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# Trade and Credit Reallocation: How Banks Help Shape Comparative Advantage

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# Trade and Credit Reallocation: How Banks Help Shape Comparative Advantage

## Abstract

Trade and innovation cause structural change. Productive factors must flow from declining to growing industries. Banks play a major role in cutting credit to non-viable firms in downsizing sectors and in providing new credit to finance investment in expanding, innovative sectors. Structural parameters of a country's banking system thus influence comparative advantage and trade, and can magnify the gains from trade liberalization. The analysis shows how insolvency laws, minimum capital standards, and cost of bank equity determine credit reallocation, sectoral expansion and trade patterns.

JEL-Codes: F100, G210, G280.

Keywords: capital reallocation, banking, trade, comparative advantage.

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# 1 Introduction

Innovation and trade are major sources of structural change. Innovative firms with better products conquer world markets and drive the expansion of export industries, while declining sectors with less productive firms must shrink. To exploit comparative advantage, capital and labor must flow from declining towards expanding industries. But the process of sectoral reallocation is, by no means, without frictions. When capital and labor are locked into current uses, a country cannot reap the gains from trade and fails to exploit its comparative advantage.

Many countries are heavily dependent on banks to finance investment, especially in Europe. A major function of the banking sector is to allocate credit to its best use. By terminating credit lines to firms with poor prospects, banks release capital that would otherwise be locked up in unproductive uses, and make it available for investment of new or expanding firms. Thereby, banks support the Schumpeterian process of creative destruction and contribute to a more efficient allocation of capital. Given the dominant role of banks in financing aggregate investment, structural parameters of the banking system importantly influence credit flows and capital reallocation.

The goal is to explain how banks help shape comparative advantage. Such an analysis not only sheds light on the process of capital reallocation and structural change but also identifies new determinants of trade that could be tested in empirical work. In particular, our findings point to the importance of insolvency laws, capital regulation and cost of bank equity in influencing credit reallocation and sectoral trade patterns. The analysis is also informative about the reverse effects, namely, how trade accelerates structural change in the domestic economy, and how institutional reform addressing the efficiency of the banking sector can ease this process.

We propose a framework of credit reallocation developed in earlier work (Keuschnigg and Kogler, 2017) as part of a Heckscher-Ohlin model of trade. We picture an economy with two goods and two sectors: an expanding sector with productive investments and

a traditional sector with more opaque projects. Banks initially allocate credit to both sectors. They play a *Schumpeterian* role in the sense that they terminate and reallocate credit when prospects change. They terminate 'non-performing' loans of traditional firms whenever their investments turn out to be poor, and make the proceeds available for financing more projects in the innovative sector. The extent of credit reallocation inherently depends on a bank's capital structure and the institutional environment. When liquidating poorly performing firms, a bank must absorb short-term losses that erode its equity buffer. Its capital structure thus determines the capacity to reallocate credit. Consequently, sectoral investment and trade patterns become dependent on institutional and regulatory characteristics that influence how banks choose their capital structure.

To the best of our knowledge, this is the first paper that integrates a meaningful structural banking model to explain the frictions in credit flows and the reallocation of capital in a model of international trade. Our analysis thus identifies novel bank-related and institutional determinants of trade and comparative advantage. We consider three policy interventions, namely, (i) bank regulation with higher capital standards, which capture the essence of recent banking reforms; (ii) institutional reforms relating to investor protection and bankruptcy law. They aim at a lower cost of bank equity and more efficient bankruptcy procedures; and (iii) trade liberalization targeted at lower export costs in the innovative sector. To identify the main channels, we first evaluate these policies in a small, open economy and then turn to an analysis of global trade equilibrium.

We obtain three main results. First, *bank regulation* with tighter capital standards boosts credit reallocation. Better capitalized banks can more easily absorb larger write-offs and, in turn, liquidate and reallocate credit more frequently. Banks help shape comparative advantage by shifting investment and output to the innovative sector. Second, *institutional reforms* such as better investor protection and more efficient bankruptcy laws make bank equity cheaper, and enable banks to extract more capital when liquidating non-performing loans. This induces more credit reallocation and shifts final investment and output to the expanding sector. Countries with strong institutions thus tend to en-

joy a comparative advantage in innovative industries. By raising supply, regulatory and institutional reforms in large economies decrease the world market price of innovative goods and thus entail a feedback effect on the home country and spillovers to foreign economies. Third, we consider a *trade liberalization* scenario which lowers export costs and thereby allows for higher domestic producer prices in the innovative sector. Such a policy facilitates specialization in that sector by both accelerating reallocation and encouraging entry. While this result is standard, the transmission mechanism is entirely different. Most importantly, we highlight interaction effects of trade liberalization with institutional and regulatory reform. A banking sector that more efficiently reallocates credit supports the productive specialization of the economy and can magnify the gains from trade liberalization.

The remainder of this paper is organized as follows: Section 2 explains how our analysis relates to and extends existing research. Section 3 sets out the model. Sections 4 and 5 investigate policy interventions in a small, open economy and in an integrated world equilibrium, respectively. Section 6 concludes.

# 2 Relation to the Literature

Classical trade theory predicts that comparative advantage and trade patterns result from cross-country differences in technology (Ricardian) or endowments (Heckscher-Ohlin). Trade induced structural change rests on capital and labor flowing from shrinking to expanding sectors. As Mussa (1978) emphasized, this process is not at all without frictions, consumes resources and may result in permanent effects on industry structure. He postulated a technology using labor in a 'capital movement industry', making reallocation costly. More recent research points to agency problems, limited contract enforcement or labor market rigidities which affect the ease and speed of reallocation. In the presence of such frictions, domestic institutions that help mitigate or overcome such frictions become important determinants of specialization and trade (see survey by Nunn and Trefler,

2014). A general conclusion is that countries with strong institutions are more likely to enjoy a comparative advantage in sectors prone to frictions.

Almost exclusively, the trade and finance literature focuses on financial frictions where incentive problems at the firm level limit the access to external finance and hamper firm entry and investment. Financial intermediaries channel savings to firms, subject to a break-even condition. Financial development relates to the effectiveness in exercising oversight and control, thereby improving incentives and easing access to external finance.[1] It may also relate to competitiveness in terms of intermediaries' ability to extract rents, thereby raising firms' cost of finance. A well-developed financial sector becomes a source of comparative advantage in industries that intensively rely on external finance, see early work by Kletzer and Bardhan (1987) and Baldwin (1989). More recent contributions include Beck (2002), Wynne (2005), Ju and Wei (2011), and Egger and Keuschnigg (2015, 2017). Manova (2013) and Chaney (2016) relate financial constraints to firm heterogeneity. They highlight that exporters are particularly dependent on external finance due to high fixed upfront investments.[2] Another strand of research explores the effects of short-run trade finance, bridging the time between production and delivery (Antràs and Foley, 2015; Niepmann and Schmidt-Eisenlohr, 2017). Financial frictions may also lead to a complementarity in trade and capital movements, that is, financially less developed countries may attract capital if they open up to trade (Antràs and Caballero, 2009).

Empirical results broadly support the importance of credit constraints for international trade (e.g., Beck, 2002, 2003; Svaleryd and Vlachos, 2005; Manova, 2008; Becker et al., 2013; and Chor and Manova, 2012). Financial development boosts exports especially in financially dependent industries with high fixed costs of market entry. The estimates of Svaleryd and Vlachos (2005) suggest that in OECD countries differences in financial

[1] Financial development is usually exogenous. Do and Levchenko (2007) point to a reverse link and argue that a comparative advantage can shape financial institutions. For instance, a country specializing in financially intensive goods faces high demand for external finance, which fosters intermediation.

[2] According to Manova (2013), three quarters of the impact of credit constraints are specific to trade and result from distorted firm entry into exporting and reduced firm sales abroad.

development have stronger effects on trade patterns than differences in human capital.

Our analysis explores an entirely different route. It abstracts from incentives at the firm level and the well-understood problems with access to external finance. Instead, we focus on the characteristics of the banking sector. We emphasize credit reallocation which is a major function of banks in economies that undergo structural change. Reallocation is a driving force of productivity-enhancing innovation and creative destruction. We offer a structural model of financial development which accelerates reallocation and helps exploit a comparative advantage in innovative industries. Empirical evidence on 'Zombie' lending (e.g., Japan in the 1990s, European periphery today) demonstrates that an ill-functioning banking sector can lock up capital in existing uses with little productivity. Conversely, a resilient and well-functioning financial sector is a prerequisite for the productivity-enhancing reallocation mechanism to work.

Our focus on banks is consistent with their central role in reallocating capital and financing investment. Indeed, banks dominate financial intermediation in many countries, especially in Europe. The theoretical trade-finance literature has either modeled intermediaries in reduced form[3] or focused on how institutional and firm-level parameters affect the tightness of credit constraints. We instead propose a full-fledged model of banks that characterizes their main decisions such as lending, capital structure, loan liquidation and credit reallocation. We thereby identify novel determinants of comparative advantage such as capital regulation, cost of bank equity or efficiency of bankruptcy procedures.

A well-functioning financial system importantly contributes to an efficient capital allocation. Wurgler (2000) estimates that the elasticity of investment to value added significantly increases in various measures of financial development. Thus, more (less) productive industries grow (shrink) faster in countries with a developed financial sector. Similarly, evidence from the U.S. (Acharya et al., 2011) and France (Bertrand et al., 2007) shows that banking reforms render capital allocation more efficient. Conversely, a weak fi-

[3]Exceptions are Ju and Wei (2011) who picture imperfect competition in intermediation, and Egger and Keuschnigg (2015) who distinguish active and passive intermediaries.

nancial sector blocks reallocation as poorly capitalized banks often delay the liquidation of non-performing loans to avoid write-offs and violating regulatory or solvency standards. Instead, they engage in 'Zombie lending' to quasi-insolvent borrowers, which locks up capital in unprofitable firms and depresses productivity. Japan's 'lost decade' during the 1990s after the collapse of asset prices and collateral values serves as a prominent example (Peek and Rosengren, 2005; Caballero et al., 2008). Recent evidence points to similar problems in the Euro area after the financial crisis (Acharya et al., 2016; Schivardi et al., 2017). Building on the literature on misallocation and financial frictions (e.g., Hsieh and Klenow, 2009), Gopinath et al. (2017) relate low productivity growth in Southern Europe (Spain, Portugal and Italy) to large capital inflows, a relatively weak financial sector and large capital misallocation. They find no such increase in misallocation in countries with seemingly more robust banking sectors such as Germany, France and Norway.

On the theoretical side, capital reallocation has received much less attention. It is addressed in the finance-growth literature (e.g., King and Levine, 1993; Almeida and Wolfenzon, 2005; or Eisfeldt and Rampini, 2006) which highlights distortions due to financial frictions represented, for instance, by taxes or adjustment costs. These models picture financial institutions mostly in reduced-form if at all. Recent contributions in banking theory emphasize the interaction of loan liquidation with regulatory constraints (Keuschnigg and Kogler, 2017) or risk-shifting incentives (Bruche and Llobet, 2014; Homar & Van Wijnbergen, 2017) as explanations for 'Zombie lending' and insufficient credit reallocation. The key novel contribution of this paper, in merging the trade and banking literature, is to shed light on the role of banks in financing productivity-enhancing structural change and shaping a country's trade patterns.

Credit reallocation goes in line with a reorientation of firms when hit by foreign competition. Feenstra (2018) points to substantial gains from trade due to creative destruction which arise from higher productivity due to downsizing of less productive and expansion of more productive firms. Indeed, Bloom et al. (2016) investigate employment growth of firms subject to Chinese import competition in 12 European countries and find that

the less R&D intensive firms experience strong downsizing, while the most R&D intensive quintile of firms actually expand. The response to import competition seems to be quite heterogeneous with some firms being able to pull off a fresh start with a more innovative strategy. Bernard et al. (2017) document similar patterns among industrial firms in Denmark. While many experienced substantial downsizing or closed down, more R&D intensive firms were able to engineer renewed growth by switching to highly innovative service sectors. From 2002 to 2007, about 10 percent of industrial firms switched to other industries, which accounted for 42% of employment losses in the industrial sector. In our model, the reallocation of credit is also associated with serial entrepreneurship. Poorly performing firms in the traditional sector are liquidated. Some entrepreneurs get a second chance and start fresh with a new firm in the innovative sector. Indeed, Gompers et al. (2010) report that about 9.5 percent of start-ups had previous business experience, and that serial entrepreneurs are often more successful than first-time entrepreneurs.

# 3 The Model

Consider a competitive economy supplying distinct goods, $x$ and $z$, where $x$ refers to an innovative, expanding and $z$ to a traditional, downsizing sector. The relative price of $x$-goods is $v$. The $x$-sector offers innovative investment projects that succeed or fail. Projects in the $z$-sector reveal a performance signal already at an early stage. If the firm is seen to have little chance for success and repayment appears unlikely, banks as financiers may prematurely liquidate the 'non-performing' loan and use the proceeds to finance new firms in the expanding sector. Banks thus play a central role in financing structural change by lending up-front and reallocating credit if performance is bad.

The timing is: (i) Entrepreneurs develop business ideas which turn out to be more or less innovative; (ii) banks attract deposits and equity elastically supplied by investors and provide loans to entrepreneurs, who start a firm either in the innovative or traditional sector; (iii) banks learn the performance of $z$-firms and liquidate loans if prospects are

poor. They reallocate the proceeds to finance additional $x$-projects in the expanding sector; (iv) production, consumption and trade take place when projects mature at the end of the period.

## 3.1 Technologies and Preferences

**Technologies:** Both sectors offer investment projects ('firms'). Each of them is operated by an entrepreneur and requires one unit of capital. The $x$-sector hosts firms with more radical innovations. They produce $x$ units of the innovative goods that can be sold at price $v$ with probability $p$, or fail with zero earnings. Investments mature at the end of period, with no information in between. In the $z$-sector, firms are heterogeneous and, in general, less innovative. Importantly, their success probability $q'$ is unknown ex ante and uniformly distributed, $q' \sim U[0,1]$. Since projects are otherwise more standard, banks can monitor and receive an early performance signal in the interim period which perfectly reveals the type $q'$. If prospects are good, credit is continued and firms produce numeraire output $z$ with probability $q'$ and zero else. If success and repayment become unlikely, the firm can be prematurely liquidated.

**Preferences:** All agents are risk-neutral. Preferences are linear homogeneous and additively separable in effort. Given income $y_j$, demand of household $j$ follows from

$$w_j = \max_{c_{jx},c_{jz}} u(c_{jx}, c_{jz}) - h_j \quad s.t. \quad vc_{jx} + c_{jz} \leq y_j. \tag{1}$$

We specify Cobb Douglas utility with expenditure shares $\gamma = vc_{jx}/y_j$ and $1-\gamma = c_{jz}/y_j$. Welfare is real income minus effort cost, $w_j = y_j/v_c(v) - h_j$ where $v_c$ is the price index, changing by $\hat{v}_c = \gamma\hat{v}$. Denoting aggregate income by $Y$, total demand is

$$Y = vC_x + C_z, \quad C_x = \gamma Y/v, \quad C_z = (1-\gamma)Y. \tag{2}$$

## 3.2 Banks

Banks provide loans of size 1 to a mass of $n_x$ firms in the $x$-sector and $n_z$ firms in the $z$-sector giving loan portfolio size $n_x + n_z$. They attract deposits $d$ and equity $e$ from investors in the beginning, paying gross returns 1 and $\rho \equiv 1 + \theta$ where $\theta > 0$ denotes an equity premium.

When lending to $x$-firms, loans are repaid with probability $p$. No information is revealed in-between. When lending to $z$-firms, in contrast, the bank monitors in the interim period and learns the success probability $q'$, which is drawn from a uniform distribution, $q' \sim U[0,1]$. If prospects are good, credit is continued and repaid with probability $q'$. If $q'$ turns out to be quite low, making full repayment unlikely, the bank can terminate the loan and extract the liquidation value. Banks reallocate these proceeds to the innovative sector and finance new $x$-firms.

More precisely, banks liquidate unprofitable firms with $q' < q$ where $q$ is the pivotal type. Only a share $\int_q^1 dq' = 1 - q$ of startups continue, while the remaining part is closed down. Ex ante, the unconditional success probability is

$$\hat{q} = \int_q^1 q' dq' = \frac{1 - q^2}{2}, \quad \frac{d\hat{q}}{dq} = -q. \tag{3}$$

The success probability conditional on not being liquidated is

$$\bar{q} = E[q' | q' \geq q] = \frac{\int_q^1 q' dq'}{1 - q} = \frac{1 + q}{2}, \quad \frac{d\bar{q}}{dq} = \frac{1}{2}. \tag{4}$$

With a uniform distribution, these probabilities are linked by $\hat{q} = (1 - q)\,\bar{q} = (1 - q^2)/2$.

The sequence of events in bank lending is: (i) pay out $n_x + n_z$ loans of size one; (ii) monitor and get a perfect performance signal $q'$ on loans to $z$-firms; (iii) liquidate a share $q = \int_0^q dq'$ of non-performing $z$-loans and use the proceeds for new loans to $x$-firms. Depending on the stringency of bankruptcy law, banks must write off a part $c$ of the loan upon liquidation and can extract only the liquidation value equal to a fraction $1 - c$.[4]

[4]Note: $c$ is liquidation cost, whereas $c_j$ with an index $j$ refers to consumption of good $j$.

Liquidation thus releases $(1-c)\,qn_z$ funds for new lending. Given credit reallocation, the loan portfolio and the number of active firms evolve as

$$n'_x = n_x + (1-c)\,qn_z, \quad n'_z = n_z - qn_z. \tag{5}$$

Liquidation losses shrink final investment by $n'_x + n'_z = n_x + n_z - cqn_z$. Figure 1 illustrates how credit reallocation affects the direction of investment and sectoral structure.

In lending to firms, banks charge gross interest $i_z$ on loans to $z$-firms and $i_x$ and $i'_x$ on initial and reallocated loans to $x$-firms. Expected profit of a bank is

$$\pi_b = pi_x n_x + \pi_{bz} n_z - d - \rho e, \quad \pi_{bz} \equiv \bar{q} i_z\,(1-q) + pi'_x\,(1-c)\,q, \quad d = n_x + n_z - e, \tag{6}$$

where $\pi_{bz}$ denotes expected earnings on a $z$-loan. With probability $1-q$, the bank continues lending and earns expected interest $\bar{q}i_z$. With probability $q$, it liquidates, extracts $1-c$ of the loan and incurs a loss $c$. Hence, the proceeds $(1-c)\,q$ become available for new loans with expected interest earnings $pi'_x$. Since loan size is one, the mass of additional $x$-firms that get funded is $(1-c)\,qn_z$.

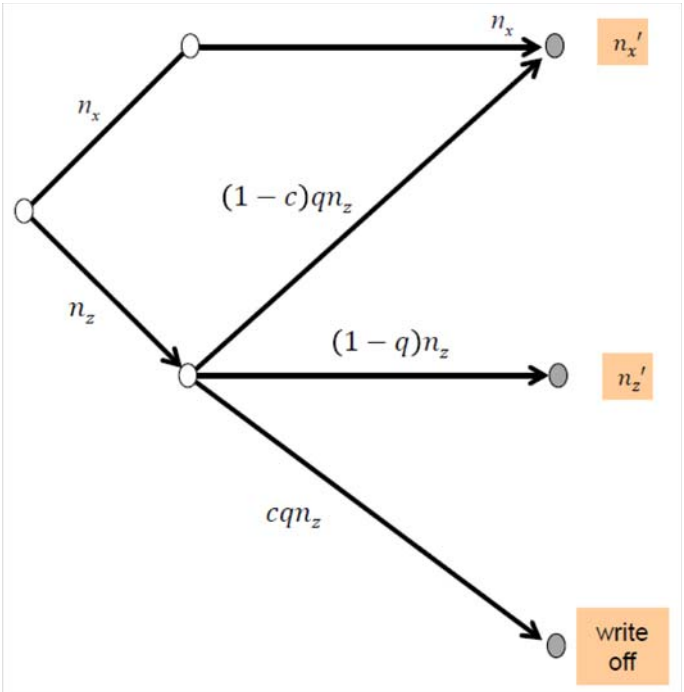


Figure 1: Credit Reallocation

Banks are 'Schumpeterian' in the sense that their credit decisions drive productivity enhancing 'creative destruction'. In liquidating poor firms, they terminate unproductive projects, extract capital and steer it towards more profitable uses by lending to additional $x$-firms. Banks finance the expansion of the innovative sector with initial lending to $x$-sector startups plus credit reallocated from the downsizing sector.

### 3.3 Entrepreneurs

There is a mass 1 of entrepreneurs who start 1 firm in 1 of the two sectors. They have no own funds and require bank credit of size 1. When setting up a firm, they anticipate future profits. In the innovative $x$-sector, firms expect profit

$$\pi_x = p\left(vx - i_x\right). \tag{7}$$

When starting a less innovative $z$-firm, the entrepreneur faces three possibilities after the performance signal is observed in the interim period: (i) continue with probability $1-q$ if the early performance signal is good; (ii) get liquidated and become a 'serial' entrepreneur by starting a new $x$-firm with probability $(1-c)\,q$; and (iii) get liquidated and fail to get a second chance with probability $cq$. The possibility of a fresh start importantly hinges on bankruptcy laws, which determine liquidation losses and credit rationing.[5] Conditional on continuation or reallocation, expected profit is

$$\pi_z = \bar{q}\left(z - i_z\right), \quad \pi'_x = p\left(vx - i'_x\right). \tag{8}$$

The ex ante profit from entering the $z$-sector amounts to

$$\bar{\pi}_z = \pi_z \cdot (1-q) + \pi'_x \cdot (1-c)\,q = \bar{z} - \pi_{bz}, \quad \bar{z} \equiv \bar{q}z\,(1-q) + vpx\,(1-c)\,q, \tag{9}$$

where $\bar{z}$ denotes expected earnings.

[5] Banks extract $1-c$ from a non-performing loan. The initial credit volume is $n_z$. Liquidation of $qn_z$ firms releases funds of $(1-c)\,qn_z$ available for new lending. Since each fresh-start needs a loan of size 1, it expects to get rationed with probability $cq$. In the end, $cqn_z$ firms are terminally out.

At the beginning, entrepreneurs must exert an R&D effort and prepare a business plan. Innovation is risky. With probability $s$, R&D results in an innovative $x$-project. With probability $1-s$, the entrepreneur ends with a more traditional and less profitable $z$-project. Effort cost $h(s)$ is convex and increasing. By choosing the R&D intensity $s$, an entrepreneur maximizes her welfare equal to expected real income net of the effort cost,

$$w_e = \max_s \ \pi_e/v_c - h(s), \quad \pi_e \equiv s \cdot \pi_x + (1-s) \cdot \bar{\pi}_z. \tag{10}$$

Optimal R&D balances the increase in expected real profits with marginal effort cost,

$$\pi_x - \bar{\pi}_z = v_c h'(s). \tag{11}$$

By the law of large numbers, a fraction $n_x = s$ of entrepreneurs ends up in the innovative sector while the other part is left with a more traditional project, $n_z = 1-s$. The result of initial R&D effort thus determines sectoral entry, $n_x + n_z = 1$. Note that some entrepreneurs become 'serial'. They first accumulate experience in a $z$-firm and, when failing, go for a fresh start in the expanding $x$-sector.[6]

## 3.4 Credit Reallocation

**Capital Structure:** Banks first choose capital structure and initial lending and subsequently decide on liquidation and reallocation of credit. Their capacity to absorb liquidation losses on non-performing loans and to reallocate credit to new ventures importantly depends on the capital structure. When liquidating loans, a bank must make sure that it remains solvent and still satisfies minimum capital standards. Liquidation generates a loss and diminishes bank equity since a part $c$ of the loan must be written off. After substantial write-offs, a bank is typically unable to quickly raise new equity. Hence, new lending is restricted to the funds $(1-c)\,qn_z$ which are released in the liquidation process.

[6] One could include an additional fixed R&D effort to redesign a firm's business model, thereby making reallocation more difficult. For simplicity, we abstract from this complication. At this stage, firms already have invested in R&D and have additionally accumulated valuable business experience.

More specifically, we assume that banks must always maintain a capital ratio of at least $k \geq 0$. Since lending to $z$-firms involves costly liquidation and banks are unable to raise new equity at a time of distress, they must raise a voluntary capital buffer ex ante to keep satisfying capital standards even after incurring liquidation losses,

$$e - cqn_z \geq k \cdot (n'_x + n'_z). \tag{12}$$

Credit reallocation has two effects. First, when a bank liquidates $qn_z$ loans, the loss $cqn_z$ reduces *actual* equity to $e - cqn_z$. Second, liquidation shrinks assets (outstanding loans) to $n'_x + n'_z = n_x + n_z - cqn_z$, making *required* equity fall by $kcqn_z$. The *net loss of equity*, which must be covered by a 'voluntary' buffer ex ante, is $(1-k)\, cqn_z$. This extra buffer becomes smaller when the capital standard is tighter. Importantly, (12) is equivalent to a solvency constraint if capital requirements are zero, $k = 0$. In this case, the capital buffer must cover the short-term losses during the reallocation process, $e \geq cqn_z$.

**Reallocation:** We solve the banking problem by backward induction and first derive the liquidation rate $q$. After observing success probabilities, banks decide about loan liquidation to maximize expected earnings $\pi_{bz}$ on initial $z$-loans. They take loan rates and capital structure as given and must satisfy capital requirements per $z$-project:

$$\pi_{bz} = \max_q \int_q^1 q' i_z dq' + \int_0^q pi'_x (1-c)\, dq' + \lambda \cdot [e - cqn_z - kn_x - k(1-cq)\, n_z] / n_z. \tag{13}$$

The optimal cut-off is characterized by

$$pi'_x (1-c) - qi_z = \lambda (1-k)\, c \quad \Rightarrow \quad q = \frac{pi'_x (1-c) - \lambda (1-k)\, c}{i_z}. \tag{14}$$

**Lending:** In the first stage, banks raise equity capital and deposits and cut loan rates to compete for borrowers until they hit break-even. Note bank profits as in (6), $\pi_b = [pi_x - 1]\, n_x + [\pi_{bz} - 1]\, n_z - \theta e$, and $d\pi_{bz}/de = \lambda / n_z$ from (13). Since optimal equity must satisfy $d\pi_b/de = \lambda - \theta = 0$, the regulatory constraint binds as long as equity earns a premium. Using the binding constraint to substitute for $e$ yields

$$\pi_b = [pi_x - r]\, n_x + [\pi_{bz} - r - \theta (1-k)\, cq]\, n_z, \quad r \equiv (1-k) \cdot 1 + k \cdot \rho = 1 + \theta k. \tag{15}$$

When a bank operates at the regulatory minimum, a loan of size 1 to an $x$-firm must be refinanced with equity $k$ and deposits $1-k$, giving a weighted cost of capital $r$. Since a $z$-loan might involve credit losses in case of premature liquidation, the bank must raise additional equity $(1-k)\,cq$ ex ante to satisfy capital requirements. A loan to the downsizing sector thus makes more intensive use of bank equity due to the extra buffer which makes the refinancing cost exceed the common cost $r$ by $\theta\,(1-k)\,cq$.

Bank profit is linear in loans, $n_x$ and $n_z$. Competition thus drives down loan rates until break-even. For $x$-loans, zero profits imply $pi_x = r$. When offering credit to a $z$-firm, banks set interest rates for continued and reallocated loans, $i_y$ and $i'_x$. They first set the ratio of loan rates so that the liquidation decision in (14) maximizes the joint surplus. Thereafter, they scale down rates to shift the surplus to firms. These are the best deals that banks can offer since they maximize firm profits subject to a break-even condition.

Adding the surplus of banks and firms per $z$-project in (15) and (9) yields a joint surplus of $S \equiv \bar{z} - r - \theta\,(1-k)\,cq$. The joint surplus is maximized ($dS/dq = 0$) if the gain $vpx\,(1-c) - qz$ from reallocation is equal to the cost of bank equity $\theta\,(1-k)\,c$ that is additionally required to absorb liquidation losses. The optimal liquidation rate is

$$q = \frac{vpx\,(1-c) - \theta\,(1-k)\,c}{z}. \tag{16}$$

The liquidation cost or equity premium can be so high and the capital standard so low that banks might not reallocate credit, $q = 0$.[7] In such a 'rigid' economy, sectoral investment and output are exclusively determined by entry.

Given $q$, loan rates $i_z$ and $i'_x$ must satisfy two conditions: a $z$-loan yields zero profits,

$$\pi_{bz} \equiv \bar{q} i_z\,(1-q) + pi'_x\,(1-c)\,q = r + \theta\,(1-k)\,cq, \tag{17}$$

and the liquidation decision in (14) supports the optimal cut-off $q$ in (16). Since $q$ is fixed by (16), one uses (14) with $\lambda = \theta$ to eliminate $pi'_x\,(1-c)$ in (17). Rearranging and noting $\bar{q}\,(1-q) = (1-q^2)\,/2$ yields interest on a continued $z$-loan. Knowing $i_z$ and $q$, we also

[7] This requires $\theta\,(1-k)\,c > vpx\,(1-c) \Leftrightarrow c > vpx/\,[vpx + \theta\,(1-k)]$ leading to $q = 0$.

find interest $i'_x$ on a reallocated $z$-loan,

$$i_z = \frac{2}{1+q^2} \cdot r, \quad i'_x = \frac{q \cdot i_z + (1-k)\,\theta c}{(1-c)\,p}. \tag{18}$$

**Entry:** Substituting for competitive loan rates gives expected profits

$$\pi_x = vpx - r, \quad \bar{\pi}_z = \bar{z} - \pi_{bz} = \bar{z} - r - \theta\,(1-k)\,cq. \tag{19}$$

Anticipating expected profit for each outcome, entrepreneurs set up a firm by design of a business plan and choose R&D intensity, $\pi_x - \bar{\pi}_z = v_c h'(s)$. Assuming identically and independently distributed R&D risks, the law of large numbers leads to sectoral entry $n_x = s$ and $n_z = 1 - s$. Given entry, subsequent reallocation shrinks the number of firms in the $z$-sector and augments those in the $x$-sector. After that, the average firm succeeds at rates $p$ and $\bar{q}$ in the two sectors.

## 3.5 Equilibrium

Investors are endowed with capital $I > 1$ which they invest in deposits, bank equity and an alternative investment opportunity $A$ with a gross return 1. Investor profits are

$$\pi_i = \rho e + d + A - \theta e, \quad e + d + A = I, \quad \rho = 1 + \theta. \tag{20}$$

To exercise oversight and control, equity investors incur management costs $\theta e$, measured in units of traditional sector output. It is a classical result of corporate finance that active forms of financing are more costly than passive funds. For simplicity and tractability, we assume that the equity premium is fixed. Assets are perfect substitutes and the supplies of deposits and equity are perfectly elastic at gross returns 1 and $\rho$.

Noting final sectoral investment in (5), aggregate outputs amount to

$$X \equiv pxn'_x, \quad Z \equiv \bar{q}zn'_z + A - \theta e. \tag{21}$$

Apart from the production of traditional firms, $z$-sector supply is augmented by output of the alternative technology which converts one unit of capital into one unit of output. Residual capital use $A = I - e - d$ is positive since $I > 1$ and $e + d = n_x + n_z = 1$.

Aggregate income is $Y = \pi_e + \pi_b + \pi_i = pvxn_x + \bar{z}n_z + A - \theta e$, where the second equality results upon substituting profit definitions. Using (5), (9) and (21) yields the national income identity,

$$Y = vX + Z. \tag{22}$$

The resource constraint on capital use is identically fulfilled by the assumption of residual investment in the traditional sector. Combining (2) and (22) yields

$$v\left(C_x - X\right) + \left(C_z - Z\right) = 0. \tag{23}$$

This condition reflects trade balance in an open economy without international capital flows. Worldwide, market clearing for innovative goods, $\sum_i \left(C_x^i - X^i\right) = 0$, implies market clearing for traditional goods, $\sum_i \left(C_z^i - Z^i\right) = 0$.

# 4 Small Open Economy

We evaluate the trade effects of four policy interventions: (i) bank regulation with higher capital standards $k$; (ii) investor protection that reduces the investor's cost of supervision and control, and thus reduces the equity premium $\theta$;[8] (iii) more efficient bankruptcy procedures that reduce liquidation costs $c$, allowing banks to extract a larger share from terminated loans; and (iv) trade liberalization favoring the innovative export sector.

Our scenarios picture an economy exporting innovative goods. Exporters incur transport costs, compliance to foreign regulations, extra legal costs and market research, export insurance etc. With a producer price $v$, they must charge $(1+\tau)\,v$ to foreign clients to cover real trade costs $\tau$. Competition forces them to match the world price, $v^* = (1+\tau)\,v$, giving price changes $\hat{v}^* = \hat{v} + \hat{\tau}$ where $\hat{\tau} \equiv d\tau/(1+\tau)$. Hats indicate percent changes,

[8] A tax reform such as an allowance for corporate equity to eliminate the debt bias in corporate taxation would have a similar effect on the equity premium and the cost of bank equity. Schepens (2016) found that Belgian banks raised their equity ratios by about 13% compared to other European banks after Belgium introduced a tax deduction of notional interest on equity capital.

i.e., $\hat{v} = dv/v$, whereas rates and shares ($d\theta$, $dk$, $dc$, etc.) are stated in absolute changes. With a given world price, trade frictions in a small open economy reduce domestic prices by $\hat{v} = -\hat{\tau}$. Liberalization squeezes trade costs and boosts domestic prices.

Without loss of generality, we assume low capital requirements, $k \to 0$, consistent with low standards in reality, and simplifying comparative statics. The regulatory constraint (12) collapses to a solvency constraint, $e = cqn_z$, so that bank equity can never become negative. Raising standards by $dk > 0$ is equivalent to introducing capital requirements.

## 4.1 Aggregate Supply

The output response is driven by initial entry and credit reallocation, which depends on liquidation decision of banks. The liquidation rate $q$ in (16) changes by

$$dq = \frac{vpx\,(1-c)}{z} \cdot \hat{v} - \frac{\varepsilon_{qc}}{z} \cdot dc - \frac{c}{z} \cdot d\theta + \frac{\theta c}{z} \cdot dk, \quad \varepsilon_{qc} \equiv vpx + \theta. \tag{24}$$

A higher price makes liquidation and new lending more attractive as fresh starts in the innovative sector promise larger profits. Higher bankruptcy costs reduce liquidation. When the equity premium rises, banks liquidate more hesitantly. Liquidation requires a higher capital buffer which is costly. In contrast, higher capital standards reduce the voluntary capital buffer since liquidation also shrinks a bank's balance sheet. For this reason, the *net* use of equity in liquidation falls which facilitates reallocation.

Sectoral entry shifts in response to expected future profits which, in turn, depend on funding costs that rise with higher capital standards. Noting $r = 1 + \theta k$ with $k \to 0$ and $pi_x = r$, expected profit $\pi_x = vpx - r$ of an $x$-firm clearly rises with an increasing output price but suffers on account of higher capital standard,

$$dr = \theta \cdot dk, \quad d\pi_x = vpx \cdot \hat{v} - \theta \cdot dk. \tag{25}$$

Using the Envelope theorem on $\bar{\pi}_z = \max_q \bar{z} - r - \theta\,(1-k)\,cq$ yields

$$d\bar{\pi}_z = vpx(1-c)q \cdot \hat{v} - cq \cdot d\theta - (1-cq)\,\theta \cdot dk - \varepsilon_{qc} q \cdot dc. \tag{26}$$

Expected profit of a $z$-entrant rises when a higher price of innovative goods boosts the gains from reallocation. Higher funding and liquidation costs as well as tighter capital standards make these firms less profitable.

Entry in the $x$-sector, $n_x = s$, hinges on initial R&D effort, driven by $\pi_x - \bar{\pi}_z = v_c h'(s)$, which determines the success of firms in developing a more innovative product rather than a simpler traditional design. Taking the differential gives $d\pi_x - d\bar{\pi}_z = v_c h'' dn_x + \gamma v_c h' \hat{v}$. Noting (25) and (26) gives

$$dn_x = \beta_v \cdot \hat{v} + \beta_\theta \cdot d\theta - \beta_k \theta \cdot dk + \beta_c \cdot dc, \tag{27}$$

where coefficients are defined by (A.1) in Appendix A and positive. Traditional firms are subject to early liquidation and use bank equity more intensively. For this reason, a higher equity premium as well as more costly liquidation reduce their profitability and unambiguously encourage direct entry into the innovative sector. Tighter capital standards raise funding costs in both sectors. A loan to a traditional firm makes more intensive use of costly bank equity due to the extra capital buffer. However, a higher capital standard reduces this buffer and additionally benefits traditional sector: Expected profit of an $x$-entrant shrinks by $d\pi_x = -\theta \cdot dk$, while expected profit of a $z$-entrant shrinks by $d\bar{\pi}_z = -(1 - cq)\,\theta \cdot dk$ only. On net, a higher capital standard shifts entry from the $x$- to the $z$-sector. Finally, a higher price of the innovative good boosts expected profit of an $x$-startup. But a $z$-startup benefits as well since it expects to enter the $x$-sector on a second chance with probability $(1 - c)\,q$. Except in a very degenerate case, a higher price benefits successful innovators more than those which start with a more conservative business model. In consequence, entry shifts to the innovative sector (see A.1 in Appendix A for $\beta_v > 0$).

Final investment of the innovative sector, $n'_x = n_x + (1 - c)\,qn_z$, changes by

$$dn'_x = [1 - (1 - c)\,q] \cdot dn_x + n_z \cdot d[(1 - c)\,q]. \tag{28}$$

Expansion of the $x$-sector feeds on initial entry decisions (first term) and subsequent reallocation (second term). Appendix A derives in several steps the response of final

investment, $dn'_x$, and aggregate supply $dX = px \cdot dn'_x$.

Noting $d(1-c)q = (1-c)dq - qdc$, the change in the reallocation rate reflects a *behavioral* effect due to more aggressive liquidation and a *mechanical* effect in case of a rising liquidation cost, which directly lowers the proceeds available for new lending. More frequent credit reallocation adds to investment in the innovative sector. When initial entry shifts to the innovative sector, subsequent capital reallocation might reinforce or offset the effect of entry on final investment and output.

**Assumption 1** ***(Inelastic entry)*** *The entry elasticity* $\eta \equiv [1-(1-c)q]/(v_c h'') > 0$ *is small relative to the reallocation elasticity* $\mu \equiv (1-c)n_z/z > 0$*, so that* $\mu > \eta q$*. Entry is inelastic when* $h''$ *is large.*

To highlight the novel reallocation channel and avoid cumbersome case distinctions, we restrict the relative magnitude of the elasticities as defined in Appendix A. The assumption pins down supply effects.

**Proposition 1** ***(Supply)*** *Reflecting entry and reallocation, aggregate supply of the innovative sector increases with a higher output price, lower liquidation costs, a lower cost of bank equity and higher capital standards.*

**Proof.** Use (A.3) to get

$$\hat{X} = \delta_v \cdot \hat{v} - \delta_\theta \cdot d\theta + \delta_k \theta \cdot dk - \delta_c \cdot dc, \tag{29}$$

with coefficients

$$\begin{aligned} \delta_v &\equiv \frac{[1-(1-c)q]\beta_v + \mu(1-c)vpx}{n'_x} > 0, \quad \delta_\theta \equiv \frac{(\mu-\eta q)c}{n'_x} > 0, \\ \delta_k &\equiv \frac{(\mu-\eta q)c}{n'_x} > 0, \quad \delta_c \equiv \frac{q+(\mu-\eta q)\varepsilon_{qc}}{n'_x} > 0. \end{aligned}$$

We imposed Assumption 1, $\mu > \eta q$, to sign the coefficients positive. ■

A higher price boosts final investment and supply of the innovative sector. The entry and reallocation margins reinforce each other. A rising liquidation cost involves several effects. The direct, mechanical effect slows down the expansion of the $x$-sector since less capital is extracted upon liquidation and, in turn, less bank credit is made available to finance additional investment in the innovative sector. In addition, a higher liquidation loss reduces the liquidation rate in (24) which locks up a larger number of weak firms in the traditional sector. However, since more costly liquidation cuts the ex ante profits of traditional firms without affecting profitability of innovative investment, entry in (27) shifts towards the innovative sector which tends to offset induced reallocation. By Assumption 1, entry is inelastic so that the mechanical and behavioral reallocation effects dominate. A higher liquidation cost thus shrinks the innovative sector, $\delta_c > 0$.

If bank equity becomes more costly, for instance, due to lacking investor protection or tax disadvantages of equity, banks seek to economize on the voluntary capital buffer by liquidating non-performing loans less aggressively, see (24). This slows down reallocation and locks up credit in the traditional sector, thereby shifting sectoral supply from the innovative to the traditional sector. The shock also raises funding costs relatively more in the traditional sector which uses bank equity more intensively. As $z$-firms become less profitable compared to innovative firms, entry shifts towards the innovative sector. In our main scenario where reallocation responds more elastically, a higher equity premium leads to a contraction of aggregate supply in the innovative sector, $\delta_\theta > 0$. Finally, tighter capital requirements force banks to build up larger capital buffers which makes them liquidate poorly performing loans more aggressively, see (24). More frequent credit reallocation, in turn, boosts the expansion of the innovative sector. In addition, the net effect on relative profits shifts entry towards the $z$-sector, see (27). Given inelastic entry, the reallocation channel dominates and tighter capital standards boost the expansion of the innovative sector, $\delta_k > 0$.

## 4.2 Demand

National income equals $Y = \pi_e + \pi_b + \pi_i$. In equilibrium, $\pi_b = 0$ and $\pi_i = I$. A marginal change in the liquidation rate has no effect on income since liquidation maximizes the joint surplus.[9] Income thus changes by $dY = d\pi_e = (\pi_x - \bar{\pi}_z)\, dn_x + n_x d\pi_x + n_z d\bar{\pi}_z$. Upon substitution and using (5), we get

$$\hat{Y} = (\gamma_s + \alpha_v) \cdot \hat{v} - \alpha_\theta \cdot d\theta - \alpha_k \theta \cdot dk - \alpha_c \cdot dc, \tag{30}$$

where the supply side income share is $\gamma_s \equiv vX/Y$ and the $\alpha$-coefficients are defined as

$$\begin{aligned} \alpha_v &\equiv \frac{\pi_x - \bar{\pi}_z}{Y}\beta_v > 0, \quad \alpha_k \equiv \frac{1 - cqn_z + (\pi_x - \bar{\pi}_z)\,\beta_k}{Y} > 0, \\ \alpha_\theta &\equiv \frac{cqn_z - (\pi_x - \bar{\pi}_z)\,\beta_\theta}{Y}, \quad \alpha_c \equiv \frac{\varepsilon_{qc} qn_z - (\pi_x - \bar{\pi}_z)\,\beta_c}{Y}. \end{aligned}$$

Changes in national income reflect direct effects and indirect ones which arise from induced entry into the innovative sector. A higher price directly boosts national income, in proportion to the supply side income share $\gamma_s$ of the innovative sector. Since it also boosts entry in that sector, it yields an income gain in proportion to $\pi_x - \bar{\pi}_z$. Bank regulation in terms of a higher capital standard $k$ directly erodes income in proportion to the final credit to GDP ratio $(1-e)/Y$ (note $e = cqn_z$). Income further declines since regulation also discourages entry into the innovative sector where expected income is higher.

A higher resource cost of managing bank equity shrinks income in proportion to the GDP share of bank equity, $e/Y$. This direct effect offset by the income losses from shifting towards the traditional sector, but only partly so if entry is inelastic. Finally, higher liquidation costs directly impose a marginal income loss. First, when banks liquidate a non-performing $z$-loan, they are left with less funds for new lending to additional $x$-projects. The marginal output loss is $d\bar{z}/dc = vpxq$ per $z$-startup, or $vpx$ for each of the $qn_z$ liquidated loans. Second, higher liquidation costs force banks to raise a larger capital buffer ex ante. The binding regulatory (solvency) constraint requires bank equity

[9] Evaluating at $k = 0$ gives $d\pi_e = [vpx\,(1-c) - qz - \theta c]\, n_z \cdot dq = 0$ since competition leads banks to choose liquidation so as to maximize the joint surplus of a $z$-firm as in (16).

of $e = cqn_z$ with an additional cost that amounts to $\theta \cdot de/dc = \theta q n_z$, or $\theta$ per liquidated loan. Adding up gives a total income loss equal to $\varepsilon_{qc}$ per liquidated loan. However, since these losses fall on traditional sector firms only, entry shifts towards the innovative sector, leading to offsetting income gains in proportion to $\pi_x - \bar{\pi}_z$. The mechanical income loss prevails when entry is inelastic ($\beta_c$ is small).

Given constant expenditure shares, demand in (2) changes by $\hat{C}_x = \hat{Y} - \hat{v}$ or

$$\hat{C}_x = -\left(1 - \gamma_s - \alpha_v\right) \cdot \hat{v} - \alpha_\theta \cdot d\theta - \alpha_k \theta \cdot dk - \alpha_c \cdot dc, \tag{31}$$

Domestic demand for innovative goods changes in proportion to income, plus an additional price effect. A price increase of one percent reduces demand by one percent. Since it also boosts income by $\gamma_s + \alpha_v$ percent, demand shrinks by $1 - \gamma_s - \alpha_v$ percent on net, as long as entry is not too elastic and, thus, $\alpha_v$ not too large. The other demand shocks simply reflect the income changes noted in (30).

## 4.3 Banks, Reallocation and Trade

The trade pattern is reflected in the trade balance $\zeta_x = X - C_x$. In defining the relative change in excess supply, $\hat{\zeta}_x \equiv v d\zeta_x / Y$, one obtains the change in the trade structure

$$\hat{\zeta}_x = \gamma_s \cdot \hat{X} - \gamma \cdot \hat{C}_x. \tag{32}$$

We focus on a developed and technologically advanced country which runs a trade surplus $\zeta_x > 0$ in innovative $x$-goods, implying $\gamma_s > \gamma$. Upon substitution, we have

$$\hat{\zeta}_x = \sigma_v \cdot \hat{v} - \sigma_c \cdot dc - \sigma_\theta \cdot d\theta + \sigma_k \theta \cdot dk, \tag{33}$$

where coefficients are defined as

$$\sigma_v \equiv \gamma_s \delta_v + \gamma\left(1 - \gamma_s - \alpha_v\right), \quad \sigma_c \equiv \gamma_s \delta_c - \gamma \alpha_c, \quad \sigma_\theta \equiv \gamma_s \delta_\theta - \gamma \alpha_\theta, \quad \sigma_k \equiv \gamma_s \delta_k + \gamma \alpha_k.$$

A country can specialize only if factors flow from declining to expanding industries. The frictions and impediments to factor reallocation across sectors are relatively neglected

in trade theory, in particular, when it comes to the role of the banking sector. This is in stark contrast to the dominant role of banks in financing sectoral investment. What are the determinants of credit reallocation and what is the role of the banking sector in shaping a country's trade pattern?

**Bank regulation:** Depending on structural characteristics of the banking sector, banks can importantly influence the 'Schumpeterian process' of creative destruction by liquidating poorly performing firms and reallocating credit to more promising investments. Empirical evidence points to a key role of capital standards $k$, leading us to explore the consequences of bank regulation for structural change and trade patterns.

**Proposition 2** ***(Bank capital regulation)*** *Higher capital standards boost reallocation towards the innovative sector, but reduce entry. The supply of innovative goods rises if entry is relatively inelastic. Tighter capital standards reduce income and demand. Demand and supply reactions augment the trade surplus in innovative goods.*

**Proof.** See (24-27) on loan termination, profits and initial entry. Entry and reallocation affect aggregate investment and output as in (28-29). The effects on income, demand, and the trade balance follow by (30-33). ■

Intuition rests on the fact that bank equity is expensive due to the extra costs of oversight and control by shareholders. Higher capital standards thus raise the cost of capital $r$ and reduce firm profits in both sectors. However, banks must build up an extra voluntary capital buffer when financing firms in the downsizing sector. Since banks expect write offs on non-performing $z$-loans, they need this voluntary buffer to absorb the associated loss of equity capital without violating capital standards ex post. However, the write-offs also shrink the banks' balance sheets and partly reduce the need for bank equity, giving a net voluntary buffer proportional to $1-k$. The higher capital standards are, the smaller is the voluntary buffer on $z$-loans subject to liquidation risk. The upshot is that higher capital standards raise the cost of capital in both sectors, but only the

standard sector benefits from the savings in the voluntary buffer. Entry thus shifts from the innovative towards the standard sector.

Raising minimum capital standards reduces the *net* equity buffer during the reallocation process, making banks liquidate more aggressively poorly performing loans. More loanable funds are released in the downsizing sector and more entrepreneurs with previous business experience receive a second chance to start a new venture in the expanding industry. Although firm entry declines and shifts towards the standard sector, strong reallocation reverses the entry effect and leads to an expansion of the innovative sector, at least as long as entry is relatively inelastic. Since bank equity is expensive and requires resource costs for management, control and supervision, higher capital standards reduce national income and demand. In addition, firm entry shifts towards the standard sector which further reduces income and demand. In consequence, tighter bank capital regulation, by facilitating reallocation from declining to expanding industries, and by reducing domestic demand, results in a larger trade surplus in innovative goods.

**Institutional reforms:** A potential impediment to structural change results from inefficient bankruptcy procedures. Good insolvency laws can make firm liquidation more efficient and protect asset values. In reducing liquidation losses $c$, bankruptcy reform can help banks (and other investors) extract more funds from terminated loans for new lending to more promising projects. Another area of institutional reform is better investor protection and corporate governance which reduce the costs of oversight and control and help limit investor risk. We capture this in reduced form by a reduction of the required equity premium $\theta$ which, in turn, reduces bank funding costs. A lower equity premium will also result if government eliminates the tax bias against equity capital. We jointly discuss both policy interventions since they have qualitatively similar effects. In both cases, a *reduction* in $c$ and $\theta$ indicates a *policy improvement*.

**Proposition 3** ***(Institutional reform)*** *Better insolvency laws and investor protection favor entry into the traditional sector. They boost termination of weak firms and reallocation towards the innovative sector, leading to a net increase in innovative goods supply.*

*They also raise aggregate income and consumption demand. The trade surplus in innovative goods improves if the entry elasticity is not too large.*

**Proof.** Evaluate (24-33) for $dc < 0$ and $d\theta < 0$, and see (A.5-A.8). ■

When the equity premium falls, banks afford a larger capital buffer which allows them to liquidate non-performing loans more aggressively. Lowering liquidation costs yields the same incentives but involves an additional mechanical effect as more capital is released from terminated loans. Such reforms thus boost reallocation by raising the liquidation rate $q$. Accelerating reallocation eventually increases the supply of innovative goods. Although more entrepreneurs start firms in the traditional sector, see (27), innovative investment and output rise on net when entry is relatively inelastic. At the same time, aggregate income also rises either due to higher average earnings of $z$-firms or smaller management costs of bank equity. Demand for innovative goods picks up. Although supply and demand both increase, the supply effect prevails and the trade surplus rises. Appendix A derives the combined adjustment by substituting coefficients. As long as the entry elasticity $\eta$ is small - as in our main scenario - lower liquidation costs create excess supply and raise the export surplus in innovative goods ($\sigma_c > 0$ in 33 and A.6). Similarly, with low capital standards, the GDP share of bank equity is very low so that the supply side reactions of reducing the cost of bank equity dominate over the income effect. A lower equity premium and, in turn, declining funding costs of firms thus tend to augment the export surplus in innovative goods ($\sigma_\theta > 0$ in A.8). Good institutions foster a comparative advantage in innovative goods by facilitating the process of credit reallocation. In reducing resource costs, they also expand national income.

## 4.4 Magnifying Gains from Trade Liberalization

**Trade liberalization:** In a small open economy, the world price of innovative goods is fixed. Cutting export costs raises the domestic producer price by $\hat{v} = -\hat{\tau}$.

**Proposition 4** ***(Trade liberalization)*** *A higher price of $x$-goods attracts entry and accelerates credit reallocation towards innovative sector investment. It expands aggregate supply and raises income. In spite of somewhat higher income, the increase in domestic producer prices reduces consumer demand. Supply and demand reactions both contribute to a larger trade surplus in innovative goods.*

**Proof.** See (24-33) as before and (A.4) for $\sigma_v > 0$. ■

A higher price boosts the trade surplus in innovative goods since it stimulates supply and cuts demand, $\sigma_v > 0$. The effect on trade patterns is standard, but the mechanism is entirely different. A higher price boosts earnings and profitability of innovative firms. Given better prospects in the expanding $x$-sector, banks terminate poorly performing loans more aggressively and provide new loans to traditional firms that opt for a fresh start and move to the innovative sector. Aggregate output thus draws on own start-up investment as well as reallocation from the downsizing sector. While output of innovative goods rises, consumers cut back on demand. Both supply and demand reactions result in a larger trade surplus. Trade liberalization also raises national income due to higher firm profits.

An country benefits from trade liberalization if the latter raises welfare. Noting preferences in (1), domestic welfare is equal to real income minus R&D effort costs of entrepreneurs, $w = Y/v_c - h(n_x)$. Since market equilibrium is constrained efficient, variations of entry and loan liquidation cannot affect welfare, $dw/dn_x = dw/dq = 0$. This leaves only the direct effects of a higher price on national income and the price index. Using $\hat{v}_c = \gamma \cdot \hat{v}$ and (30) with $\alpha_v Y/v_c - h' = 0$ on account of optimal entry, one obtains the welfare effect in percent of real income is

$$\hat{w} \equiv \frac{dw}{Y/v_c} = (\gamma_s - \gamma) \cdot \hat{v}. \tag{34}$$

In an export country with $\gamma_s > \gamma$, welfare rises by the typical terms of trade effect. When trade liberalization raises the domestic price by 1 percent, aggregate welfare rises by $\gamma_s - \gamma$ percent of national income.

**Magnification:** The gains from trade liberalization may be larger or smaller. An inefficient banking sector engaging in 'Zombie' lending may stand in the way of capital reallocation and structural change. Intuitively, when capital gets stuck in the less productive downsizing sector and does not flow freely to the expanding innovative sector, trade liberalization is probably less beneficial. How can policy reform address the efficiency of capital reallocation and thereby magnify the gains from trade liberalization?

Trade liberalization facilitates exports and boosts the domestic producer price of the innovative good, $\hat{v} = -\hat{\tau} > 0$. An export nation thus reaps terms of trade gains, see (34). The first order effect of trade liberalization could be larger or smaller, depending on the quality of institutions and bank regulation. Noting the definitions of the GDP shares $\gamma_s$ and $\gamma$, and of $\hat{w}$ in (34), we find $\hat{w}/\hat{v} = \gamma_s - \gamma$ to be equivalent to $dw/dv = (X - C_x)/v_c = \zeta_x/v_c$. A country benefits from the increase in the relative price of exports in proportion to its 'real' trade surplus.

The effect of institutional parameters on the magnitude of these gains is given by interaction terms such as $d(dw/dv)/dk = (d\zeta_x/dk)/v_c$. In a small open economy, a change in the institutional environment does not affect the price index which exclusively depends on the given world price. Using $\hat{\zeta}_x \equiv vd\zeta_x/Y$ and the result in (33) with a constant relative price finally results in

$$d\frac{dw}{dv} = \frac{Y}{v_c v}\hat{\zeta}_x = \frac{Y}{v_c v}\left(\sigma_k\theta \cdot dk - \sigma_c \cdot dc - \sigma_\theta \cdot d\theta\right). \tag{35}$$

If entry is relatively inelastic compared to reallocation, the elasticities $\sigma_i$ are all positive, see (33) and (A.5-A.8) in Appendix A. We thus have

**Proposition 5** ***(Magnification of gains from trade liberalization)*** *Higher regulatory capital standards ($dk > 0$), more efficient bankruptcy laws (lower liquidation losses, $dc < 0$), and better investor protection (lower costs of bank equity, $d\theta < 0$) all magnify the welfare gains from trade liberalization.*

**Proof.** See (35). ■

Intuitively, a more efficient bank sector, resting on high capital standards, low costs of equity, and an efficient loan liquidation process with small losses, allows the economy to better specialize in the production of innovative goods. The supply share and trade surplus are larger, which makes the economy more exposed to trade shocks and changes in the relative price. Thereby, a stronger and more efficient banking sector magnifies the effects of trade shocks and allows for larger welfare gains from trade liberalization. The precise channels are the same as those determining the changes in the trade balance as described in the preceding Propositions.

# 5 World Economy

In large open economies, national policies affect the world price $v^*$. The induced price changes have an additional second-order effect on the domestic economy and create spillovers to other countries. In this section, we abstract from export costs and assume that countries are symmetric but not identical. World market equilibrium requires $d\zeta_x + \sum_i d\zeta_x^i = 0$ where $\zeta_x^i$ denotes excess supply in other countries. Multiplying by $v = v^i$, dividing by world income $Y + \sum_i Y^i$, and using a country's income share $\omega^i \equiv Y^i / \left(Y + \sum_i Y^i\right)$ gives changes in global market clearing $\omega \hat{\zeta}_x + \sum_i \omega^i \hat{\zeta}_x^i = 0$, which pins down the impact on the world price. Note that income shares add up to one, $\omega + \sum_i \omega^i = 1$. The domestic trade surplus, $\zeta_x$, adjusts as in (33). Given symmetry, trade imbalances in foreign countries respond to price changes in exactly the same way,

$$\hat{\zeta}_x^i = \sigma_v^i \cdot \hat{v}^*, \quad \sigma_v^i \equiv \gamma_s^i \delta_v^i + \gamma^i \left(1 - \gamma_s^i - \alpha_v^i\right) > 0. \tag{36}$$

**Lemma 1** ***(World price)*** *The world market price $v^*$ falls with the capital standard $k$ and rises with the liquidation cost $c$ and the equity premium $\theta$ of a large economy.*

**Proof.** Use (33) and (36), substitute $\hat{v} = \hat{v}^*$ and solve $\omega \hat{\zeta}_x + \sum_i \omega^i \hat{\zeta}_x^i = 0$,

$$\hat{v}^* = \frac{\omega}{\sigma_v^*} \left[\sigma_c \cdot dc + \sigma_\theta \cdot d\theta - \sigma_k \theta \cdot dk\right], \tag{37}$$

where $\sigma_v^* \equiv \omega\sigma_v + \sum_i \omega^i \sigma_v^i > 0$ is the GDP-weighted price elasticity. ■

In tightening capital standards, improving efficiency of insolvency laws, and making bank equity more available, the home country strengthens its banking sector. Banks thus more aggressively liquidate non-performing loans concentrated in declining industries and redirect lending to firms with better prospects in the expanding innovative sector. This facilitates reallocation and allows the home economy to better specialize in the production of innovative goods. An expanding $x$-sector boosts domestic supply and trade surplus in those goods. This puts downward pressure on the world market price $v^*$. The price decrease is stronger the larger the country's share in world GDP $\omega$ is.

Consequently, reforming the banking sector in a large country entails two additional effects that are not present in the small open economy: feedback on the home country and spillovers to other countries. First, the declining world market price translates into a lower domestic price of innovative goods, $\hat{v} = \hat{v}^*$. In Section 4, we show that this discourages entry into the $x$-sector and slows down credit reallocation. As a result, supply of innovative goods falls, while demand rises. This price change thus partly offsets the direct effects of policy interventions summarized in Propositions 2 and 3. Taken together, the net effects in a large home country are as follows:

**Proposition 6** ***(Feedback)*** *A more efficient banking sector with tighter capital standards, better investor protection, and reformed insolvency laws in a large open economy facilitates specialization in the innovative sector. The net responses of investment, production, and consumption are less pronounced than in a small open economy.*

**Proof.** See Appendix B. ■

Appendix B provides detailed derivations, which demonstrate that the effects of bank regulation and institutional reforms on the domestic economy in terms of supply, demand, and trade balance are qualitatively similar but weaker compared to the small open economy analyzed in Section 4. For a large country, the feedback effect may be quite strong

and could potentially introduce some ambiguities, see (B.1-B.4) in Appendix B. However, the consequences for trade are determinate in all cases.

Moreover, national policies create spillovers to other countries because they influence the terms of trade. Those countries adjust investment, output, and consumption to the decreasing world market price and may experience welfare gains or losses:

**Proposition 7** ***(Spillovers)*** *A more efficient domestic banking sector leads to a larger trade deficit in the rest of the world and raises (reduces) welfare of foreign importers (exporters) via improving (deteriorating) terms of trade.*

**Proof.** See Appendix B. ■

The declining world price translates into a lower domestic price of innovative goods in each country, $\hat{v}^i = \hat{v}^*$. As demonstrated earlier, this reduces firm profits in the $x$-sector, discourages entry, and slows down reallocation. Foreign countries shrink their innovative sector, and production declines. At the same time, consumption rises due to the lower price. Other countries thus exhibit smaller trade surpluses or larger trade deficits. Since the rest of the world is collectively a net importer of innovative goods, its overall trade deficit is larger.

We can finally evaluate the spillovers in terms of welfare, which is measured by indirect utility and reflects real income, see (34). The lower world price reduce both (nominal) income due to smaller firm profits in the $x$-sector and the price index. In an exporting country, the effect of smaller income prevails and causes a welfare loss. In contrast, an importing country where the price effect dominates enjoys a welfare gain.

# 6 Conclusions

For a country to fully exploit its comparative advantage, it must embrace structural change and reduce the frictions that may lock up capital and labor in old uses and stand in the

way of reallocation from declining to expanding industries. Given the predominant role of banks in financing investment, the structure of a country's banking sector is critical in this process. Banks can support the Schumpeterian process of creative destruction in resolving non-performing loans and redirecting credit to more promising investments. Depending on the institutional environment and their access to loss-absorbing equity, banks can accelerate or slow down the reallocation of capital, resulting in more or less frequent fresh starts for a better use of entrepreneurial labor and capital. Specifically, our analysis identifies novel, bank-related and institutional determinants of reallocation with direct consequences for trade and specialization: the quality of insolvency laws, the cost of bank equity and the tightness of capital regulation. Those factors importantly influence the capital structure of banks and their ability to reallocate credit.

Our main findings point to three different policies targeting the efficiency of the banking sector. First, tighter capital standards raise the loss-absorbing capacity of banks, which strengthens their ability to release capital in the downsizing sector by liquidating non-performing loans and redirecting credit towards expanding industries. Second, more efficient bankruptcy procedures reduce the waste in the process of resolving unprofitable firms and allow banks to extract more funds for new lending to more promising projects. Third, reforming investor protection and corporate governance, or eliminating the debt bias in corporate taxation, can reduce banks' cost of equity and incentivize them to build up larger capital buffers. Consequently, their ability to liquidate poor loans and lend to firms moving towards the expanding sector is enhanced. Ultimately, all three reforms mitigate frictions in reallocation of capital and help a country specialize in and dedicate more resources to an expanding, innovative sector.

In addition to influencing trade patterns and specialization, these three reforms enhance the potential of conventional trade policy to improve economic performance: Trade liberalization lowers export costs, shifts firm profitability from declining to expanding sectors, and thus yields the usual terms of trade gains if the country is a net exporter of the innovative good. Most importantly, our analysis reveals that an efficient banking sec-

tor reflecting a well-developed regulatory and institutional environment can magnify the gains from trade liberalization because it facilitates specialization in expanding sectors.

The predominant role of banks in financing investment and the findings of empirical research on 'zombie' lending of weakly capitalized banks, as discussed in Section 2, leads us to believe that the proposed mechanisms are quantitatively important. Future research could empirically test how the novel structural parameters - liquidation costs, costs of bank equity, and capital standards - affect credit reallocation and trade patterns. Research could also incorporate credit reallocation in quantitative general equilibrium models to explore the economic significance of the discussed policy interventions.

# Appendix

## A. Small Open Economy

**Entry:** Entry in the $x$-sector follows from the differential of $\pi_x - \bar{\pi}_z = v_c h'(s)$, as given in (27) where coefficients are defined by

$$\beta_v \equiv \frac{[1-(1-c)q]\,vpx - \gamma v_c h'}{v_c h''}, \quad \beta_\theta \equiv \frac{cq}{v_c h''}, \quad \beta_k \equiv \frac{cq}{v_c h''}, \quad \beta_c \equiv \frac{\varepsilon_{qc} q}{v_c h''}. \tag{A.1}$$

All coefficients are positive. To show $\beta_v > 0$, use $\bar{z} \equiv \bar{q}z(1-q) + vpx(1-c)q$ and get $v_c h' = \pi_x - \bar{\pi}_z = [1-(1-c)q]\,vpx - [z\bar{q}(1-q) - \theta(1-k)cq]$. We thus have

$$v_c h'' \beta_v = (1-\gamma)[1-(1-c)q]\,vpx + \gamma[z\bar{q}(1-q) - (1-k)\theta cq]. \tag{A.2}$$

The first square bracket is positive. Note $\hat{q} = \bar{q}(1-q) = (1-q^2)/2$, which is declining in $q$ by $d\hat{q}/dq = -q$. Hence, as $q$ rises from $0 \to 1$, the second square bracket starts out positive and ends in the negative, falling from $z/2$ to $-(1-k)\theta c$. Since we evaluate differentials at $k = 0$, we get the threshold value

$$1 - q^{\circ 2} = q^\circ 2\theta c/z \quad \Leftrightarrow \quad q^\circ = -\frac{\theta c}{z} + \sqrt{1 + (\theta c/z)^2} > 0.$$

A sufficient condition for $\beta_v > 0$ is $q = \frac{vpx(1-c)-\theta(1-k)c}{z} < q^\circ$. As $\frac{\theta c}{z} \to 0$, $q^\circ \to 1$, so that $q < q^\circ$ would be always satisfied. For $\theta c$ small, the last square bracket is positive, which is sufficient for $\beta_v > 0$. Even if it were negative in a degenerate case, $\beta_v$ would be small in our main scenario of inelastic entry (large value of $h''$). The supply side reaction to a higher price in Proposition 1 would thus remain unaffected.

**Supply Side Reactions:** To derive the impact on aggregate supply, we start with (28) and substitute (24) for $d\left(1-c\right)q = \left(1-c\right)\cdot dq - q\cdot dc$ and (27) for $dn_x$, giving

$$\begin{aligned} dn'_x &= \left[\left[1-\left(1-c\right)q\right]\beta_v + \left(1-c\right)vpx\tfrac{(1-c)n_z}{z}\right]\cdot\hat{v} \\ &- \left[\left(1-c\right)\tfrac{n_z}{z} - \left[1-\left(1-c\right)q\right]\tfrac{q}{v_c h''}\right]c\cdot d\theta \\ &+ \left[\left(1-c\right)\tfrac{n_z}{z} - \left[1-\left(1-c\right)q\right]\tfrac{q}{v_c h''}\right]\theta c\cdot dk \\ &- \left[q + \left(\left(1-c\right)\tfrac{n_z}{z} - \left[1-\left(1-c\right)q\right]\tfrac{q}{v_c h''}\right)\varepsilon_{qc}\right]\cdot dc. \end{aligned}$$

Inspecting (28) motivates the definition of a reallocation elasticity $\mu \equiv \left(1-c\right)n_z/z > 0$ and an entry elasticity $\eta \equiv \left[1-\left(1-c\right)q\right]/\left(v_c h''\right) > 0$, leading to

$$\begin{aligned} dn'_x &= \left[\left(1-\left(1-c\right)q\right)\beta_v + \left(1-c\right)vpx\mu\right]\cdot\hat{v} - \left(\mu-\eta q\right)c\cdot d\theta \\ &\quad + \left(\mu-\eta q\right)c\theta\cdot dk - \left[q + \left(\mu-\eta q\right)\varepsilon_{qc}\right]\cdot dc, \end{aligned} \tag{A.3}$$

where $\beta_v \equiv \left(\eta vpx - \gamma h'\right)/h'' > 0$ was already shown in (A.1). Reallocation strengthens the entry effect of a price increase. Using this in $dX = px\cdot dn'_x$ pins down the response in aggregate supply given in (29).

**Trade Balance:** We first show that a higher relative price raises the trade surplus in innovative goods, $\sigma_v \equiv \gamma_s\delta_v + \gamma\left(1-\gamma_s-\alpha_v\right) > 0$. Substituting for the coefficients and collecting terms gives:

$$\sigma_v = \gamma_s\frac{\mu\left(1-c\right)vpx}{n'_x} + \gamma\left(1-\gamma_s\right) + \left[\gamma_s\frac{1-\left(1-c\right)q}{n'_x} - \gamma\frac{\pi_x-\bar{\pi}_z}{Y}\right]\beta_v. \tag{A.4}$$

The first two terms are clearly positive. To show that the third term is positive, use $\gamma_s = vpxn'_x/Y$ so that $\gamma_s/n'_x = vpx/Y$, $\pi_x - \bar{\pi}_z = vpx - \bar{z} + \theta cq$, and $\beta_v$ defined in (A.2):

$$\begin{aligned}
&\left[vpx\left(1-(1-c)\,q\right) - \gamma\left(vpx - \bar{z} + \theta cq\right)\right]\frac{\beta_v}{Y} = \\
&\left[vpx\left(1-(1-c)\,q\right) - \gamma\left(vpx\left(1-(1-c)\,q\right) - z\bar{q}\left(1-q\right) + \theta cq\right)\right]\frac{\beta_v}{Y} = \\
&\left[\left(1-\gamma\right)vpx\left(1-(1-c)\,q\right) + \gamma\left(z\bar{q}\left(1-q\right) - \theta cq\right)\right]\frac{\beta_v}{Y} = \frac{v_c h''\beta_v^2}{Y} > 0.
\end{aligned}$$

Therefore, a higher price $v$ unambiguously boosts the trade surplus.

Next, we sign the effect of liquidation costs $c$ on trade, $\sigma_c \equiv \gamma_s\delta_c - \gamma\alpha_c$. Substituting coefficients, separating the mechanical supply effect, collecting the other terms and using $\gamma_s/n'_x = vpx/Y$ yields $\sigma_c = \gamma_s\frac{q}{n'_x} + \left[\mu - \eta q - \gamma\frac{qn_z}{vpx}\right]\frac{vpx\varepsilon_{qc}}{Y} + \gamma\frac{\pi_x - \bar{\pi}_z}{Y}\beta_c$. Rewriting the square bracket with $\mu = (1-c)\,n_z/z$ gives

$$\begin{aligned}
\sigma_c &= \left[q + \left(\left[vpx\left(1-c\right)/z - \gamma q\right]\frac{n_z}{vpx} - \eta q\right)\varepsilon_{qc}\right]\frac{vpx}{Y} + \gamma\frac{\pi_x - \bar{\pi}_z}{Y}\beta_c \qquad \text{(A.5)}\\
&= \frac{vpxq + \left[\left(\theta c/z + \left(1-\gamma\right)q\right)n_z - \eta q\cdot vpx\right]\varepsilon_{qc}}{Y} + \gamma\frac{\pi_x - \bar{\pi}_z}{Y}\beta_c.
\end{aligned}$$

The second line results from substituting $vpx\left(1-c\right)/z = q + \theta c/z$ from (16) as evaluated at $k = 0$. Collecting terms and using $\beta_c = \varepsilon_{qc}q/\left(v_c h''\right)$, $\eta = \left[1-(1-c)\,q\right]/\left(v_c h''\right)$, and $\pi_x - \bar{\pi}_z = vpx - \bar{z} + \theta cq$ eventually gives

$$\begin{aligned}
\sigma_c &= \frac{vpxq + \left[\theta c/z + \left(1-\gamma\right)q\right]n_z\varepsilon_{qc}}{Y}\\
&\quad - \frac{\varepsilon_{qc}q}{v_c h''}\frac{\left(1-\gamma\right)\left[1-(1-c)\,q\right]vpx + \gamma\left[\bar{q}z\left(1-q\right) - \theta cq\right]}{Y} \qquad \text{(A.6)}\\
&= \frac{vpxq + \left[\theta c/z + \left(1-\gamma\right)q\right]n_z\varepsilon_{qc}}{Y} - \frac{\beta_v\varepsilon_{qc}q}{Y}.
\end{aligned}$$

The last equality again uses the definition of $\beta_v$ in (A.2). The first expression is unambiguously positive the second is likely negative but small as long as entry is relatively inelastic (i.e., $h''$ is large and $\eta$ and $\beta_v$ are small) such that the coefficient $\sigma_c$ is positive.

To derive the effect of a higher equity premium $\theta$, $\sigma_\theta \equiv \gamma_s\delta_\theta - \gamma\alpha_\theta$, we substitute

coefficients and use $\gamma_s/n'_x = vpx/Y$:

$$\begin{aligned}\sigma_\theta &= \frac{(\mu-\eta q)\,c\cdot vpx-\gamma cqn_z}{Y}+\gamma\frac{\pi_x-\bar{\pi}_z}{Y}\beta_\theta \\ &= \frac{(1-\gamma)\,cqn_z+c^2\theta n_z/z-\eta qc\cdot vpx}{Y}+\gamma\frac{\pi_x-\bar{\pi}_z}{Y}\beta_\theta.\end{aligned} \tag{A.7}$$

The last line substitutes for $\mu$ and uses $vpx\,(1-c)/z = q+\theta c/z$ from the liquidation decision (16). Again, we collect the last two terms, which are proportional to $h''$, substitute for $\pi_x-\bar{\pi}_z$ and obtain:

$$\begin{aligned}\sigma_\theta &= \frac{(1-\gamma)\,cqn_z+c^2\theta n_z/z}{Y} \\ &\quad -\frac{cq}{v_c h''}\frac{(1-\gamma)\,[1-(1-c)\,q]\,vpx+\gamma\,[\bar{q}z\,(1-q)-\theta cq]}{Y} \\ &= \frac{(1-\gamma)\,cqn_z+c^2\theta n_z/z}{Y}-\frac{\beta_v cq}{Y}.\end{aligned} \tag{A.8}$$

The is expression is positive in our main scenario with inelastic entry ($\beta_v$ is small).

## B. World Economy

**Proof of Proposition 5 (Feedback):** We compute the effects of capital requirements, liquidation cost, and equity premium on the home country taking into account the response of the world market price $v^*$, see Lemma 1.

Starting with capital standards $k$, one obtains the effects on supply of the innovative sector by substituting for $\hat{v} = \hat{v}^* = -\omega\sigma_k\theta/(\sigma_v^*)\cdot dk$ in (29) and using $\sigma_k$,

$$\hat{X} = \left[\delta_k-\omega\cdot\delta_v\frac{\gamma_s\delta_k+\gamma\alpha_k}{\sigma_v^*}\right]\theta\cdot dk. \tag{B.1}$$

Collecting terms and using $\sigma_v^* \equiv \omega\sigma_v+\sum_i\omega^i\sigma_v^i > \omega\gamma_s\delta_v$ shows that the square bracket can be positive or negative:

$$\delta_k\left(1-\omega\frac{\gamma_s\delta_v}{\sigma_v^*}\right)-\omega\frac{\gamma\delta_v\alpha_k}{\sigma_v^*}. \tag{B.2}$$

Aggregate income $Y$ clearly decreases in capital requirements due to the negative direct effect and due to a lower world price, see (30). To get the effects on consumption

$C_x$, we substitute for $\hat{v}^*$ in (31):

$$\hat{C}_x = -\left[\alpha_k - \omega \cdot (1 - \gamma_s - \alpha_v)\,\frac{\gamma_s\delta_k + \gamma\alpha_k}{\sigma_v^*}\right]\theta \cdot dk. \tag{B.3}$$

Again, we note $\sigma_v^* > \omega\gamma\,(1 - \gamma_s - \alpha_v)$ such that $\omega\gamma\,(1 - \gamma_s - \alpha_v)\,/\sigma_v^* < 1$ and find that the sign of the expression in square brackets remains ambiguous:

$$\alpha_k\left(1 - \omega\frac{\gamma\,(1 - \gamma_s - \alpha_v)}{\sigma_v^*}\right) - \omega\frac{\gamma_s\,(1 - \gamma_s - \alpha_v)\,\delta_k}{\sigma_v^*}. \tag{B.4}$$

Substituting (B.1-B.4) into $\hat{\zeta}_x = \gamma_s \cdot \hat{X} - \gamma \cdot \hat{C}_x$, collecting terms, factoring out the elasticity $\sigma_k \equiv \gamma_s\delta_k + \gamma\alpha_k$, and finally using $\sigma_v \equiv \gamma_s\delta_v + \gamma\,(1 - \gamma_s - \alpha_v)$ yields

$$\hat{\zeta}_x = \left[1 - \omega\frac{\sigma_v}{\sigma_v^*}\right]\sigma_k\theta \cdot dk > 0. \tag{B.5}$$

The definition of $\sigma_v^*$ implies $\sigma_v^* > \omega\sigma_v$ such that the square bracket is positive. Tighter capital requirements contribute to a higher trade surplus in innovative goods.

If the impact of the reforming country is not too large ($\omega \to 0$), policy effects are qualitatively the same as in the small open economy, $\hat{X} > 0 > \hat{C}_x$. Supply rises and demand falls, although to a smaller extent. When the country is large relative to the rest of the world, the adjustment in supply and demand become ambiguous. In view of (B.5), only two other cases are possible: either demand rises but supply even more, $\gamma_s \cdot \hat{X} > \gamma \cdot \hat{C}_x > 0$; or demand falls but supply shrinks even more, $0 > \gamma \cdot \hat{C}_x > \gamma_s \cdot \hat{X}$.

Next, we consider liquidation costs and equity premium, which lower exports and raise the world market price of innovative goods, see Lemma 1. Substituting the price reaction in (37) into (29) together with $\sigma_c = \gamma_s\delta_c - \alpha_c$ and $\sigma_\theta = \gamma_s\delta_\theta - \gamma\alpha_\theta$ gives

$$\hat{X} = -\left[\delta_c - \omega\delta_v\frac{\gamma_s\delta_c - \gamma\alpha_c}{\sigma_v^*}\right] \cdot dc - \left[\delta_\theta - \omega\delta_v\frac{\gamma_s\delta_\theta - \gamma\alpha_\theta}{\sigma_v^*}\right] \cdot d\theta. \tag{B.6}$$

The change in the world price weakens the adjustment to shocks that would obtain in a small open economy ($\omega \to 0$). Using $\sigma_v^* > \omega\sigma_v > \omega\gamma_s\delta_v$ and collecting terms reveals that both expressions in square brackets are positive:

$$\left[\delta_c\left(1 - \omega\tfrac{\delta_v\gamma_s}{\sigma_v^*}\right) + \omega\tfrac{\delta_v\gamma\alpha_c}{\sigma_v^*}\right] > 0, \quad \left[\delta_\theta\left(1 - \omega\tfrac{\delta_v\gamma_s}{\sigma_v^*}\right) + \omega\tfrac{\delta_v\gamma\alpha_\theta}{\sigma_v^*}\right] > 0. \tag{B.7}$$

Domestic supply of $x$-goods decreases in liquidation cost and the equity premium even when taking into account the world price effect. By (27), more firms directly enter into the $x$-sector. The rising world price works in the same direction. The reduction in aggregate supply thus results from a declining reallocation rate $(1-c)\,q$.

Similarly, we get the effects on consumption demand by substituting for $\hat{v}^*$ into (31):

$$\begin{aligned}\hat{C}_x &= -\left[\alpha_c + \omega\left(1-\gamma_s-\alpha_v\right)\tfrac{\gamma_s\delta_c-\gamma\alpha_c}{\sigma_v^*}\right]\cdot dc \\ &\quad -\left[\alpha_\theta + \omega\left(1-\gamma_s-\alpha_v\right)\tfrac{\gamma_s\delta_\theta-\gamma\alpha_\theta}{\sigma_v^*}\right]\cdot d\theta.\end{aligned} \tag{B.8}$$

Noting $\sigma_v^* > \omega\sigma_v > \omega\gamma\left(1-\gamma_s-\alpha_v\right)$, we find that the square brackets are positive such that consumption of the $x$-good decreases in liquidation cost and equity premium:

$$\begin{aligned}\left[\alpha_c\left(1-\omega\tfrac{\gamma(1-\gamma_s-\alpha_v)}{\sigma_v^*}\right)+\omega\tfrac{\gamma_s(1-\gamma_s-\alpha_v)\delta_c}{\sigma_v^*}\right]>0,\\ \left[\alpha_\theta\left(1-\omega\tfrac{(1-\gamma_s-\alpha_v)\gamma}{\sigma_v^*}\right)+\omega\tfrac{(1-\gamma_s-\alpha_v)\gamma_s\delta_\theta}{\sigma_v^*}\right]>0.\end{aligned} \tag{B.9}$$

The institutional shocks reduce both supply and demand of $x$-goods and thus have an offsetting effect on the trade balance. To assess the net effect, substitute (B.6-B.9) into $\hat{\zeta}_x = \gamma_s\cdot\hat{X} - \gamma\cdot\hat{C}_x$, collect terms, factor out $\sigma_c \equiv \gamma_s\delta_c - \gamma\alpha_c$ and $\sigma_\theta \equiv \gamma_s\delta_\theta - \gamma\alpha_\theta$, and finally use $\sigma_v \equiv \gamma_s\delta_v + \gamma\left(1-\gamma_s-\alpha_v\right)$ to get

$$\hat{\zeta}_x = -\left[1-\omega\frac{\sigma_v}{\sigma_v^*}\right]\left(\sigma_c\cdot dc + \sigma_\theta\cdot d\theta\right). \tag{B.10}$$

As before, $\sigma_v^* > \omega\sigma_v$ so that the square bracket is positive. The trade surplus in innovative goods thus decreases in liquidation cost and equity premium.

**Proof of Proposition 6 (Spillovers):** Foreign countries are symmetric and respond to changes in the world market price in the same way like the home country, see Section 4. The effect on foreign trade balances follows from differentiating $\zeta_x^i = X^i - C_x^i$, which yields $\hat{\zeta}_x^i = \sigma_v^i\cdot\hat{v}^*$. Given a decreasing world price $\hat{v}^* < 0$ as a result of national policies (see Lemma 1), the trade deficit (surplus) in innovative goods rises (falls).

Welfare of foreign countries responds to changing terms of trade according to $\hat{w}^i = (\gamma_s^i - \gamma^i)\cdot\hat{v}^*$. A rising world market price increases (decreases) welfare of exporters (im-

porters) with $\gamma_s^i > (<)\, \gamma^i$. The three banking reforms lower the world price, see Lemma 1. Foreign exporters (importers) thus experience negative (positive) spillovers.

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