

w o r k i n g
p a p e r

16 29

**A New Perspective on the
Finance-Development Nexus**

Pedro S. Amaral, Dean Corbae, and Erwan
Quintin



FEDERAL RESERVE BANK OF CLEVELAND

Working papers of the Federal Reserve Bank of Cleveland are preliminary materials circulated to stimulate discussion and critical comment on research in progress. They may not have been subject to the formal editorial review accorded official Federal Reserve Bank of Cleveland publications. The views stated herein are those of the authors and are not necessarily those of the Federal Reserve Bank of Cleveland or the Board of Governors of the Federal Reserve System.

Working papers are available on the Cleveland Fed's website:

<https://clevelandfed.org/wp>

A New Perspective on the Finance-Development Nexus

Pedro S. Amaral, Dean Corbae, and Erwan Quintin

The existing literature on financial development focuses mostly on the causal impact of the quantity of financial intermediation on economic development. This paper, instead, focuses on the role of the financial sector in creating securities that cater to the needs of heterogeneous investors. To that end, we describe a dynamic extension of Allen and Gale (1989)'s optimal security design model in which producers can tranche the stochastic cash flows they generate at a cost. Lower tranching costs in that environment lead to capital deepening and raise aggregate output. The implications of lower tranching costs for TFP, on the other hand, are fundamentally ambiguous. In other words, our model predicts that increased financial sophistication/complexity—a securitization boom, e.g.—can have adverse consequences on aggregate productivity as it is conventionally measured.

Keywords: Endogenous security markets, financial development, economic development.

JEL classification: E44; E30.

Suggested citation: Amaral, Pedro, Dean Corbae, and Erwan Quintin, “A New Perspective on the Finance-Development Nexus” Federal Reserve Bank of Cleveland, Working Paper no. 16-29.

Pedro S. Amaral (pedro.amaral@clev.frb.org) is at the Federal Reserve Bank of Cleveland, and Dean Corbae (dcorbae@gmail.com) and Erwan Quintin (equintin@bus.wisc.edu) are at the Wisconsin School of Business. The authors thank Julio Suarez at AFME and Sharon Sung at SIFMA for help with the data, and Tristan Young for research assistance.

1 Introduction

A vast literature studies the two-way connection between financial intermediation and economic development. [Goldsmith \(1969\)](#), [McKinnon \(1973\)](#) and [Shaw \(1973\)](#) document the correlation between economic and financial development within and across countries. [King and Levine \(1993\)](#) confirm this strong correlation with detailed cross-country data and find some support for the hypothesis that financial development causes economic development.¹ Furthermore, they make the case and present some evidence that financial development raises aggregate output both by fostering the accumulation of resources and by helping direct these resources to their best use.

A related literature quantifies the importance of financial development for aggregate productivity and output using structural models where the connection between finance, investment and resource allocation is made explicit. Those models take an explicit stand on what frictions cause the quantity of intermediation to vary across economies and propose various methods to measure the importance of those frictions. For instance, [Amaral and Quintin \(2010\)](#) describe a span-of-control model in the spirit of [Lucas \(1978\)](#) where producers' ability to borrow is limited by imperfect contract enforcement.² They argue that this type of frictions alone could account for much of the development gap between middle-income nations such as Mexico and Argentina and the United States.³

By and large, the existing literature has focused on the overall quantity of financial intermediation. In this paper, instead, we focus on the role the financial sector plays in promoting investment by creating financial products that cater to the needs of heterogeneous investors.

¹[Rajan and Zingales \(1998\)](#) use industry-level data to provide more evidence that causation runs, at least in part, from financial development to economic development.

²For similar exercises, see e.g. [Erosa \(2001\)](#), [Jeong and Townsend \(2007\)](#), [Erosa and Cabrillana \(2008\)](#), [Quintin \(2008\)](#), [Buera, Kaboski, and Shin \(2011\)](#), [Buera and Shin \(2013\)](#), [Caselli and Gennaioli \(2013\)](#). Papers that study the finance-development nexus qualitatively include [Greenwood and Jovanovic \(1990\)](#), [Bencivenga and Smith \(1991\)](#), [Banerjee and Newman \(1993\)](#), [Khan \(2001\)](#) and [Amaral and Quintin \(2006\)](#). See also [Hopenhayn \(2014\)](#) for a detailed review of the literature on finance and misallocation.

³[Midrigan and Xu \(2014\)](#) find that these frictions have a lower impact once agents are given more time to self-finance to mitigate the impact of the borrowing constraints they face, but [Moll \(2014\)](#) argues that the mitigating effects of self-financing depend critically on the nature of the idiosyncratic shocks producers face.

To understand the idea, consider an economy that contains agents who by taste or by constraint only want to invest in safe securities. Without some financial engineering, the capital these agents are able to provide cannot be tapped to finance risky investment projects. By tranching risky cash flows into securities with different characteristics, financial intermediaries allow heterogeneous agents to combine their resources and fund projects whose fundamental characteristics may not meet the particular needs of any specific type of investor. Financial engineering – tranching, in particular – makes it possible to activate projects that could not be funded otherwise.

It follows, and this is the main point we make in this paper, that economies where security creation is costly direct less capital to productive uses. We establish this formally in a dynamic extension of [Allen and Gale \(1989\)](#)’s optimal security design model. Our overlapping generation environment contains agents who are risk-neutral and other agents who are highly risk-averse and thus have a high willingness to pay for safe securities. Absent transaction costs, it would be optimal for producers to sell the safe part of the stochastic cash-flows they generate to risk-averse agents and the residual claims to risk-neutral ones. But tranching cash-flows in this fashion is costly. As a result of these costs, some potentially profitable projects are left inactive, which results in less capital formation, output and dynamic wealth accumulation.

While the implications of varying tranching costs for the level of economic development are clear, the impact on average productivity of making the securitization of risky cash-flows cheaper is fundamentally ambiguous, as we illustrate via numerical simulations. Intuitively, whether measured TFP goes up following a drop in security creation costs depends on whether the productivity of those projects that become active following the reduction are above or below average compared to incumbent producers.

This aspect of our environment is in sharp contrast to what emanates from traditional models of missallocation, as described for instance by [Hopenhayn \(2014\)](#). In those models, mitigating financial disruptions allows producers to operate closer to their optimal scale which drives wage rates up and causes low productivity managers to exit. Both aspects – estab-

lishments operating closer to their optimal scale and the exit of less productive managers – result in higher TFP as it is conventionally measured. In our model, lowering securitization costs allows previously infra-marginal producers to become profitable, which can lower TFP. Securitization booms, that is, can be bad for aggregate productivity even when they cause investment booms.

2 Financial complexity and development: preliminary evidence

To motivate the model we put forward in Section 3, we start by arguing that there is a positive correlation between different measures of financial complexity and development. Our broad measure of development is real GDP per capita and we consider two proxies for financial complexity: private bond market capitalization and securitization as shares of GDP. This evidence is, of course, merely suggestive, but it will show that the relationship between complexity and macroeconomic aggregates our model implies is broadly borne out by the data.

2.1 Corporate bonds

The first measure of tranching volumes we consider is the relative importance of bond market capitalization across countries. Fundamentally, firms issue bonds in order to raise funds from investors who require more guarantees than equity investors and more liquidity than direct lenders might, and are willing to pay premia for those features. Participating in bond markets is costly however, since it requires becoming listed on the corresponding exchanges, the production of issuer and issue ratings, not to mention compliance with accounting and disclosure standards. Participation in bond markets is profitable only when these costs are outweighed by the benefits of raising funds from heterogenous investors, just like in our model.

One should expect bond market participation costs to vary a lot across countries. Nations

such as the United States, with a long history of bond trading, high competition between exchanges, and established benchmarks for pricing (a well defined yield curve with high liquidity at all maturities) have low participation costs compared to nations with shorter bond trading histories and weaker institutions.

We have data on the market capitalization of private corporate debt (for both financial and non-financial corporations) as a fraction of GDP for 49 (developed and developing) countries compiled in the Financial Development and Structure Dataset, from [Beck, Demirguc-Kunt, and Levine \(1999\)](#), that uses the corporate debt data from the Bank for International Settlements. As panel A in figure 1 shows, this measure of private bond capitalization is positively correlated with development levels (the coefficient of correlation is 0.37), as our model would predict.

2.2 Securitization

The second proxy for tranching activities we consider is securitization in the traditional sense. In this context, the intermediaries in the model play the traditional role of channeling savings from households to borrowers and originate securities that are collateralized by the revenue streams the acquired projects produce. These securities may have multiple tranches offering dividends with different risk profiles.

The global securitized debt market is growing fast. According to data from the Securities Industry and Financial Markets Association (SIFMA), the global amount of consolidated securitized debt outstanding went from \$4.8 trillion in 2000 to \$13.6 trillion in 2010. The vast majority, by country of collateral, is in the US (roughly 77 percent), but even developing countries like China, South Africa, India and Malaysia have budding debt securitization markets growing at a fast pace.

We have data on outstanding securitized debt for a set composed mostly of developed countries.⁴ In panel B of Figure 1 we plot the total outstanding securitized debt by country as

⁴Our data for Australia and New Zealand, Canada, Japan, Malaysia, South Africa, South Korea and the U.S., comes from SIFMA, while data for European countries (Belgium, France, Greece, Ireland, Italy, The

a fraction of GDP against GDP per capita and show that there is a clear positive relationship (the coefficient of correlation is 0.44).⁵

This relationship is robust to the exclusion of residential mortgage-backed securities (RMBS). A large fraction of total securitized debt is backed by residential mortgages. The model we present below is one where the collateral backing these securities is better interpreted as some form of commercial or business loans. With that in mind we subtract the amount of outstanding RMBS from our measure of outstanding securitization. Panel C in Figure 1 shows that the positive relationship between securitization and development is only slightly attenuated (the coefficient of correlation is 0.33).

The environment we present below is one where financial intermediaries originate and then sell collateralized debt securities. In reality, the originating institutions (mostly banks) may choose to keep such securities in their balance sheets for a variety of reasons, primarily, in Europe, for the purpose of using it as collateral in repo operations with the European Central Bank and the Bank of England.

For European countries, we can breakdown issuance between retained and placed, from 2007 to 2015. Unfortunately, we lack information on outstanding amounts that were placed. We therefore assume that the outstanding amount of placed securities in 2015 is just the sum of placed issuance between 2007 and 2015. Panel D in Figure 1 presents such a measure against GDP per capita in 2015. The relationship between this measure of securitization and development continues to be positive if a little attenuated (the coefficient of correlation is 0.27).

Netherlands, Portugal, Russia, Spain and the United Kingdom) comes from the Association for Financial Markets in Europe (AFME).

⁵For the U.S. and the European countries we have averaged our measures between 2007 and 2015. For the remaining countries the averages are for 2007 to 2010 because of data availability.

3 The environment

Consider an economy where time is discrete and infinite and where there is one consumption good. Each period, a mass one of two-period lived households is born. For simplicity, we will assume that these households only value consumption at the end of the second, and final, period of their life. Each household is endowed with a unit of labor which they deliver in the first period of their life for a competitively determined wage. Since they do not value consumption in that first period, they invest all their labor earnings at the beginning of the second period of their life and consume the proceeds from this investment at the end of the period.

Fraction $\theta \in (0, 1)$ of these households – type 1 households – are risk-neutral. The remainder – type 2 households – are infinitely risk-averse, in the sense they seek to maximize the lowest possible realization of their investment return.⁶ All agents have access to a safe storage technology that is subject to decreasing returns. Specifically, when a quantity k of the good is stored in the aggregate, the technology returns Ak^ω where $A > 0$ and $\omega < 1$. Proceeds are distributed on a pro-rata basis to all agents. From the point of view of a given (atomistic) agent then, and in any equilibrium, storage offer a safe gross return R_t .

In what follows, selling securities to risk-averse agents only makes sense if their willingness to pay for safe securities is higher than that of risk-neutral agents. To deliver this feature in a tractable way, assume that risk-averse agents incur transaction or time costs that erode their net payoff from storage by a ration $\delta \in (0, 1)$. Letting $r_{1,t}$ and $r_{2,t}$ denote the net payoffs from storage for the two agent types at date t we have

$$r_{1,t} = R_t > (1 - \delta)R_t = r_{2,t}.$$

Each period, the economy also contains a large mass of one-period lived producers. They can each operate an establishment whose activation requires an investment of one unit of the

⁶One way to formalize this is that they have CRRA preferences with infinite curvature. See [Epstein and Zin \(1989\)](#).

consumption good at the start of any period. Production, unlike storage, is risky. Specifically, an active project operated by a producer of skill $z_t > 0$ yields gross output

$$z_t^{1-\alpha} n_t^\alpha$$

at the end of the period t , where $\alpha \in (0,1)$, n_t is the quantity of labor employed by the project.

The skill level z_t of a particular producer is subject to aggregate uncertainty. Producers must decide whether to activate their project before knowing whether aggregate conditions $\eta \in \{B, G\}$ are good (G) or bad (B). The aggregate condition follows a first-order Markov process with known transition function $T : \{B, G\} \rightarrow \{B, G\}$. Producer types are a pair, $z = (z_B, z_G) \in \mathbb{R}_+^2$, of skill levels given the realization of the aggregate shock. What we mean here is that if a producer is of type (z_B, z_G) , then their idiosyncratic productivity is z_B during bad times, while it is z_G during good times. The mass of producers in a given Borel set $Z \subset \mathbb{R}_+^2$ is $\mu(Z)$ in each period. Producer types are public information.

After the aggregate shock is realized, conditional on having activated a project, and taking the wage rate, w_t , as given, a producer of talent z solves

$$\Pi(w_t; z) \equiv \max_{n>0} z^{1-\alpha} n^\alpha - n w_t,$$

where Π denotes net operating income. Let

$$n^*(w_t; z) \equiv \arg \max_{n>0} z^{1-\alpha} n^\alpha - n w_t$$

denote the profit-maximizing labor used, given values of the aggregate shock and the wage. We note for future reference that n^* is linear in the realized level z of skill.

Investments in projects are intermediated. Specifically, a stand-in intermediary can buy any given project for a project-type-specific price $\kappa(z_B, z_G)$ that is determined in equilibrium. We note for now that $\kappa(z_B, z_G) \geq 1$ must hold in any equilibrium, since producers must fund

the unit of capital they need. (This abstracts from potential limited commitment and other moral hazard issues by assuming that active producers must in fact invest capital.)

The intermediary finances its investments by issuing securities, i.e. claims to the pool's output. A security is a mapping from the aggregate state to a non-negative dividend. We require that dividends be non-negative for the same reasons as in [Allen and Gale \(1989\)](#). Allowing negative dividends is formally similar to allowing households to short-sell securities. As is well known, doing so can lead to non-existence, even in static versions of the environment we describe. More importantly perhaps, securitization cannot generate private profits when short-sales are unlimited in this case, since any value created by splitting cash-flows could be arbitrated away in the traditional Modigliani-Miller sense.⁷ As a result, no costly securitization could take place in equilibrium. Note that pooling projects eliminates project-specific risk, but aggregate shocks can't be diversified away. Forming a pool of different project types would do nothing to change that, hence there is no loss of generality in assuming that the intermediary forms pools of one given type at a time.

Creating a pure pass-through structure – i.e., issuing exactly one security whose stochastic payoff is the pool's payoff and sold to risk-neutral agents – is free.⁸ Selling securities to the risk-averse agents, on the other hand, carries a fixed cost c per project included in the pool. We think of this cost as evaluating the worst-case scenario payoff of securities, which is all that risk-averse agents care about.⁹

The intermediary can either pay c to create two securities – one for each household type – or avoid that cost by creating only one security that she then sells to risk-neutral agents.

⁷See [Allen and Gale \(1989\)](#) for the formal version of this argument.

⁸Note that this is purely a normalization.

⁹Alternatively, we could simply assume that creating one security type is free but that creating additional securities carries a additional cost. One can show that, as long as the gap between z_B and z_G is high enough, the only point of tranching cash-flows in such an environment is to extract the risk-free part of a producer's cash-flow to sell it to risk-averse agents and sell the residual claims to risk-neutral agents.

In the no-tranching case, profits are:

$$\mu(z_B, z_G) \left[q_t^1(B) \Pi(w_t(B); z_B) + q_t^1(G) \Pi(w_t(G); z_G) - \kappa(z_B, z_G) \right], \quad (3.1)$$

where $q_t^1(\cdot)$ is the willingness-to-pay vector for households of type 1 for each possible realization of the aggregate shock. If the intermediary decides to tranche the pool's cash-flows, profits are:

$$\mu(z_B, z_G) \left[q_t^1(G) \left(\Pi(w_t(G); z_G) - \Pi(w_t(B); z_B) \right) + q_t^2 \Pi(w_t(B); z_B) - \kappa(z_B, z_G) - c \right]. \quad (3.2)$$

This expression anticipates a fact we will establish later, which is that if the intermediary chooses to extract risk-free securities from the pool, it maximizes the production of those securities. Since $\Pi(w_t; z_B)$ is the lowest possible realization of profits, this is the highest risk-free cash flow the intermediary can sell per project in the pool. It is profitable for the intermediary to purchase projects of type (z_B, z_G) provided a feasible pair of security types exists such that profits are non-negative.

Old households of type $i \in \{1, 2\}$ enter date 0 with assets $a_0^i > 0$. The aggregate state of the economy in that initial period is summarized by $\Theta_0 = \{a_0^1, a_0^2, \eta_{-1}\}$ where $\eta_{-1} \in \{B, G\}$ is the aggregate shock at date $t = -1$. An equilibrium, then, is state-contingent project prices $\{\kappa_t(z_B, z_G)\}_{t=0}^{+\infty}$ for each producer types, wage rates $\{w_t(\eta)\}_{t=0}^{+\infty}$ for each $\eta \in \{B, G\}$, security menus for each project and household types, consumption plans $\{c_t^i\}_{t=0}^{+\infty}$ for each household type and, finally, pricing kernels $\{q_t^1, q_t^2\}$ such that, at all dates t :

1. Old agents consume the payoff of their security holdings at each date, while young agents save their entire labor income;
2. Security menus solve the intermediary's problem;
3. Profits are exactly zero for the intermediary (i.e κ equals gross securitization profits);
4. Producers of type z are active if and only if $\kappa_t(z_B, z_G) \geq 1$;

5. The market for labor clears:

$$\int_{Z_t} n^*(w_t(\eta); z) d\mu = 1 \text{ for all } \eta \in \{B, G\},$$

where Z_t denotes the set of active establishments at date t ;

6. Pricing kernels satisfy:

$$\begin{aligned} \text{(a) } q_t^1(\eta) &= \frac{T(\eta|\eta_{-1})}{1+r_{1,t}} \text{ for each } \eta \in \{B, G\}; \\ \text{(b) } q_t^2 &= \frac{1}{1+r_{2,t}}. \end{aligned}$$

4 Properties of equilibria

4.1 Aggregation and measured TFP

In this environment, the aggregate production function that results from adding up the individual establishments' production plans takes a familiar neoclassical form. In order to derive it, let $Z_\Theta \subseteq \mathbb{R}_2^+$ denote the set of types that operate establishments (an equilibrium set to be established later) given the aggregate state, Θ , of the economy. Let K denote the aggregate quantity of capital used to operate active projects in a given period. In equilibrium this has to equal the measure of establishments activated:

$$K = \int_{Z_\Theta} d\mu.$$

It will be useful to define the average productivity among active establishment when the (new) realization of the aggregate state is $\eta \in \{B, G\}$:

$$\bar{z}(\eta) \equiv \frac{\int_{Z_\Theta} z_\eta d\mu}{\int_{Z_\Theta} d\mu},$$

and to note that this implies $K\bar{z}(\eta) = \int_{Z_\Theta} z_\eta d\mu$.

In our case, the measure of labor supplied is one, but generalizing, let N denote the total mass of employment. Then, for the labor market to clear, and using the solution to the establishments' labor choice problem, we must have that for each η :

$$\begin{aligned} N &= \int_{Z_\Theta} n^*(z_\eta, w(\eta)) d\mu \\ &= n^*(1, w(\eta)) \int_{Z_\Theta} z_\eta d\mu \\ &= n^*(1, w(\eta)) K \bar{z}(\eta). \end{aligned}$$

We can now write the aggregate production function given aggregate capital, aggregate labor and the aggregate productivity shock:

$$\begin{aligned} F(\eta, K, N) &= \int_{Z_\Theta} z_\eta^{1-\alpha} n^*(z_\eta, w)^\alpha d\mu \\ &= \int_{Z_\Theta} z_\eta n^*(1, w(\eta))^\alpha d\mu \\ &= \int_{Z_\Theta} z_\eta \left(\frac{N}{K \bar{z}(\eta)} \right)^\alpha d\mu \\ &= \left(\frac{N}{K \bar{z}(\eta)} \right)^\alpha \int_{Z_\Theta} z_\eta d\mu \\ &= \bar{z}(\eta)^{1-\alpha} N^\alpha K^{1-\alpha}. \end{aligned}$$

This is a standard-looking neoclassical production function, where the term $\bar{z}(\eta)^{1-\alpha}$ plays the role of measured TFP, which in this environment is a function of the efficiency of activated establishments.

The set of equilibrium conditions defined above implies an aggregate feasibility constraint that must hold every period. Letting

$$K_t^E = \theta a_{t-1}^1 + (1 - \theta) a_{t-1}^2$$

denote economy-wide wealth at the start of the period, we can write the part of the capital

stock devoted to the storage technology as $K_t^S = K_t^E - I_t$, where I_t , investment devoted to productive activities is defined below. Output is the sum of productive activities and storage returns:

$$Y_t = F(A_t, K_t, N_t) + A (K_t^S)^\omega.$$

On the expenditure side and starting with consumption, recall that agents only consume when old, and simply define aggregate consumption as the sum of each type's consumption,

$$C_t \equiv \theta c_{1t} + (1 - \theta) c_{2t} + c_{Et},$$

where c_{Et} is the consumption of entrepreneurs that has to equal their payments from selling projects: $\int_{Z_\Theta} \kappa(z) d\mu$. Aggregate investment is the sum of next period's capital and the expenditures intermediaries incur in creating new securities:

$$I_t = K_{t+1} + \int_{Z_\Theta} c 1_{b(z) > 0} d\mu.$$

The result is that we can express the aggregate feasibility constraint in a familiar form, as aggregate output equals the sum of aggregate consumption and investment.

4.2 Financial policies

This section solves the stand-in intermediary's problem given states prices, $(q^1, q^2) \in \mathbb{R}_+^2 \times \mathbb{R}_+$, and the wage, $w(\eta)$, for each possible realization of the aggregate shock $\eta \in \{B, G\}$. It is important to observe, first, that we can treat each project type separately. There is no role in our model for combining claims from different project type pools to create a new pool and a new set of securities.¹⁰

¹⁰Our agents can extract the risk-free portion of any combination of assets in one step. In practice, this process often involves the re-securitization of securities from different pools. Our specification encompasses any and all benefits these activities could yield. Indeed, given the assets that are used for the creation of securities, the intermediary can choose to directly reach the overall bound on the supply of risk-free assets. Our specification thus fully encompasses any value CDO-type practices could create.

Consider then a particular project type $z \equiv (z_B, z_G)$ and rewrite the maximum per-project profits the intermediary can generate on the corresponding pool as:

$$q^2 b + q^1(G) \left(\Pi(w(G); z_G) - b \right) + q^1(B) \left(\Pi(w(B); z_B) - b \right) - \kappa(z_B, z_G) - c 1_{\{b > 0\}},$$

where the non-negativity restriction on payoffs imposes:

$$b \leq \Pi(w(B); z_B).$$

The following, intuitively obvious, remark will help us fully characterize the intermediary's optimal policy:

Remark 1. *In any equilibrium, κ is monotonic among active projects.*

Proof. Assume by way of contradiction that, for a given (z_B, z_G) , there exist $(z'_B, z'_G) \geq (z_B, z_G)$ such that $\kappa(z'_B, z'_G) < \kappa(z_B, z_G)$. Then, if profits are zero at (z_B, z_G) , as must be true given the free-entry condition, they have to be strictly positive at (z'_B, z'_G) , which cannot happen in equilibrium. \square

Given this monotonicity of project prices, the binary decision of whether or not to operate a project is monotonic in z . Given activation, it also turns out that the financial policy of intermediaries satisfies a simple bang-bang property, recorded in the following proposition:

Proposition 2. *If the intermediary activates projects of type $z \equiv (z_B, z_G)$, then it also activates all projects of type $z' > z$. Furthermore, among active projects and μ -almost surely:*

1. *Either $b(z) = 0$ or $b(z) = \Pi(w(B); z_B)$*
2. *$b(z_B, z_G)$ is monotonic in z_B in the sense that given z_G , $b(z'_B, z_G) \geq b(z_B, z_G)$ whenever $z'_B > z_B$, strictly so when $b(z_B, z_G) > 0$.*

Proof. Since producers maximize a linear objective over a compact and convex set, the result follows almost immediately from the Extreme Value Theorem stated for instance in [Ok \(2007\)](#).

Optimal policies for active producers must be extreme: producers either issue the most safe debt they can or none at all. See [Quintin and Corbae \(2016\)](#) for details. \square

These results follow from a fundamental feature of environments in the spirit of [Allen and Gale \(1989\)](#) such as ours: producers take state prices as given, hence have a linear objective which, in turn, leads to bang-bang financial policies. One key consequence is that when producers choose to create some risk-free debt, they max out the production of such debt.

5 Existence

Existence of an equilibrium given initial conditions $\Theta_0 = \{a_0^1, a_0^2, \eta_{-1}\}$ requires, first, that an interest rate and wage exist that clear capital and labor markets in the first period. Since both types save their entire wages when young and those savings become the new starting assets, conditions that guarantee existence in each period also guarantee that a well-defined path of wealth exists. It is easy to show, using standard arguments, that decreasing returns imply that all those paths live in a set that is bounded away from zero and bounded above.

Take starting conditions Θ_0 as given. Capital available to be deployed is $K^E = \theta a_0^1 + (1 - \theta)a_0^2$. Some of this capital – call it K^S – is stored, and this pins down gross storage returns R as well as the two willingnesses to pay (q^1, q^2) for securities. A pair of wages, then, yields a mass K of producers that choose to be active and a set Z_{Θ_0} of active producer types.

For equilibrium, we need a pair of wages that clears markets. While the search for market clearing wages is two-dimensional, the fact that Z_{Θ_0} is set prior to the realization of the aggregate shock, and hence is the same regardless of that realization, means that if we know what bad time wages $w(B)$ are, only one value of $w(G)$ can also clear wages during good times and, furthermore, the Cobb-Douglas functional forms we have assumed for production functions imply that $\frac{w(G)}{w(B)}$ is a constant greater than one. It follows from this reduction to a one-dimensional search and from the monotonicity of both profits and labor demand in those wages that, given K^S , there is only one pair of wages that clears labor markets. This, in

turn, implies a level of securitization costs and an overall demand for capital. We have an equilibrium if, and only if, that overall demand for capital (i.e. I as defined in section 4.1) equals starting aggregate wealth minus the storage capital, K^S .

This suggests a natural algorithm for finding period equilibria:

1. Guess a storage capital, \hat{K}^S ;
2. Compute the resulting demand for capital given market clearing wages, $I\left(\hat{K}^S; w(B), w(G)\right)$;
3. Update the guess for storage until capital markets clear.

Standard arguments show that the loop described above defines a correspondence that lives on a compact space, is non-empty, convex valued, and upper hemi-continuous. Moreover, our functional forms imply that the loop does not lead to zero storage. Kakutani's fixed point theorem now implies:

Proposition 3. *An equilibrium exists. Furthermore, all equilibria feature strictly positive storage.*

As discussed by [Allen and Gale \(1989\)](#), it is not possible to provide general conditions that guarantee uniqueness in this environment with endogenous security designs. Here, for instance, there may co-exist equilibria that feature tranching and equilibria that do not. While this complicates comparative statics considerations, our model does yield clear predictions for the impact of making tranching cheaper, as we will now show.

6 Comparative statics

6.1 Tranching costs and capital deepening

Consider two distinct economies that differ in one respect only. Economy \bar{c} features high tranching costs, while economy \underline{c} features low tranching costs. To start with an extreme case, assume that \bar{c} is infinitely (i.e. prohibitively) high, while \underline{c} is low. Obviously, for any

equilibrium in economy \bar{c} in the first period with a certain level of wages, an equilibrium with at least that wage level exists in economy \underline{c} . It follows that lower tranching costs must cause capital deepening over time, hence higher output. This section formalizes this intuition.

One complication here is that the economy's evolution is affected not just by fundamental parameters, but also by the realization of aggregate shocks. To deal with this issue, we will compare economies that experience identical aggregate shock draws and show that, given these draws, lower tranching costs imply higher wealth accumulation. A second complication is that equilibrium paths may not be unique. We will show that uniformly higher wage, output and wealth paths enter the set of equilibrium paths when tranching costs fall.

Holding all other parameters the same, let $\mathcal{W}(\Theta, c; \eta)$ be the set of equilibrium wages given initial conditions and the cost of tranching as a function of the current realization of the aggregate shock. The previous section has established that this set is not empty. Standard arguments also imply that $\mathcal{W}(\Theta, c; \eta)$ is closed and bounded. As mentioned above, to be able to make clear comparative statements, we will need to focus on a particular path $\{\eta_t\}_{t=0}^{+\infty}$ of aggregate shocks. Given this path and the properties of \mathcal{W} , we may define $w^*(\Theta, c; \eta)$ to be the highest wage compatible with equilibrium, given initial conditions, the cost of tranching and the current realization of the aggregate shock. We begin with a fairly intuitive observation:

Lemma 4. *Holding wealth levels constant, the highest period equilibrium wage w^* rises when c falls.*

Proof. (sketch) The highest wage is associated with the lowest amount of resources directed to storage in the equilibrium set. Call that level \underline{K}^S . A fall in tranching costs is tantamount to an upward shift in the demand for labor at all possible wages, given \underline{K}^S . It follows that a new equilibrium must exist with a storage amount in $[0, \underline{K}^S]$. With more capital used in production and lower tranching costs, the highest equilibrium wage can only rise for a given realization of the aggregate shock. \square

In our environment, wages today are wealth tomorrow. Given initial conditions $\Theta_0 = (a_0^1, a_0^2, \eta_{-1})$ and η_0 , w^* is higher in period 0 when tranching costs are lower, as we have

just established. This implies that wealth is higher at the start of period 1. Even holding tranching costs the same as before (they are now even lower), this would cause demand to shift at all possible values of K^S since $K^E - K^S$, the amount directed to risky production, is now higher. So maximum equilibrium wages must be higher in period 1 as well, given η_1 . These considerations imply, first, that in any given economy and for a given path of aggregate shocks, there is a uniformly higher path of aggregate wages, capital and output from production, which can be constructed by selecting the equilibrium with the highest wage in each period. Second, in economies with lower tranching costs, this uniformly highest equilibrium path of capital and output is higher than any equilibrium path in a comparable economy with lower tranching costs. In summary:

Proposition 5. *Consider two economies that are identical except for the fact that tranching costs are lower in economy \underline{c} than in economy \bar{c} . An equilibrium path exists in economy \underline{c} that is uniformly higher in terms of capital, output and wages than every equilibrium path in economy \bar{c} .*

Proof. Select the highest equilibrium wage in economy \underline{c} in each period. That path must be associated with higher wealth at every period than any path in economy \bar{c} , given the realization of aggregate shocks. \square

Despite the fact that we cannot guarantee uniqueness, it is thus possible to formulate strong comparative statics predictions in this environment. When tranching costs fall, new paths that feature uniformly more wealth, higher wages and higher output enter the equilibrium set. As we will now discuss, the connection between tranching costs and measured TFP is much more subtle.

6.2 An illustrative example

To illustrate the mechanisms described above we set up an example comparing two economies that differ only in tranching costs. There are two possible states of the world $\eta = \{B, G\}$,

with identical aggregate productivities $A_B = A_G = 1.5$. The transition matrix F is such that the probability of remaining in the bad state is $T_{BB} = 0.2$ and the probability of remaining in the good state is $T_{GG} = 0.9$. Storing K units of the consumption good returns $1.1K^{0.7}$, the transaction costs that risk-averse consumers face are given by $\delta = 0.65$, and the tranching costs are set at $\bar{c} = 0.3$. In production, we assume $\alpha = 0.65$, $z_B = [0, 1]$ and $z_G = [0, 1]$ (under the proviso that for any pair $z = (z_B, z_G)$, $z_B \leq z_G$ without loss of generality.) Productivities z are distributed according to μ , which we assume is a bivariate exponential distribution on (z_B, z_G) , with parameter $\lambda = 0.25$, that is truncated and rescaled so that for all z such that $z_B > z_G$, $\mu(z) = 0$. This distribution is shown in figure 2.

Figure 3 illustrates the intermediaries' optimal policy decisions. A number of projects is not activated, as they are unprofitable in expected value terms, regardless of the security structures used to finance them – this is the darker area in the figure.¹¹ Among the activated projects there is a set that is productive enough in bad times such that it is more profitable to finance these projects by issuing risk-free debt. This is the tranching set, identified by the label $\Pi^T \geq \Pi^{NT}$. For these projects, the price that the risk-averse households are willing to pay is enough to compensate the intermediary for not paying the risk-neutral constituency in bad times. For projects that do not pay enough in bad times, but pay enough in good times, the intermediary simply issues equity. That is the non-tranching region, identified by the label $\Pi^T < \Pi^{NT}$.

The slope of the line separating the activated projects from those that remain dormant is different in the two operating regions: it is steeper in the tranching region than in the non-tranching one. Intuitively, productivity in bad times is more valuable under tranching, given the higher willingness to pay of risk-averse households. As a consequence, a marginal decrease in z_B in that region needs to be compensated with a larger rise in z_G , in order to keep profits constant, when compared to the non-tranching region. Notice also that there is a vertical line separating tranching from non-tranching operations. That is because once a project is active, whether it is more profitable to tranche or not, does not depend on z_G , only

¹¹The figure is for the case where the aggregate state is $\eta_{-1} = G$.

on z_B , as can be seen by subtracting equation (3.2) from equation (3.1).

Decreasing tranching costs increases capital deepening and output, as shown in proposition 5. In the context of the present example, we cut the tranching costs from $\bar{c} = 0.3$ to $\underline{c} = 0.04$. The results, as far as changes in the intermediaries' policies are concerned, are shown in Figure 4. For the same starting level of assets, as tranching costs drop, more establishments with relatively high levels of z_B open, while others, with relatively low levels of z_B , close. Figure 5 shows how much capital deepening increases as the costs of tranching change, conditional on the aggregate state. In our example, where tranching costs are reduced from $\bar{c} = 0.3$ to $\underline{c} = 0.04$, the mass of activated establishments, which equals the amount of productive capital, is higher in the low tranching cost economy by 15 to 24 percent, depending on whether last period's shock was good or bad. Moreover, more projects are financed through tranching than before, as can be seen by the movement in the kink that separates the tranching and non-tranching regions in Figure 4.

As tranching costs drop, projects that were marginally unprofitable (under tranching) become profitable and are activated (identified by the label "Active only for \underline{c} " in Figure 4). As wages increase, under Lemma 4, projects that were marginally profitable (financed through equity only) become unprofitable (identified by the label "Active only for \bar{c} ") and are abandoned. Although some projects are activated and others are abandoned, Proposition 5 guarantees that the mass of the former is larger than that of the latter, that is, more capital is deployed for productive use when tranching costs are lower.

Using the algorithm laid out in Section 5 and common aggregate shock realizations, we simulate paths for these two economies that differ only in tranching costs. Figure 6 reports these simulations, where the low tranching cost economy (\underline{c}) is represented by the full line, and the high tranching cost economy (\bar{c}) appears as a dashed line. All variables appear as percentage deviations from the sample mean in economy \underline{c} . The simulation starts out in the good state, but visits the bad state occasionally (and briefly) given the assumed transition matrix T .

Panel A reports the production by active establishments – what we termed $F(A, K, N)$

in Section 4.1 – while Panel B reports aggregate GDP, which includes the returns from storage. Economy \underline{c} exhibits higher output regardless of the aggregate state and the measure of output used. Aggregate wealth K^E (Panel D) is also uniformly higher in economy \underline{c} , reflecting the fact that wages are higher there, but the real difference is in the capital put into establishments (Panel C). While mean wealth is roughly 3 percent higher in economy \underline{c} , the mean establishment capital is 13 percent higher.

6.3 Tranching costs and TFP

While we can show that capital deepening and output are higher for economies where tranching costs are smaller, regardless of what the realized state is, this is not necessarily the case for measured establishment TFP – what we termed $\bar{z}(\eta)^{1-\alpha}$ in Section 4.1. In general, this will increase when tranching costs fall, if and only if, the average TFP of the net entrants is higher than that of the incumbent projects that are not abandoned. This, of course depends not only on the productivity of the entering and exiting projects, but also on the underlying distribution of projects.

Moving from the economy with high tranching costs \bar{c} , to the one with low tranching costs \underline{c} , implies the loss of a set of establishments with relatively low z_B and relatively high z_G (identified by the label “Active only for \bar{c} ” in Figure 4) and the addition of another set of establishments with relatively high z_B and relatively low z_G (identified by the label “Active only for \underline{c} ”). In our example, this means that while measured establishment TFP is higher in economy \underline{c} when the realized state is $\eta = B$, it is actually lower when the realized state is $\eta = G$. This is exactly what Panel E in Figure 6 bears out.

In this environment, as tranching costs decrease, the projects that enter will always be financed through tranching. This happens because if a non-tranching project z is not profitable when tranching costs are high, it will surely not be profitable under lower tranching costs and higher wages. In fact, not only do no new tranching projects open when tranching costs drop, but there is actually a mass of exiting non-tranching projects, and these will be to

the NW of the entering tranching projects, which means that they will have relatively higher z_G and relatively lower z_B , compared to the entering tranching projects. Again, this happens because the iso-profit curves are steeper under tranching than under non-tranching, as argued above.

In general, though, it does not have to be necessarily the case that measured establishment TFP is smaller in good times and higher in bad time as tranching costs fall. Conceivably, one can think of (admittedly perverse) distributions where the average productivity before tranching costs decrease is, say, smaller than that of the net entrants once costs drop, if the realized state is $\eta = G$. Because the measure of operated establishments actually increases, as shown above, the average TFP may increase, when $\eta = G$, even though all exiting projects are more productive than all entering projects.

These considerations extend to aggregate TFP. But what happens here also depends, in addition, on how relatively (un)productive the storage technology is and how widely it is used. In the case of our example, it turns out that aggregate TFP is uniformly higher in economy \underline{c} , although negligibly so (Panel F in Figure 6).

6.4 A comparison with models of misallocation

Unlike what happens in environments where TFP differences stem from resource misallocation across establishments, such as in Restuccia and Rogerson (2008) or in Amaral and Quintin (2010), in the present framework individual establishments are operated at their optimal level. In particular, establishment-level TFP is independent of the particular security structure used to finance production. Therefore, as tranching costs decrease and capital deepening occurs, TFP increases, if and only if, the average TFP of net entrants is higher than that of incumbent projects. As we argue above, even in this simple two-state model one cannot make sweeping conclusions. Not only does this depend on the actual realized state, but also on the underlying productivity distribution.

In traditional models of misallocation, mitigating financial disruptions allows producers to

operate closer to their optimal scale, which drives wage rates up and causes low productivity managers to exit. Both effects result in higher TFP as it is conventionally measured. In our model, lowering securitization costs allows previously infra-marginal producers to become profitable, which can, and typically does, lower TFP.

7 Conclusion

This paper shows that by allowing producers (or intermediaries) to create securities that appeal to investors with heterogeneous tastes, financial development can lead to capital deepening, higher wages, output and welfare over time. Tranching cash flows allow heterogeneous investors to combine their resources to fund risky, productive projects that would not be activated otherwise. The implications of this sort of financial development for aggregate TFP, on the other hand, are fundamentally ambiguous since the capital deepening it implies can lead to the activation of projects whose productivity is below that of already active projects.

References

- ALLEN, F., AND D. GALE (1989): “Optimal Security Design,” *The Review of Financial Studies*, 1(3), 229–63.
- AMARAL, P. S., AND E. QUINTIN (2006): “A competitive model of the informal sector,” *Journal of Monetary Economics*, 53(7), 1541–1553.
- (2010): “Limited Enforcement, Financial Intermediation, And Economic Development: A Quantitative Assessment,” *International Economic Review*, 51(3), 785–811.
- BANERJEE, A. V., AND A. F. NEWMAN (1993): “Occupational Choice and the Process of Development,” *Journal of Political Economy*, 101(2), 274–98.
- BECK, T., A. DEMIRGUC-KUNT, AND R. LEVINE (1999): “A new database on financial development and structure,” Policy Research Working Paper Series 2146, The World Bank.
- BENCIVENGA, V. R., AND B. D. SMITH (1991): “Financial Intermediation and Endogenous Growth,” *Review of Economic Studies*, 58(2), 195–209.
- BUERA, F. J., J. P. KABOSKI, AND Y. SHIN (2011): “Finance and Development: A Tale of Two Sectors,” *American Economic Review*, 101(5), 1964–2002.
- BUERA, F. J., AND Y. SHIN (2013): “Financial Frictions and the Persistence of History: A Quantitative Exploration,” *Journal of Political Economy*, 121(2), 221 – 272.
- CASELLI, F., AND N. GENNAIOLI (2013): “Dynastic Management,” *Economic Inquiry*, 51(1), 971–996.
- EPSTEIN, L. G., AND S. E. ZIN (1989): “Substitution, Risk Aversion, and the Temporal Behavior of Consumption and Asset Returns: A Theoretical Framework,” *Econometrica*, 57(4), 937–69.
- EROSA, A. (2001): “Financial Intermediation and Occupational Choice in Development,” *Review of Economic Dynamics*, 4, 303–34.
- EROSA, A., AND A. H. CABRILLANA (2008): “On Finance As A Theory Of Tfp, Cross-Industry Productivity Differences, And Economic Rents,” *International Economic Review*, 49(2), 437–473.
- GOLDSMITH, R. (1969): *Financial Structure and Development*. Yale University Press, New Haven, CT.
- GREENWOOD, J., AND B. JOVANOVIC (1990): “Financial Development, Growth, and the Distribution of Income,” *Journal of Political Economy*, 98(5), 1076–1107.

- HOPENHAYN, H. A. (2014): “Firms, Misallocation, and Aggregate Productivity: A Review,” *Annual Review of Economics*, 6(1), 735–770.
- JEONG, H., AND R. TOWNSEND (2007): “Sources of TFP growth: occupational choice and financial deepening,” *Economic Theory*, 32(1), 179–221.
- KHAN, A. (2001): “Financial Development And Economic Growth,” *Macroeconomic Dynamics*, 5(03), 413–433.
- KING, R., AND R. LEVINE (1993): “Finance and Growth: Schumpeter Might Be Right,” *Quarterly Journal of Economics*, 108, 717–737.
- LUCAS, R. (1978): “On the Size Distribution of Business Firms,” *Bell Journal of Economics*, 9, 508–23.
- McKINNON, R. (1973): *Money and Capital in Economic Development*. The Brookings Institution, Washington, DC.
- MIDRIGAN, V., AND D. Y. XU (2014): “Finance and Misallocation: Evidence from Plant-Level Data,” *American Economic Review*, 104(2), 422–58.
- MOLL, B. (2014): “Productivity Losses from Financial Frictions: Can Self-Financing Undo Capital Misallocation?,” *American Economic Review*, 104(10), 3186–3221.
- OK, E. A. (2007): *Real Analysis with Economic Applications*. Princeton University Press, Princeton, NJ.
- QUINTIN, E. (2008): “Limited enforcement and the organization of production,” *Journal of Macroeconomics*, 30(3), 1222–1245.
- QUINTIN, E., AND D. CORBAE (2016): “Asset Quality Dynamics,” 2016 Meeting Papers 418, Society for Economic Dynamics.
- RAJAN, R., AND L. ZINGALES (1998): “Financial Dependence and Growth,” *American Economic Review*, 88, 559–86.
- RESTUCCIA, D., AND R. ROGERSON (2008): “Policy Distortions and Aggregate Productivity with Heterogeneous Plants,” *Review of Economic Dynamics*, 11(4), 707–720.
- SHAW, E. (1973): *Financial Deepening in Economic Development*. Oxford University Press, New York, NY.

Figure 1: Measures of financial complexity and development levels

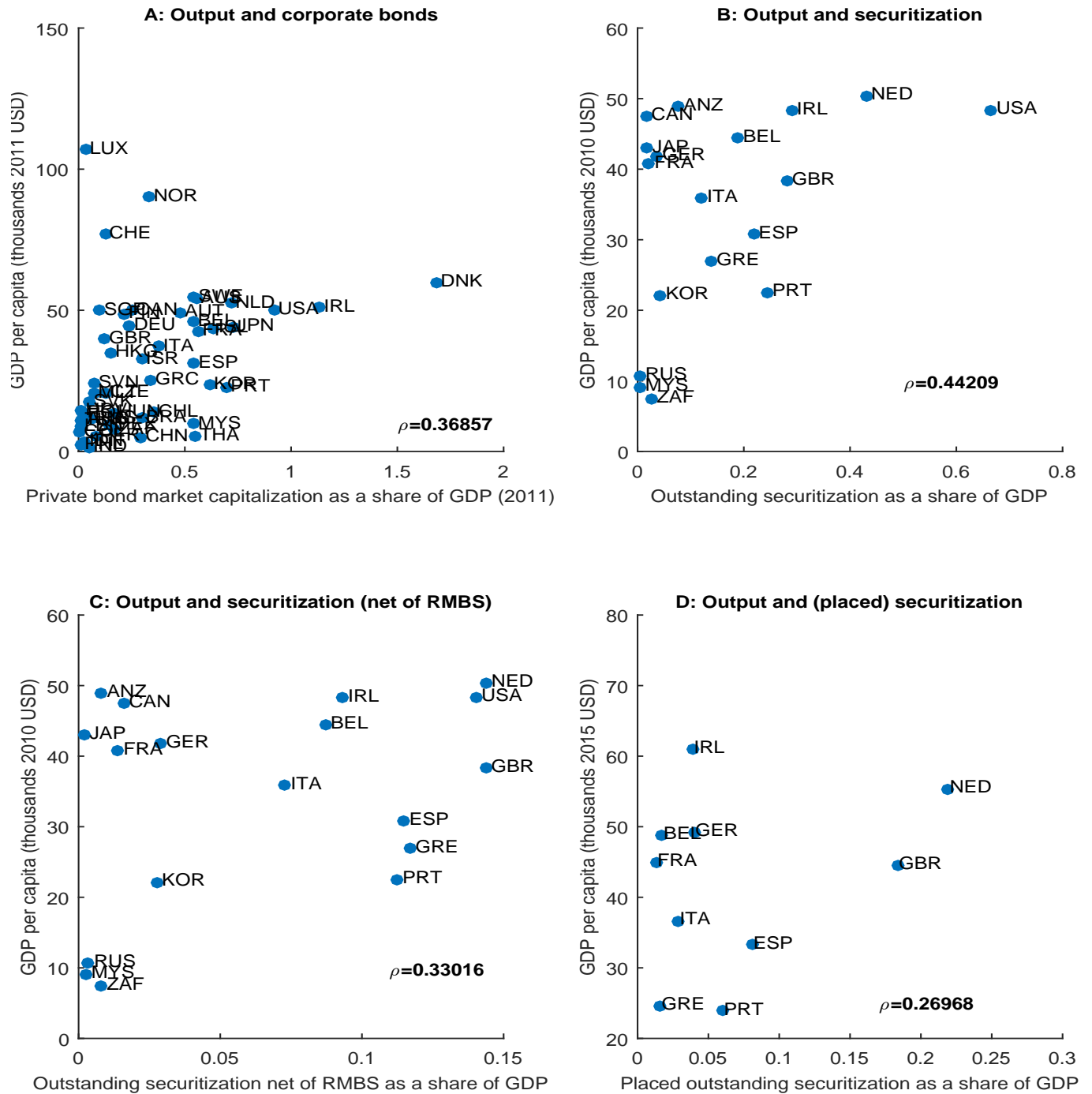


Figure 2: **Productivity distribution**

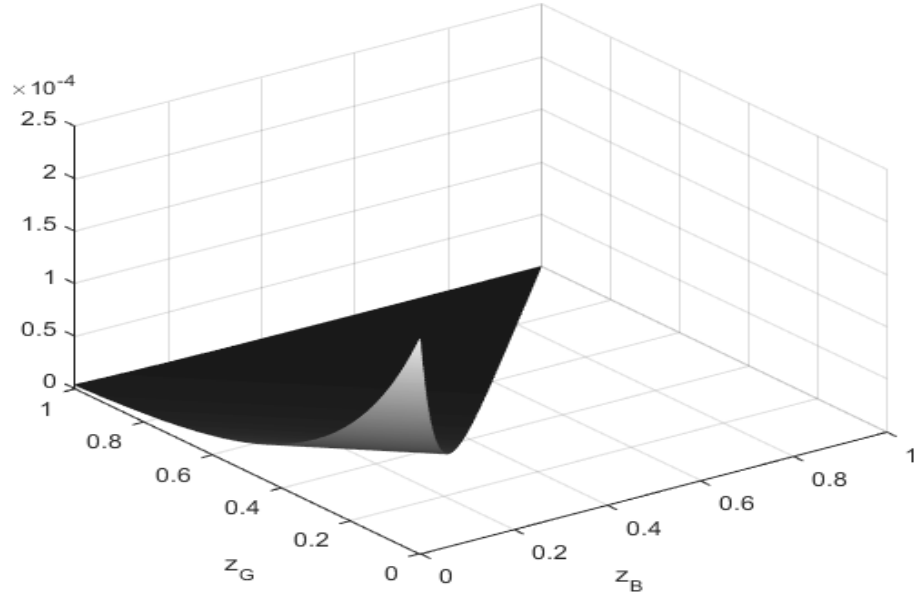


Figure 3: **Intermediaries' policies**

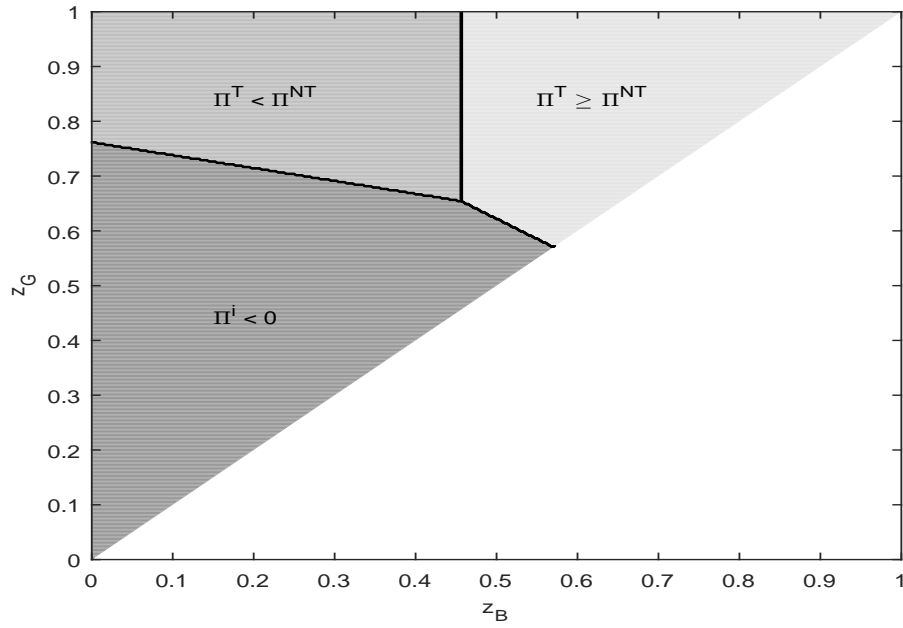


Figure 4: Decreasing tranching costs

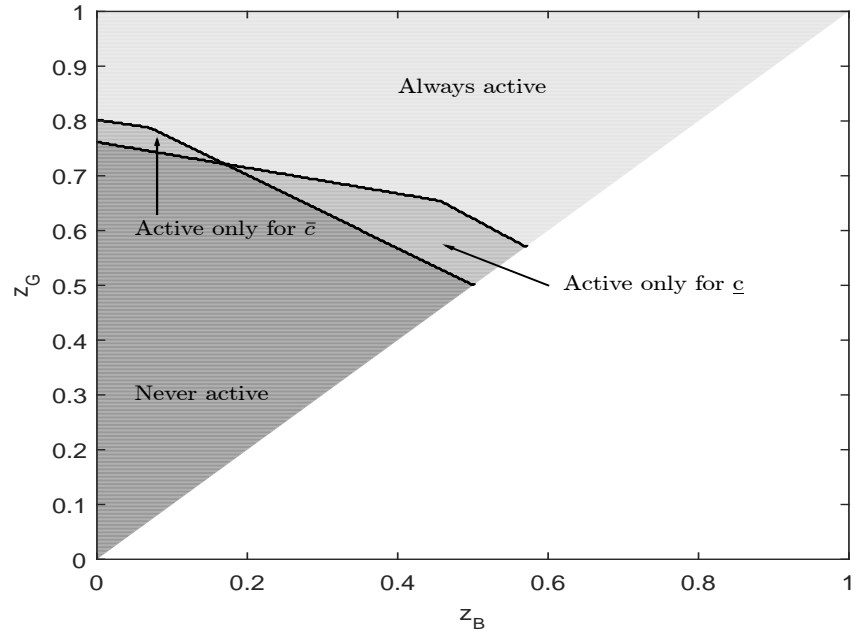


Figure 5: Capital used in production

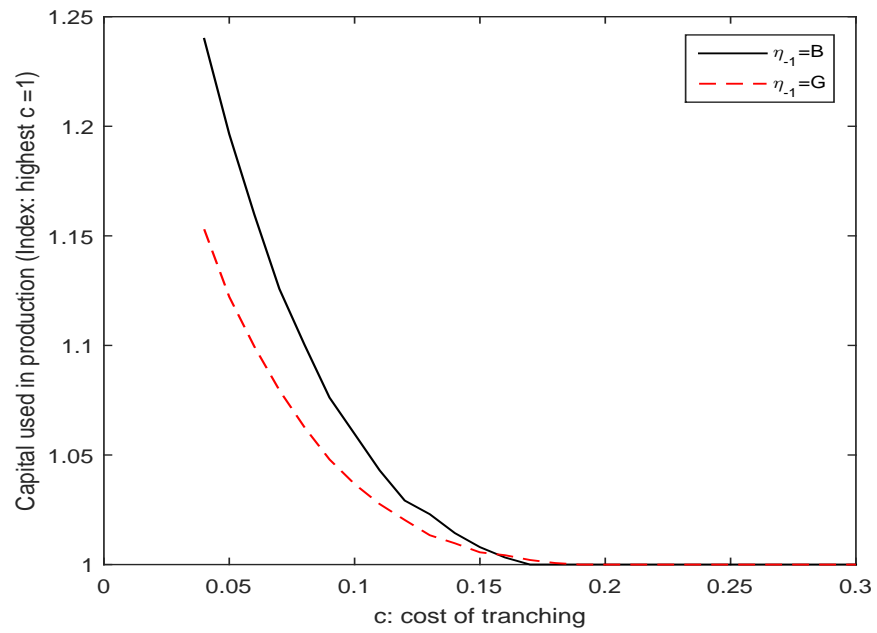


Figure 6: Simulating illustrative example economies

