t, say j will win all the mobile banks, and thus has an optimal deviation to $\min(t^*(\alpha_j), (t_i)_-)$. The regulator setting a higher t, say i, only wins domestically tied banks and so a beneficial deviation is to adopt the closed-economy optimal $t^*(\alpha_i)$, as this maximises the benefits the regulator gets per bank. Iterating at most once more this guarantees that the pure strategy equilibrium either has i) one regulator undercutting the other at $t^*(\alpha_2)$, or ii) is of the form where regulator 1 sets $t^*(\alpha_1)$ and regulator 2 sets $t^*(\alpha_2)$. But the first case cannot be an equilibrium, as a pure strategy equilibrium does not exist if both regulators set the same level of t as each would undercut the other to generate a first order increase in the number of mobile banks in the deviating country without materially increasing the risk of failure of banks in that country. And the second case cannot be an equilibrium if (16) does not hold, because regulator 1 has the incentive to move just below $t^*(\alpha_2)$ in order to attract all mobile banks. ■

Proof of Claim 3. The regulator with a higher t will not attract any mobile banks. In this case a profitable deviation is to set t to the closed-economy optimal level as this maximises the welfare per bank. ■

Proof of Claim 4. Suppose otherwise that regulator 2 mixes in this region. It has a beneficial deviation to lower the level of stringency to $t^*(\alpha_2)$ which raises its welfare per bank. It still attracts all mobile banks given $t^*(\alpha_2) < t^*(\alpha_1)$. The result then follows by applying Claim 1. ■

Proof of Claim 5. That the lower bound of the mixing distribution is below $t^*(\alpha_2)$ follows from Claims 3 and 4. Suppose that regulator i sets $t_i^{down} < t_j^{down}$. We have that $t_i^{down} < t^*(\alpha_i)$. Therefore i should raise its lower bound up to just below t_j^{down} as this increases welfare without losing market share. This yields the desired contradiction. ■

Proof of Claim 6. Suppose that the regulators leave a gap in their mixing distributions. Let t_{gap} and t^{gap} be the lower and upper bound of this gap, respectively. Suppose there is at least one regulator, say j which does not have a mass point at t_{gap}. Therefore whenever regulator i is planning to set t_{gap}, it should instead offer the regulation t^{gap} at the top of the gap. This increases its payoff without altering its probability of attracting mobile banks. We therefore have a contradiction. Suppose therefore that both regulators have a mass point at t_{gap}. Then either one has a beneficial deviation undercutting the other, again a contradiction. ■

Proof of Claim 7. Suppose otherwise that in equilibrium regulator i sets a mass point at some $t_i \in [t_*, t^*(\alpha_2))$. Regulator j should therefore take all the mass in $[t_i, t_i + \varepsilon]$ and move it to just below t_i. But this then opens up a gap in the support of regulator j. We have already established that this is not possible in equilibrium – a contradiction. ■

Proof of Claim 8. We established that regulator 1 will include $t^*(\alpha_1)$ in the support of its mixing strategy (Claim 3). We have also established that regulator 2 will include $t^*(\alpha_2)$ in its mixing (Claim 6). We have also established that there can be no mass point in the region $[t_*, t^*(\alpha_2))$ (Claim 7). This yields the result for regulator 1 immediately. For regulator 2 suppose that it does not have a mass point at $t^*(\alpha_2)$ then it is not possible for regulator 1 to be willing to mix between $t^*(\alpha_1)$ and $t^*(\alpha_2)$ as the latter would lower her welfare per bank attracted and not alter the expected number of banks attracted – a contradiction. ■

Proof of Proposition 2.

1. The lower bound t_* is defined implicitly by (17). By inspection this is independent of α_2.

2. For the behaviour of regulator 1 we use (21) to establish:

$$\frac{\partial F_1(t;\alpha_1,\alpha_2)}{\partial \alpha_2} = \frac{1-B_1}{1-B_2-B_1} \cdot \frac{-\left[\begin{array}{r} W(t;\alpha_2)\left[W_t \cancelto{0}{\frac{\partial t_*}{\partial \alpha_2}} + W_\alpha(t_*;\alpha_2)\right] \\ -W(t_*;\alpha_2)W_\alpha(t;\alpha_2) \end{array}\right]}{W(t;\alpha_2)^2}$$

$$=_{\text{sign}} W(t_*;\alpha_2)W_\alpha(t;\alpha_2) - W(t;\alpha_2)W_\alpha(t_*;\alpha_2) \qquad \text{(Appendix A.2)}$$

Now note that

$$W(t_*;\alpha_2) < W(t;\alpha_2) \qquad \text{(Appendix A.3)}$$

as $t \in (t_*, t^*(\alpha_2))$ and W is concave in t.

The next step of the argument is to sign $W_{t\alpha}$. Notice

$$W_{t\alpha} = -g'(t)(1+R) - 1 + g'(t)L \qquad \text{(Appendix A.4)}$$

If $L \geq 1+R$ then (Appendix A.4) implies $W_{t\alpha} < -1 < 0$. Suppose next that $L < 1+R$ while (13) holds. In this case we will show that $\frac{\partial}{\partial t}W_{t\alpha} < 0$ still holds. We have that $W_{t\alpha}(t^*(\alpha);\alpha) < 0$ from (Appendix A.1). Therefore, given $g(\cdot)$ is convex, a sufficient condition for $W_{t\alpha}(t;\alpha) < 0$ to hold for $t \in (0, t^*(\alpha_2)]$ is that it holds weakly at $t = 0$. But this is given by (13) as

$$W_{t\alpha}(0;\alpha) = -g'(0)(1+R) - 1 + g'(0)L = g'(0)\left[L - (1+R) - \frac{1}{g'(0)}\right] \leq 0$$

So we have

$$W_{t\alpha}(t;\alpha) < 0 \ \forall t \in (0, t^*(\alpha_2)]. \qquad \text{(Appendix A.5)}$$

It follows that

$$W_\alpha(t;\alpha_2) < W_\alpha(t_*;\alpha_2) \qquad \text{(Appendix A.6)}$$

Therefore combining (Appendix A.3) and (Appendix A.6) into (Appendix A.2) yields

$$\frac{\partial F_1}{\partial \alpha_2} < 0,$$

as claimed.

Finally using (22) and (21) yields

$$\frac{d}{d\alpha_2} F_1(t^*(\alpha_2);\alpha_1,\alpha_2) = f_1(t^*(\alpha_2);\alpha_1,\alpha_2)\frac{\partial t^*(\alpha_2)}{\partial \alpha_2} + \frac{\partial F_1(t^*(\alpha_2);\alpha_1,\alpha_2)}{\partial \alpha_2} < 0 \Rightarrow \frac{\partial \rho_1}{\partial \alpha_2} > 0.$$

3. Part 1 follows from Claim 2. That F_2 is independent of α_2 is immediate from (19). Finally, using (23) we have

$$\frac{d}{d\alpha_2} F_2(t^*(\alpha_2);\alpha_1,\alpha_2) = f_2(t^*(\alpha_2);\alpha_1,\alpha_2)\frac{\partial t^*(\alpha_2)}{\partial \alpha_2} + \cancelto{0}{\frac{\partial F_2(t^*(\alpha_2);\alpha_1,\alpha_2)}{\partial \alpha_2}} < 0 \Rightarrow \frac{\partial \rho_2}{\partial \alpha_2} > 0.$$

■

Proof of Corollary 1. The probability that country 2 wins a given international bank can be labelled ω_2 and is given by:

$$\omega_2 = \int_{t=t_*}^{t^*(\alpha_2)} f_2(t;\alpha_1,\alpha_2)\,(1 - F_1(t;\alpha_1,\alpha_2))\,dt + \rho_2 \cdot \rho_1$$

Differentiating with respect to α_2 yields

$$\frac{\partial \omega_2}{\partial \alpha_2} = \frac{\partial t^*(\alpha_2)}{\partial \alpha_2} f_2(t^*(\alpha_2))\rho_1 + \frac{\partial \rho_2}{\partial \alpha_2}\rho_1 \qquad \text{(Appendix A.7)}$$

$$- \int_{t-t_*}^{t^*(\alpha_2)} f_2(t;\alpha_1,\alpha_2) \underbrace{\frac{\partial F_1}{\partial \alpha_2}}_{<0} dt + \underbrace{\frac{\partial \rho_1}{\partial \alpha_2}}_{>0} \rho_2 \qquad \text{(Appendix A.8)}$$

Where in line (Appendix A.8) we have used Proposition 2 parts 2(a), 2(b) to sign the terms, and 3(c) implicitly in the differentiation to yield $\partial f_2/\partial \alpha_2 = 0$. Finally note that (Appendix A.7) is identically zero by differentiating (23) with respect to α_2, using Proposition 2 part 3(c). We therefore have established that

$$\frac{\partial \omega_2}{\partial \alpha_2} > 0.$$

■

Proof of Proposition 3.

1. First we establish the change in the lower bound of the mixing distributions. Differentiate (17) with respect to α_1 to yield:

$$\underbrace{W_t(t_*;\alpha_1)}_{\substack{>0 \text{ as} \\ t_* < t^*(\alpha_1)}} \frac{\partial t_*}{\partial \alpha_1} + W_\alpha(t_*;\alpha_1) = \frac{B_1}{1-B_2}\left[\underbrace{W_t(t^*(\alpha_1);\alpha_1)}_{\substack{=0 \text{ as} \\ \text{optimal}}} \frac{\partial t_*}{\partial \alpha_1} + W_\alpha(t^*(\alpha_1);\alpha_1)\right]$$

$$\Rightarrow \frac{\partial t_*}{\partial \alpha_1} =_{\text{sign}} \frac{B_1}{1-B_2} W_\alpha(t^*(\alpha_1);\alpha_1) - W_\alpha(t_*;\alpha_1)$$

Now note that $\frac{B_1}{1-B_2} < 1$ and using the fact, established in the proof of Proposition 2, that $W_{\alpha t} < 0$ which yields that $W_\alpha(t^*(\alpha_1);\alpha_1) < W_\alpha(t_*;\alpha_1)$, which delivers that

$$\frac{\partial t_*}{\partial \alpha_1} < 0.$$

2. To determine the effect on regulator 1 we differentiate (21) with respect to α_1 to yield:

$$\frac{\partial F_1}{\partial \alpha_1} =_{\text{sign}} -\frac{\partial}{\partial \alpha_1} W(t_*; \alpha_2) = -\underbrace{W_t(t_*; \alpha_2)}_{>0} \underbrace{\frac{\partial t_*}{\partial \alpha_1}}_{<0} > 0.$$

   The final part follows immediately using (22).

3. Next we turn to the strategy of regulator 2. We differentiate (19) with respect to α_1 to yield:

$$\begin{aligned}\frac{\partial F_2(t; \alpha_1, \alpha_2)}{\partial \alpha_1} &= \frac{-B_1}{1 - B_2 - B_1} \cdot \frac{\left[\begin{array}{r} W(t; \alpha_1)\left[\cancelto{0}{W_t(t^*(\alpha_1); \alpha_1)}\frac{\partial t^*}{\partial \alpha_1} + W_\alpha(t^*(\alpha_1); \alpha_1)\right] \\ -W(t^*(\alpha_1); \alpha_1) W_\alpha(t; \alpha_1) \end{array}\right]}{W(t; \alpha_1)^2} \\ &=_{\text{sign}} W(t^*(\alpha_1); \alpha_1) W_\alpha(t; \alpha_1) - W(t; \alpha_1) W_\alpha(t^*(\alpha_1); \alpha_1)\end{aligned}$$

(Appendix A.9)

   Now we note that $W(t^*(\alpha_1); \alpha_1) > W(t; \alpha_1)$ by the construction of $t^*(\alpha_1)$. We also use the fact, established in the proof of Proposition 2, that $W_{\alpha t} < 0$ which yields that $W_\alpha(t; \alpha_1) > W_\alpha(t^*(\alpha_1); \alpha_1)$. And together these deliver that $\partial F_2 / \partial \alpha_1 > 0$.

   Part 2 then follows immediately using (23).

■

Proof of Proposition 4. For the first part recall that the lower bound of regulatory stringency t_* is given in (17) and can be written as:

$$W(t_*; \alpha_1) = \underbrace{\frac{B_1}{1 - B_2}}_{(\mathcal{C})} W(t^*(\alpha_1); \alpha_1)$$

Now note that $(\mathcal{C})$ is increasing in $B_i,\ i \in \{1,2\}$. As $W'(t;\alpha_1) > 0$ for $t < t^*(\alpha_1)$ we have $\partial t_*/\partial B_i > 0$ $i \in \{1,2\}$ as required.

For the second part recall that the CDF of regulator 2's stringency $(F_2(t;B_1,B_2))$ is given in (19) which can be written as:

$$F_2(t;B_1,B_2) = 1 - \underbrace{\frac{B_1}{1-B_1-B_2}}_{(\mathcal{D})} \left[\underbrace{\frac{W(t^*(\alpha_1);\alpha_1)}{W(t;\alpha_1)}}_{>1} -1 \right].$$

Now note that $(\mathcal{D})$ is increasing in $B_i,\ i \in \{1,2\}$. This delivers the second result.

For the third result we observe from regulator 1's CDF as given in (21):

$$F_1(t;\alpha_1,\alpha_2) = \underbrace{\frac{1-B_1}{1-B_2-B_1}}_{(\mathcal{E})} \underbrace{\left[1 - \frac{W(t_*;\alpha_2)}{W(t;\alpha_2)}\right]}_{(\mathcal{F})}$$

Now observe that $(\mathcal{E})$ is increasing in both B_1 and B_2, while $(\mathcal{F})$ is decreasing in both B_1 and B_2 which yields the ambiguity result. ■

Appendix B. Textual Analysis of Financial Centre Objectives

This section explains how we use textual analysis to identify a proxy for α to capture the relative importance of growth versus financial stability in the objective function of leading financial regulators. This metric is plotted in Figure 7. Below we describe which countries we use, how we collect and clean the data, and how we construct the metric.

We include the main global financial centres, i.e. European Union, United Kingdom, United States, Hong Kong and Singapore, between 2013-2023. This list is based on the top 5 financial centres as identified in the Global Financial Centre Index (Z/Yen and CDI, 2024), plus the EU.

The steps taken to construct our α proxy are as follows.

1. We use the annual reports of financial regulators for the main global financial centres we listed above. For each country we download the annual report for every year it is publicly available. Table Appendix B.1 presents the name and URL for each regulator and the sample range available.

2. We restrict the analysis to annual reports for the 2013-2023 period to allow for a complete sample. We remove from each annual report the section on monetary policy and the statistical tables. This is because the focus of our study is financial regulation. We count the frequency with which every word is used across the whole of this sample, aggregating all the countries and all the years. The word list is constructed by stripping out punctuation marks, numbers, dates, and indefinite pronouns.[34] From this list we identify the top 1000 words used across the whole sample.

3. From the list of 1000 most common words identified in step 2 we manually

[34] The counting of words is case sensitive.

create a list of growth-focused words. This list is kept fixed through this analysis to allow comparability across time and across countries. Similarly, we manually create a separate list of stability-focused words drawn from the top 1000 words identified in step 2. The words chosen to be in each list are given at the end of this Appendix.

4. For each country and each year we count the frequency with which a word from the growth-focused list appears in the annual report (having removed the monetary policy section and statistics tables as described above). We also count the frequency with which a word from the stability-focused list appears. Our α proxy for this country in this year is the ratio of these two frequencies.[35]

5. We normalise each α proxy against that of the EU in 2013 to allow trends across time and between countries to be more visible. These are then plotted graphically in Figure 7.

Table Appendix B.1: Annual Reports

Country	Authority	Sample	URL link
European Union	European Banking Authority	2012-2023	EBA
United Kingdom	Prudential Regulatory Authority	2013-2023	PRA
United States	Federal Reserve Board	1995-2023	FRB
Singapore	Monetary Authority of Singapore	1997 - 2023	MAS
Hong Kong	Hong Hong Monetary Authority	1998 - 2023	HKMA

```
Growth_list = ["growth","development", "competition","competitiveness",
        "growth", "economic", "economy", "competent", "corporate",
        "economies", "corporate", "competition", "economic",
        "efficiency","fintech", "financial centre", "output",
        "gdp", "gross value added","employment"]
```

[35]The Python code for this analysis is available at link.

```
Stability_list = ["risk","risks","resilence","ring-fencing","operational",
            "stability","basel","stress","safety","prudential",
            "disclosure","soundness","crisis","accountability",
            "capital","leverage","pillar","monitor","supervisors",
            "solvent","systemic","supervision","risk","resolution",
            "resilient","solvency", "supervisory", "regulatory",
            "requirements","standards","compliance", "regulation",
            "resilience","regulation", "provisions", "regulators",
            "requirement", "robust", "liabilities", "standard",
            "risk-based","regulated"]
```

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