Financial Engineering and Economic Development*

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May 17, 2017

Abstract

The vast literature on financial development focuses mostly on the causal impact of the quantity of financial intermediation on economic development and productivity. This paper, instead, focuses on the role of the financial sector in creating securities that cater to the needs of heterogeneous investors. 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. Lowering tranching costs in that environment leads to more financial investment, but it has ambiguous effects on capital formation, output and aggregate productivity. Much of the investment boom caused by increased securitization activities can in fact be spent on securitization costs and intermediation rents with little or even negative effects on development and productivity.

Preliminary and incomplete, comments welcome.

Keywords: Endogenous Security Markets; Financial Development; Economic Development
JEL codes: E44; E30

*We thank Julio Suarez at AFME, Sharon Sung at SIFMA and research assistance from Tristan Young. The views expressed herein are those of the authors and not necessarily those of the Federal Reserve Bank of Cleveland or the Federal Reserve System. Pedro Amaral: pedro.amaral@clev.frb.org, Dean Corbae: dcorbae@gmail.com, Erwan Quintin: equintin@bus.wisc.edu.

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]

More recently, however, a number of papers have argued, on empirical and theoretical grounds, that the effect of financial intermediation on growth and productivity becomes weaker, if not negative, at high levels of financial development. Arcand, Berkes, and Panizza

[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.

[2] For 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.

(2015), for instance, make the empirical case that once private credit reaches 100% of GDP, additional increases in private intermediation have a negative impact on growth. As they discuss, the leading explanation for eventually decreasing returns is that once the allocative benefits of better credit markets are exhausted, the nature of financial activity expansion changes. Whereas at early stages of development credit expansion caused, say, by institutional improvements, leads to the funding of new and highly productive projects, financial development eventually emphasizes "repackaging" and securitization activities which increase financial fragility without significant allocation gains.[4] Our goal in this paper is to make precise and quantify the link between repackaging (or financial engineering) activities and development and aggregate productivity.

To that end, we focus on the role the financial sector plays in creating financial products that cater to the needs of heterogeneous investors. 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 that, all else equal, a fall in tranching cost leads to more spending on the securities created by the risky production sector and hence to an investment boom. But this boom in financial investment may not lead to an increase in productive capital formation, output or TFP. In fact, we argue analytically and show via simulations that a large share of the investment boom may be dissipated into securitization costs and producer/intermediation rents rather than spent on actual capital formation.

As for aggregate TFP, securitization booms, we argue, tend to cause productivity declines. In our model, all active projects operate at their optimal scale. A reduction in tranching costs

[4] See Gennaioli, Shleifer, and Vishny (2012) for one formalization of this idea.

leads to the entry of producers whose projects were not profitable until it became cheaper to sell different parts of the associated cash-flows to different producers. There is no reason to expect that those new producers are high TFP-producers. Indeed, in an environment where all projects are operated at or near their optimal scale, high-TFP producers tend to be profitable whether or not the cash-flows they generate can be repackaged. 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 – projects 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.

We formalize these ideas 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 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. The result of these considerations is an aggregate production function which, we show, assumes a standard form and where the connection between project selection and TFP, as it is conventionally-measured, is transparent.

While the implications of varying tranching costs for investment broadly defined are clear, the impact on output or average productivity of making the securitization of risky cash-flows cheaper are fundamentally ambiguous, as we illustrate via numerical simulations. In short, when financial development takes primarily the form of repackaging, there is no reason to expect a positive correlation between the quantity of intermediation, development and growth.

2 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 inelastically 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 form 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.[5]

The economy also contains a large mass of one-period-lived producers. A unit mass of those producers operate a safe technology that transforms capital k into the consumption good according to Ak^{ω} where $A > 0$ and $\omega < 1$. These producers rent capital at gross rate R_t from households. From the point of view of a given (atomistic) household then, and in any equilibrium, this technology offers 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 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 gross payoff from the safe technology by a ratio $\delta \in (0, 1)$. Letting $r_{1,t}$ and $r_{2,t}$ denote

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

the net payoffs for the two agent types at date t we have

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

This assumption makes the opportunity cost of capital lower hence the willingness to pay for securities higher for risk-averse households than for risk-neutral households.

The remaining producers can each operate a project whose activation requires an investment of one unit of the consumption good at the start of any period. Project production, unlike the safe technology, 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 $\alpha \in (0,1)$ and 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). This aggregate shock follows a first-order Markov process with known transition function $T : \{B, G\} \to \{B, G\}$. Producer types are a pair, $z = (z_B, z_G) \in I\!R_+^2$ 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 $Z \subset I\!R_+^2$ is $\mu(Z)$ in each period. To make existence arguments quicker we will assume that with $z_G \geq z_B$ almost surely and that μ has continuous derivatives.[6] Producer types are public information.

After the aggregate shock is realized, conditional on having activated a project, and taking

[6]The assumption that all producers are more productive during good times is not essential but makes the exposition quicker by implying that producer profits are higher in good times than in bad times for all types. Assuming continuous density functions makes all mappings from prices to excess demands continuous in our existence proof. The case where μ features positive mass points can be handled by introducing lotteries as in Halket (2014).

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. Producers become active when $\kappa(z_B, z_G) \geq 1$ since they must fund the unit of capital they need but can consume any amount in excess of that (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 project'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 could not generate private profits if short-sales were unlimited since any value created by splitting cash-flows could be arbitraged away in the traditional Modigliani-Miller sense.[7] As a result, no costly securitization would take place in equilibrium.

Selling securities to risk-neutral agents is free (this is a mere normalization.) Selling securities to risk-averse agents, on the other hand, requires bearing a cost $c > 0$. One formal

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

way to justify this cost is to assume that risk-averse agents must bear a verification cost to discover the type of project used to back the securities they purchase. Paying this cost enables managers (or the intermediaries representing them) to distinguish themselves from managers with worthless projects in a manner that is visible for risk-averse agents. We think of c as standing in for additional guarantees and rating requirements certain investors – institutional investors, say – require. More broadly, the main comparative statics we carry out looks at the effect of varying that cost from zero to a value such that no securitization takes place. Variations in that cost parameter, in that sense, stand in for institutional or technological changes that make securitization easier or more difficult.

Given these assumptions, the intermediary can 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. In the no-tranching case, profits are:

$$q_t^1(B)\Pi(w_t(B); z_B) + q_t^1(G)\Pi(w_t(G); z_G) - \kappa(z_B, z_G), \tag{2.1}$$

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 project's cash-flows, profits are:

$$q_t^1(G)\left[\Pi(w_t(G); z_G) - \Pi(w_t(B); z_B)\right] + q_t^2\Pi(w_t(B); z_B) - \kappa(z_B, z_G) - c. \tag{2.2}$$

This expression anticipates on two facts we will formally establish in section 3.2. First, it only makes sense in any equilibrium in our economy for intermediaries to sell risk-free securities to risk-averse agents. Intuitively – although this requires a subtle argument as we will explain – excess returns have no value for risk neutral investors and the intermediary can sell any excess return to risk neutral agents. Second, if the intermediary chooses to extract risk-free securities from the project, it maximizes the production of those securities. Since $\Pi(w_t(B); z_B)$ is the lowest possible realization of profits, this is the highest risk-free cash flow the intermediary can sell. It is profitable for the intermediary to purchases 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 an amount k_t invested in the safe technology by households, a rental rate R_t, state-contingent project prices $\{\kappa_t(z_B, z_G)\}_{t=0}^{+\infty}$ for each producer type, 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 endowed with the safe technology behave competitively and consume their rents so that, in particular
$$R_t = A\omega k_t^{\omega-1};$$
5. Producers of type z are active if and only if $\kappa_t(z_B, z_G) \geq 1$;
6. 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 projects at date t;
7. Pricing kernels satisfy:
   (a) $q_t^1(\eta) = \frac{T(\eta|\eta_{t-1})}{1+r_{1,t}}$ for each $\eta \in \{B, G\}$;
   (b) $q_t^2 = \frac{1}{1+r_{2,t}}$.

Note that we do not state a capital market clearing condition. Because pricing kernels vanish as investment in the safe technology falls to zero, aggregate spending on securities cannot exceed aggregate wealth, so that the capital market trivially clears in the aggregate. But it is possible that spending on securities by one of the two agent types exceeds their wealth. To make sure that each type is able to fund the required spending on their respective portfolio, it is enough to assume that they can hold a negative position in the safe technology at the start of any given period. One way to implement this is to assume that the intermediary can facilitate the necessary borrowing at R_t by borrowing from one agent type and lending to the other as needed, an activity that carries zero expected return.[8]

3 Properties of equilibria

3.1 Aggregation and measured TFP

The aggregate production function that results from adding up the individual projects' 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 projects (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 projects activated:

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

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

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

[8]For risk-averse agents, we assume that borrowing carries the same transaction cost as storing does so that they can only be expected to repay $(1-\delta)R$, so that there is no kink in their budget set at zero borrowing. In addition, we continue to assume that households cannot hold negative positions in the securities created by intermediaries so that they cannot arbitrage away gross securitization profits.

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 projects' 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:

$$\begin{aligned} F(\eta, K, N) &= \int_{Z_\Theta} z_\eta^{1-\alpha} n^*(z_\eta, w)^\alpha d\mu \\ &= \int_{Z_\Theta} z_\eta n^*(1, w(\eta))^\alpha d\mu \\ &= \int_{Z_\Theta} z_\eta \left(\frac{N}{K\bar{z}(\eta)} \right)^\alpha d\mu \\ &= \left(\frac{N}{K\bar{z}(\eta)} \right)^\alpha \int_{Z_\Theta} z_\eta d\mu \\ &= \bar{z}(\eta)^{1-\alpha} N^\alpha K^{1-\alpha}. \end{aligned} \tag{3.1}$$

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 projects.

As we will discuss in more depth in section 5.2, this expression immediately implies that the effects of making tranching cheaper on TFP must be ambiguous. Unlike in traditional models of financial development, there are no untapped efficiency gains at the project level. The net impact of any change in the environment on TFP boils down to whether new entrants are more or less productive than already active and exiting producers. If anything, new entrants following a drop in tranching costs are more likely to be relatively low-productivity producers. Simply put, highly productive producers are active regardless of whether tranching is cheap or expensive.

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 safe technology as $K_t^S = K_t^E - I_t$, where I_t, investment devoted to risky activities is defined below. Output is the sum of risky project output and safe technology returns:

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

On the expenditure side and starting with consumption, recall that agents only consume when old. 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 producers that has to equal the proceeds $\int_{Z_\Theta} \kappa(z) d\mu$ from selling projects. 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,

$$C_t + I_t = Y_t.$$

That is, aggregate output equals the sum of aggregate consumption and investment.

3.2 Financial policies

This section solves the stand-in intermediary's problem given pricing kernels $(q^1, q^2) \in I\!R^2_+ \times I\!R_+$, 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 types to create a new pool and a new set of securities.[9] Next, we formally establish that, in equilibrium, it only makes sense for intermediaries to sell safe securities to risk-averse agents, a fact we have already used in the description of the environment.

Lemma 1. *In any equilibrium, the consumption of risk-averse agents is risk-free and they only purchase risk-free securities.*

Proof. Assume, by way of contradiction, that an equilibrium exists in which, in a given period, the consumption bundle (c_B, c_G) of risk-averse agents is such that $c_B > c_G$. Then, given their preferences, risk-averse agents pay nothing for the bad-realization payoff on any security, as their marginal valuation of consumption in bad times is zero. Moreover, in order for $c_B > c_G$ to hold, a positive mass of securities with higher payoffs in the bad state than in the good state must be issued to risk-averse agents. But those managers and intermediaries would be better off selling the bad state payoff to risk-neutral agents and this would strictly raise their profits. The case in which $c_B > c_G$ can be similarly ruled out. □

In short, selling risky securities to risk-averse agents would imply that managers and intermediaries are leaving money on the table. Consider then a particular project type $z \equiv$

[9] Our 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 projects. 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.

(z_B, z_G) and rewrite the maximum profit the intermediary can generate as:

$$q^2 b + q^1(G)\Big(\Pi(w(G); z_G) - b\Big) + q^1(B)\Big(\Pi(w(B); z_B) - b\Big) - \kappa(z_B, z_G) - c1_{\{b>0\}},$$

where the non-negativity restriction on payoffs imposes:

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

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

Lemma 2. *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. □

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 3. *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. That participation is monotonic in (z_B, z_G) folllows from the monotonicity of κ in productivity. As for financial policies, note that gross gains from tranching are

$$[q^2 - (q^1(G) + q^1(B))]b$$

since risk-neutral agents are willing to pay $q^1(G)+q^1(B)$ per unit of risk-free promise. These gains must exceed c to justify tranching. Since

$$q^2 = \frac{1}{R(1-\delta)} > \frac{1}{R} = q^1(G) + q^1(B),$$

gross tranching gains are maximized at $b = \Pi(w(B); z_B)$. Obviously then, if it is profitable for a manager of productivity level z_B to tranche, it is also profitable to do so for managers whose worst-case productivity is z'_B. □

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.

4 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 wages 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 invested in the safe technolgy, and this pins down gross safe 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. 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 capita by the production sector, i.e. spending on securities, equals $K^E - K^S$.[10] We will now establish that the associated fixed point problem always has a solution.

Proposition 4. *An equilibrium exists. Furthermore, all equilibria feature strictly positive investment in the safe technology.*

Proof. Start with an arbitrary guess $K^S \leq \theta a_0^1 + (1-\theta)a_0^2$ for safe technology capital and let R be the associated safe return while (q^1, q^2) are the corresponding state prices. Given these, we will first find market clearing wages (w_G, w_B). Find $w > 0$ such that when $(w_G, w_B) = (w, w)$ the labor market clears in the bad aggregate state. Such a w must exists since demand for labor in both aggregate states diverges to infinity as $w \mapsto 0$ while it goes to zero as $w \mapsto +\infty$, and since the underlying mapping is continuous.

At the resulting (w, w) there is (at least weakly and typically strictly) excess demand for labor in the good aggregate state, since $z_B \leq z_G$ $\mu-$almost surely. Starting from the pair $(w_G, w_B) = (w, w)$ so constructed, start lowering the wage w_B in the bad state while increasing the wage in the high state to a level $w_G(w_B)$ such that markets continue to clear in the bad state. The mapping $w_G(w_B)$ is continuous and must diverge to $+\infty$ as w_B becomes small. At some point then, demand for labor in the good state must equal one as needed which gives us the market clearing pair of wages we needed. By construction of $w_G(w_B)$, the labor market still clears in the bad state. We now have a pair of wages which, given, K^S (hence R) clears both labor markets. Moreover, the resulting mapping from the guess for K^S to market clearing wages is continuous.

Given (R, w_B, w_G), we can now compute (uniquely) spending on securities. In particular, we can compute total demand for capital and, for equilibrium, we need it to equal $\theta a_0^1 + (1-\theta)a_0^2 - K^S$. The full mapping from the initial guess to this demand for capital by the production sector is continuous. It is enough, therefore, to show that for small enough initial

[10] Equivalently, the requirement is that I as defined in section 3.1 equal starting aggregate wealth minus the safe technology capital capital, K^S and minus producer rents.

guesses there must be an excess supply of investment funds while for guesses large enough there is an excess demand for capital by producers. Take $K^S = K^E$, the largest possible initial guess. At that level of safe capital, the supply of capital to the production sector is zero. The arguments above show that a pair of wages exists that clears markets given the corresponding R. But this means, in particular, that some producers are active so that there is positive demand for capital by the production sector.

At the other end of the domain of definition of the mapping, assume K^S converges to zero so that R diverges to infinity. Labor market clearing requires that wages converge to zero as K^S does.[11] So do, therefore, aggregate profits, since those are linear in wages at any optimal solution the the producer problem. Aggregate producer rents, since they are bounded above by the present value of expected profits, must then converge to zero as well. With vanishing wages, the mass of active producers must fall since the labor demand of each producer type diverges to infinity. This implies that demand for capital falls to zero, so that, eventually, there must be excess supply. This completes the proof. □

As discussed by Allen and Gale (1989), it would be difficult to provide general conditions that guarantee uniqueness in this environment with endogenous security design. 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.

[11] To elaborate, this part of the argument requires two steps. First, one of the two wages must go to zero for there to be any participation by producers since pricing kernels vanish and producers must fund at least on unit of capital. But since the set Z_{Θ_0} of active producer types is common across realizations of the aggregate state, if labor markets clear with vanishing wages in the bad state, vanishing wages are also required for market clearing in the good state. If follows that if one of the two wages vanish, both must.

5 Comparative statics

5.1 Tranching costs and investment

Take a particular economy and assume that tranching costs fall in a particular period. Obviously, holding wages and safe invetsment levels the same, more producers find it profitable to operate and it follows that lower tranching costs should cause more spending on securities. This section formalizes this intuition.

One complication 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, lowering tranching costs imply higher investment on impact. Also to simplify the analysis, but with little impact on the economic ideas we formalize in this section, we will concentrate our attention on a parametric case where the two wages must always co-move. Section 5.3 will illustrate the general nature of our comparative statics results via numerical simulations.

To simplify the analysis then, assume that producers are scaled up versions of one another in the sense that $\frac{z_G}{z_B}$ is μ-almost surely a constant. Put another way, almost surely, $z_G = zA_G$ while $z_B = zA_B$, where $z > 0$ is the producer's idiosyncratic skill level and $A_G > A_B > 0$ are aggregate shocks common to all producers. Under those assumptions, the search for market clearing wages becomes one dimensional. The fact that Z_Θ 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. 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.

Proposition 5. *Assume that* $\frac{z_G}{z_B}$ *is* μ*-almost surely a constant. Assume that in a given economy and in a particular period, tranching costs suddenly fall. An equilibrium path exists where spending on securities rises on impact.*

Proof. When $\frac{z_G}{z_B}$ is μ-almost surely a constant, producer skills are summarized by a one dimensional level z. In turn, producer participation in any given period is associated with a skill threshold $\underline{z}$, while the tranching decision is governed by an upper threshold $\bar{z}$. Holding wages the same in a given period, a marginal decrease in tranching costs lowers $\bar{z}$. It may lower $\underline{z}$ as well but only if $\underline{z} = \bar{z}$ to begin with, i.e. only if all producers tranche prior to the decrease in tranching costs.

If $\underline{z}$ does not change following the decrease in tranching costs, labor markets continue to clear at the original wages. In that case, the only consequence of the decrease in tranching costs is an increase in spending on securities since the mass of producers that sell the safe part of their profits at a low discount rate has increased. This creates an excess demand for capital at the original safe capital level. If $\underline{z} = \bar{z}$ before the decrease in tranching costs then both thresholds move to the left. Bringing back labor markets to equilibrium now requires an increase in wages, hence yet again an increase in spending on securities,[12] hence an excess demand for capital as before.

In either case, there is an excess demand for capital at the original level K^S hence, using the same arguments as in our existence proof, there is an equilibrium with a safe capital level in $[0, K^S]$ hence a new equilibrium with a higher investment level. □

Falling tranching costs, in other words and not surprisingly, cause investment booms. It would seem intuitive that this boom in investment should lead to output gains and more wealth accumulation over time. Our simulations below reveal that this intuition can fail to hold. Before turning to those however, we will first discuss why the connection between tranching costs and output may not be monotonic in our environment.

[12] This specific part of the argument – as we discussed in the existence proof – follows from the fact that aggregate profits are linear in wages. The safe capital level pins down state prices. Holding the safe capital level level constant as we do in this paragraph holds state prices constant. Security spending – higher aggregate profits discounted at set of state price with possibly more tranching – must go up.

5.2 Tranching costs, output and TFP

The previous section has shown that tranching costs lead to more spending on securities. It would seem natural to expect then that the total expected payoff on that investment should be higher. In turn, since that total payoff at the end of each period has to be gross output it would follow that the risky project output must be higher in expected terms. Under the parametric assumption we made in the previous section (to wit, the assumption that $\frac{z_G}{z_B}$ is μ-almost surely a constant) and since wages are linear in GDP, both wages would then have to rise. It would then follow from these arguments that for a given path of aggregate shocks, wealth, investment, output and wages are uniformly higher following falls in tranching costs.

Where does this simple logic fail? A fall in tranching costs leads to an increase in the participation of risk-averse investors into the risky production sector. These investors require less return on their investment. While total spending on securities must rise, it is not the case that the total payoff on this investment (i.e. gross output) must also rise. In fact, our simulations below will show that much of the investment boom caused by falling tranching costs is spent on greater securitization expenditures and manager rents, and that capital formation in the risky project sector can in fact fall.

As for aggregate productivity, the connection between financial spending and TFP is embodied in the aggregate expression (3.1) we derived in section 3.1. Financial development leads to a rise in TFP if and only if the average quality of active projects rise. Intuitively and as we will confirm quantitatively in the next section, a fall in tranching costs leads to the entry of producers who, comparatively speaking, can produce higher amounts of perfectly safe output. The effect of tranching costs on TFP, then, depends on whether those safe producers tend to be productive producers. In most models (take Greenwood and Jovanovic, 1989, e.g.) risky projects are assumed to be more productive. This accords well with basic economic intuition. It only make sense to take on riskier projects if average payoffs are higher. So it seems natural to expect that, if anything, a greater share of safe projects will lead to lower TFP.

To make this stark, a comparison of our model with traditional models of financial development is useful. In standard models, TFP differences across economies stem from resource misallocation across projects.[13] In our framework, individual projects are always operated at their optimal level. More finance means more repackaging of fundamental cash flows but does not address any fundamental friction. In particular, project-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 new entrants is higher than that of incumbent projects.

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. More finance does not mean more output, wealth or higher TFP, as we will now confirm via numerical simulations.

5.3 Numerical simulations

5.3.1 Parameters

To illustrate the mechanisms described above, we will now compare economies that differ only in tranching costs via numerical simulations. Starting with an economy with no tranching costs that serves as a benchmark, we increase tranching costs until no tranching takes place in equilibrium.

We will think of one period to be 25 years. Starting with the safe technology, we normalize A to 1. We then set the parameter governing returns to scale on safe production to $\omega = 0.37$ which, in our upcoming simulations, implies a yearly rate of return of 4% for risk-neutral households. We set δ, the transaction costs infinitely risk-averse agents face to 0.22 so that the difference in yearly interest rate returns between risk-neutral and risk-averse households is 100

[13] See Restuccia and Rogerson (2008) or Amaral and Quintin (2010).

basis points, a value comparable to estimates of the Treasury convenience yield produced for example by Krishnamurthy and Vissing-Jorgensen (2012). The most standard interpretation of this convenience yield is as a premium the most risk-averse investors are willing to pay for default-free and perfectly liquid assets, which corresponds to the purpose of δ in our model.

We specify the transition matrix T for aggregate shocks so that the probability of remaining in the bad state is $T_{BB} = 0.2$ and the probability of remaining in the good state is $T_{GG} = 0.9$. This implies that the economy spends 89 percent of the time in the good state. We then make

$$\mathcal{Z} = \{(z_B, z_G) : z_G \geq z_B \text{ and } (z_B, z_G) \in [0, \bar{z}] \times [0, \bar{z}]\},$$

with $\bar{z} = 5.3$. This implies a fraction of savings devoted to securities of two-thirds, while a third goes to the safe technology.

The skill distribution function $\mu(Z)$ is a truncated bivariate normal with mean set to $(0.01, 0.02)$ which implies a (project) output difference of 1% a year between good times and bad times (28% for a 25 year period). The variance-covariance matrix is symmetric with off-diagonal elements of 0.02 and diagonal elements of 0.08. The resulting distribution of aggregate shocks is shown in figure 1. This skill distribution also implies a ratio of producer rents to value added by the risky production sector of around 10% throughout our simulations which is reasonable given the approximation for this moment in the United States obtained by Corbae and Quintin (2016.)

Below, we will want to make sure that our main points are not sensitive to particular aspects of the distribution of talent. To that end, we will also produce results for distributions of talent with higher dispersion of talent (twice the benchmark marginal variances) and less dispersion (half the variance. Because of the truncation at the 45 degree line, changing the dispersion also changes the mean of the distribution. We will show results with and without adjustments of the mean.[14]

[14] Experimenting with even more extreme distributions – such as uniform distributions – likewise did not change the basic nature of our results.

5.3.2 Algorithm

Standard arguments show that our economies eventually converge to a stochastic steady-state, i.e. a long term invariant distribution of all endogenous variables in our model.[15] To obtain statistics for all endogenous variables in this stochastic steady-state, we adopt a traditional Markov chain Monte Carlo approach.[16] Specifically, our algorithm is as follows:

1. Given parameters, solve for household and intermediary policy functions for every possible aggregate state of the economy;

2. Draw a 1000-period sequence of aggregate shocks $\{\eta_t\}_{t=1}^{1000}$ using the Markov transition matrix T and record the value of all endogenous variables starting from an arbitrary value of aggregate wealth;

3. After dropping the first 100 periods, so that assumed initial conditions have at most a negligible effect on the value of endogenous variables, compute average values for all endogenous variables.

To facilitate comparisons across economies with different costs, we use the same draw of random aggregate shocks throughout our simulations. Figure 3 displays sample paths for our economy.

5.3.3 Optimal Financial policies

Figure 2 shows the intermediaries' optimal policy decisions for an economy with an intermediate level of tranching costs. A significant mass of projects is left inactive because they are unprofitable in expected value terms, regardless of the security structures used to finance them – this is the darker area in the figure, labeled $\Pi < 0$. Among activated projects, a subset is productive enough to be more profitable after issuing risk-free debt. This is the

[15]See Brock and Mirman (1972).

[16]See Tierney (1994).

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 tranching costs. For projects that do not pay enough in bad times, but pay enough in good times, the intermediary simply issues one type of security. This 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. A vertical line separating separates the tranching from non-tranching regions. That is because once a project is active, whether or not it is more profitable to tranche does not depend on z_G. Only z_B matters in this case, as can be seen by subtracting equation (2.2) from equation (2.1).

Figure 4 shows how the intermediaries' policies change when tranching costs increase from $c_0 = 0$ to $c_4 = 1$. When there are no tranching costs, all active producers tranche because $q^2 > q^1(B) + q^1(B)$, which is guaranteed by the fact that $r_2 < r_1$. As costs become strictly positive and we move from c_0 to $c_1 = 0.1$, holding wages and the amount devoted to the safe technology fixed, profits from tranching fall. This means some projects that were hitherto tranching stop doing so but continue to operate, while others stop operating altogether (those labeled *Active only for* c_0 *(tranch.)* in panel A). This releases capital and labor and puts downward pressure on wages, allowing projects that were dormant (because they had a relatively low z_B) to become profitable under the lower wage and to come online as non-tranching projects (those labeled *Active only for* c_1 *(non-tranch.)* in panel A) and re-equilibrate the capital and labor markets at a lower level of wages and capital.

This process continues as tranching costs grow further from c_1 to $c_2 = 0.34$ (panel B of Figure 4). At this point the measure of exiting projects is still larger than that of entering ones, resulting in a net decrease in active projects, as can be seen in panel A of Figure 5.

However, as tranching costs continue to grow further, from c_2 to $c_3 = 0.44$, the mass of tranching projects that stop operating dwindles (panel C of Figure 4) and is surpassed by the mass of entering projects resulting in net entry, and resulting in a non-monotonic relationship between tranching costs and active projects seen in panel A of Figure 5. Eventually, there are no exiting projects (panel D) and there are only entering (non-tranching) projects.

5.3.4 Tranching costs, output, and TFP

One of the main points we want to make in this paper is that the relationship between tranching costs, output and TFP is non-monotonic. This occurs despite the fact that securities purchases, i.e. investments in risky projects, do decrease monotonically as tranching costs rise (panel B of figure 5). As a matter of accounting, capital formation (i.e. the mass of active projects) equals security purchases minus the sum of tranching expenditures and intermediary/manager rents. Panels A, B, E, and F show these four variables. The behavior of tranching expenditures is the dominant cause of non-monotonicity. Initially, the overall mass of tranching projects falls monotonically with tranching costs (the darker area in panel A of Figure 5). At the same time, spending on tranching costs also rise, as tranching expenditures go from zero to strictly positive. Both effects lead to less capital formation i.e. a decreasing mass of active projects. But eventually, the fact that ever fewer projects choose to tranche leads to a sharp decrease in tranching expenditures, which more than offsets the fall in gross investment, and allows the mass of active projects to rise.

To understand the stark inverse relationship between output and average TFP as tranching costs rise that is shown in panels A and C of Figure 7 it is instructive to think of output as the product of the measure of active projects and average TFP, or in terms of the relationship between $\bar{z}$ and K in equation (3.1). Going back to the above discussion of how intermediaries' policies change as tranching costs rise in Figure 4, note that the set of entering (non-tranching) projects have higher productivity in good times and lower productivity in bad times compared to the exiting (tranching) ones and to the average operating project. Because good times are more frequent than bad times under our parameterization of T, this means that initially, the average TFP is increasing as tranching costs rise, as shown in panel C of Figure 7. Nonetheless, project output is falling in this range (panel A of Figure 7), because the fall in the measure of projects outweighs the average TFP increase. As tranching costs continue to rise average TFP eventually starts falling as the net entering project becomes less productive than average. Nonetheless, because net entrance is positive and the measure of operating projects increases enough, output also increases, as the extensive margin once again dominates.

Panels B and D of Figure 6 show overall GDP (defined as project output plus safe output) and the measured productivity of capital as defined by overall GDP divided by total wealth (which in our model also equals investment). Both measures exhibit a non-monotonic relationship with tranching costs. The non-monotonicity in GDP is driven by the non-monotonicity in project output we covered above.

These qualitative findings are not sensitive to even drastic change in the shape of the producer talent distribution, as figure 6 shows. The main quantitative effect of making talent dispersion higher is that rents and tranching expenditures become higher but the overall relationship between tranching costs and endogenous variables is robust.

5.3.5 Financial engineering and economic development: a new perspective

Figure 8 summarizes the quantitative connection between financial activities as we have modeled them in this paper and economic development. As the ratio of spending on securities to project output rises, output measures (whether project output or GDP broadly defined) initially fall. At high levels of securitization – once securitization becomes essentially free – output does begin rising. In addition to being non-monotonic, the impact of even large increases in securitization activities is also small. Productivity is, likewise, relatively flat across economies with varying levels of securitization. As we have discussed above, it also shows a negative relationship with output. This is because when greater securitization does lead to more capital formation, it also tends to lead to the activation of relatively low productivity projects.

Figure 8 shows the relationship between finance and development for economies that differ in terms of the dispersion of producer talent, after adjusting the mean so that the average level of talent is the same across economies. The same relatively flat and non-monotonic pattern holds for all three economies.

On the other hand, variations in financial development caused by fundamental differences in average plant TFP levels across countries are associated with potentially big output effects in our model like in traditional models. Figure 9 illustrates this by showing the outcome of considering three levels of dispersion in talent but without adjusting the mean so that, as a result of the truncation, more dispersion now implies more talented producers on average. Now the high dispersion-high talent economy does display more intermediation and higher output and TFP. This experiment corresponds to the traditional "Enterprise leads, finance follows" view of financial development associated with Robinson (1952). Richer economies have more activity hence more intermediation. Across subgroups of economies a strong positive correlation between finance and development emerges. But within homogenous economies – among economies with similar real fundamentals – securitization booms do not give big output effects. In fact, they may well lower output.

6 Conclusion

This paper shows that by allowing producers (or intermediaries) to create securities that appeal to investors with heterogenous tastes, financial engineering leads to more investment, which accords well with intuition. Less intuitive however is the fact that the resulting securitization boom may not lead to increases in output, capital formation and TFP. Much of the spending on engineered securities may be dissipated into securitization costs and producer or intermediary rents. We view this as a natural explanation for the fact that the impact of financial development on economic development is weak at best in economies with already well developed financial markets.

In this sense, it seems appropriate to think of financial development as consisting of two phases.[17] In low-income economies, institutional gains and the resulting gains in financial activity enables productive but previously constrained producers to become active and/or operate more effectively. This causes development gains as has been emphasized by the traditional literature on financial development. While the size of those gains may be a matter of debate,[18] there is no disagreement on the direction of the effect during this initial phase of financial development.

Once higher levels of financial developments are reached and markets function well, financial innovation tends to take the form of repackaging of fundamental cash-flows to create securities that appeal to the tastes of heterogenous investors. Not only do we find the output and productivity effects of this second phase to be small, they may in fact be negative.

[17] This dichotomous view of financial development has a counterpart in the model of Acemoglu, Aghion, and Zilibotti (2006) in which, in a nutshell, economic development consists first of harvesting low-hanging fruits but becomes tougher to sustain ones obvious growth opportunities have been implemented.

[18] See the contrasting views of Midrigan and Xu (2014) on one side and Moll (2014) and Amaral and Quintin (2006), on the other.

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Figure 1: **Productivity distribution**

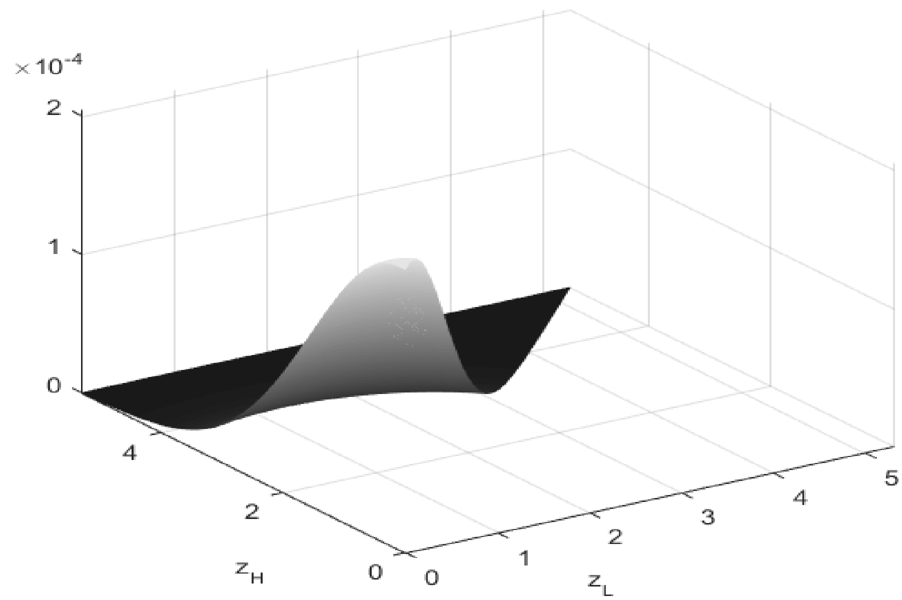

Figure 2: **Intermediaries' policies**

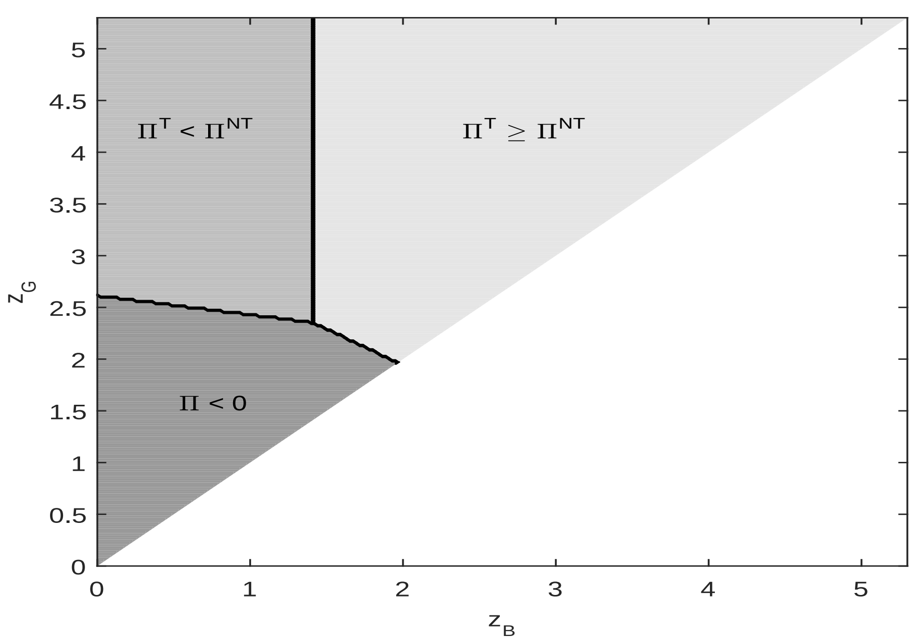

Figure 3: **Simulating illustrative example economies**

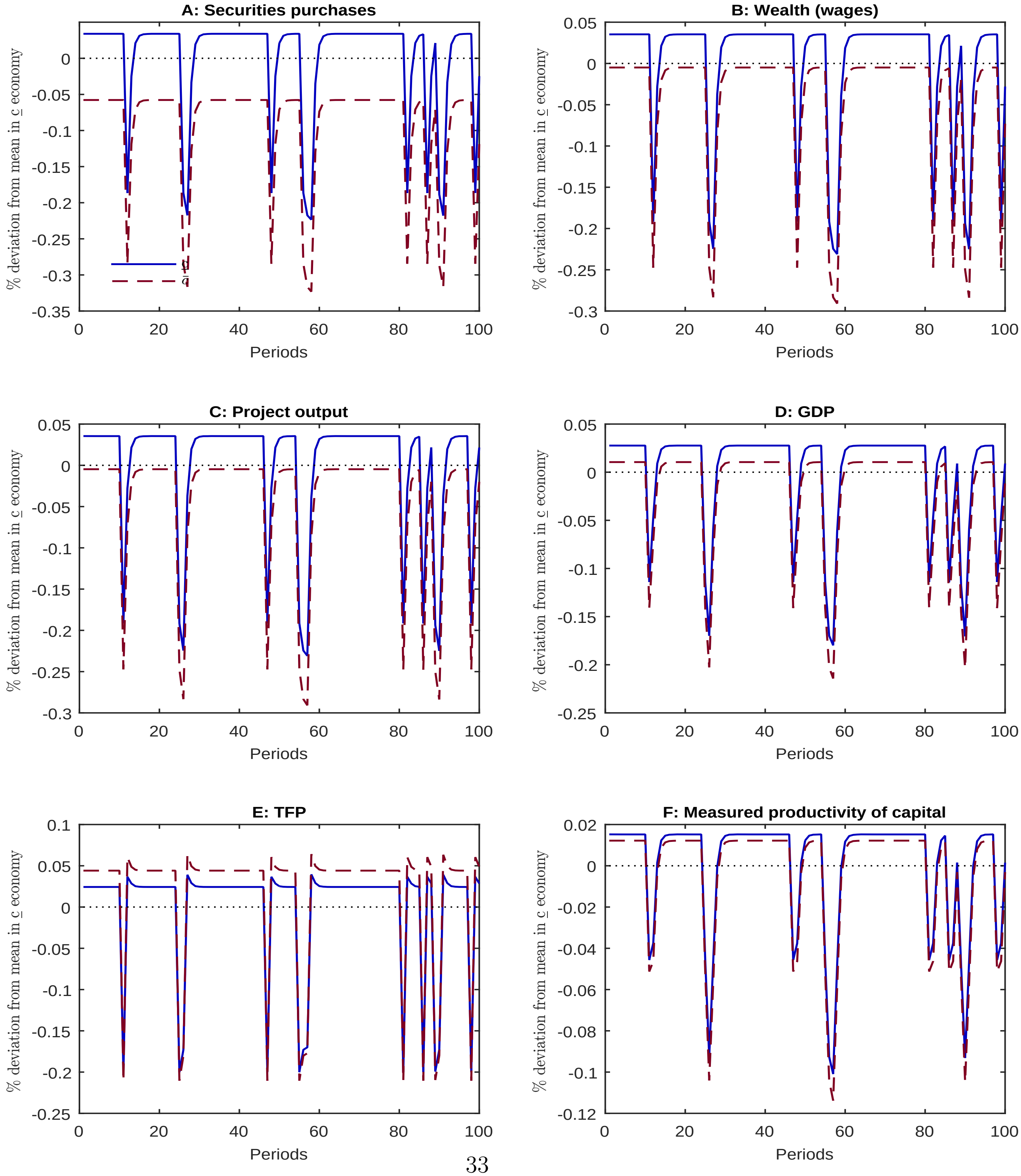

Figure 4: **Changing tranching costs**

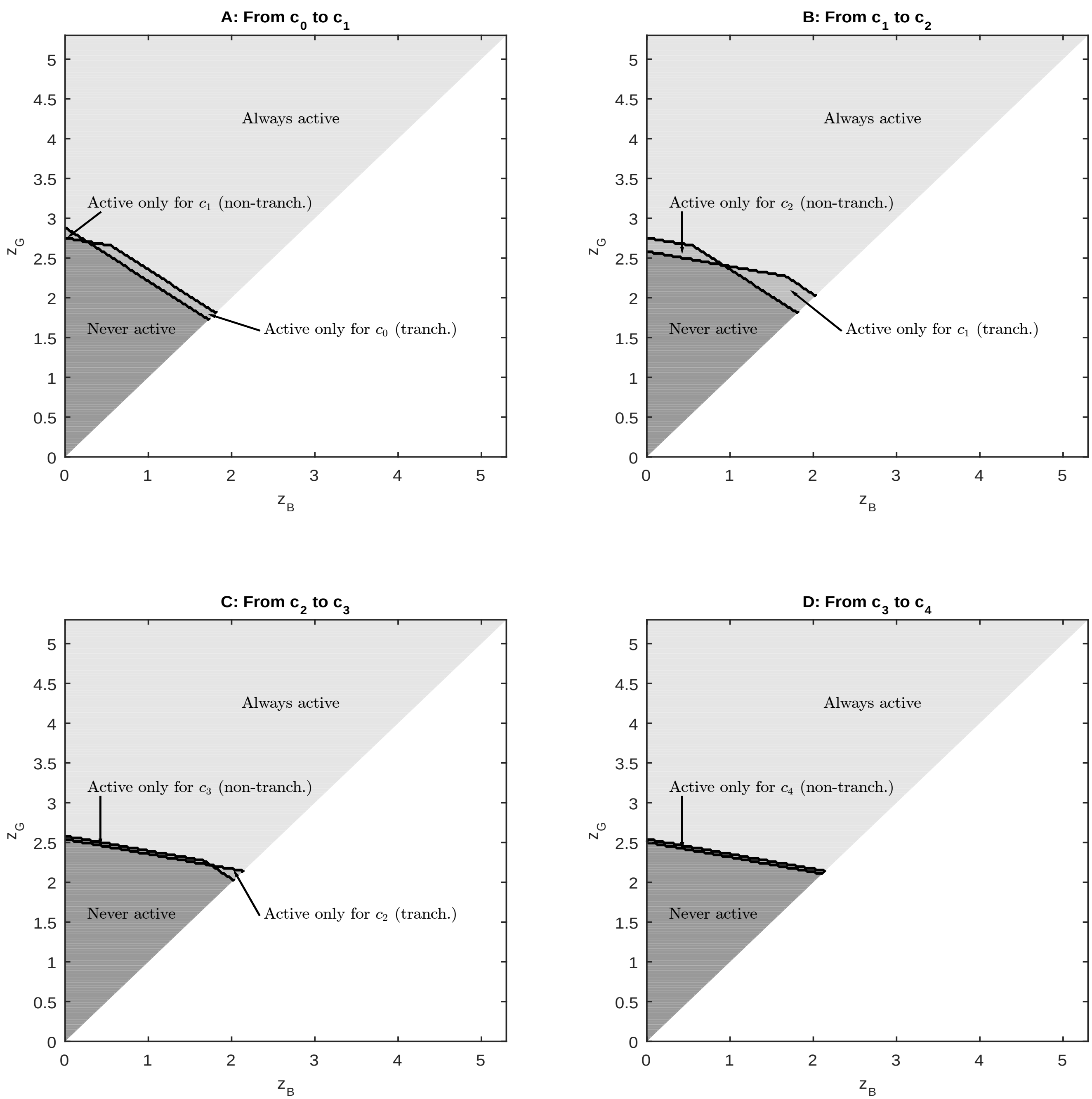

Figure 5: **Varying tranching costs: outcomes I**

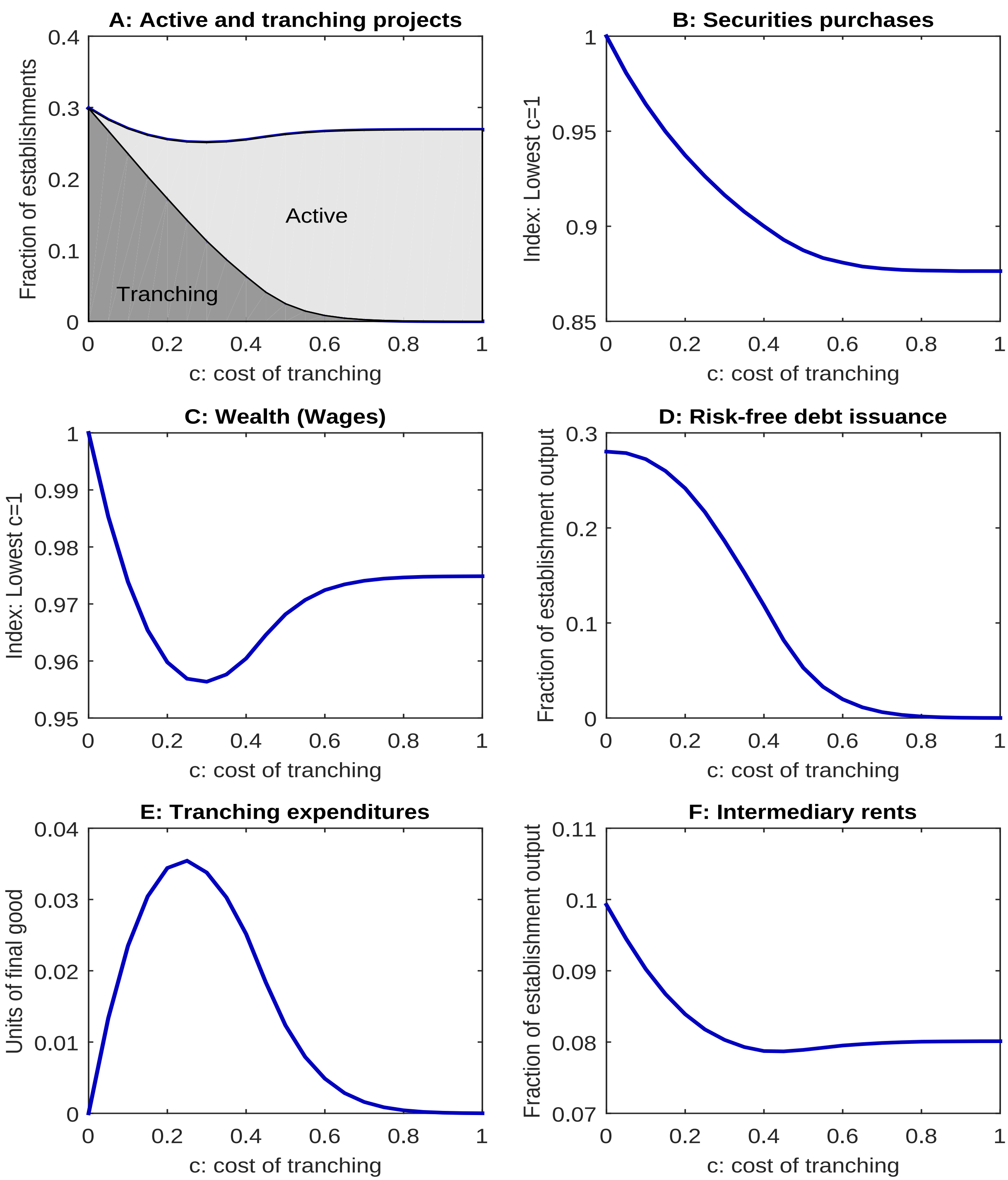

Figure 6: **Varying tranching costs: outcomes I, different talent dispersion**

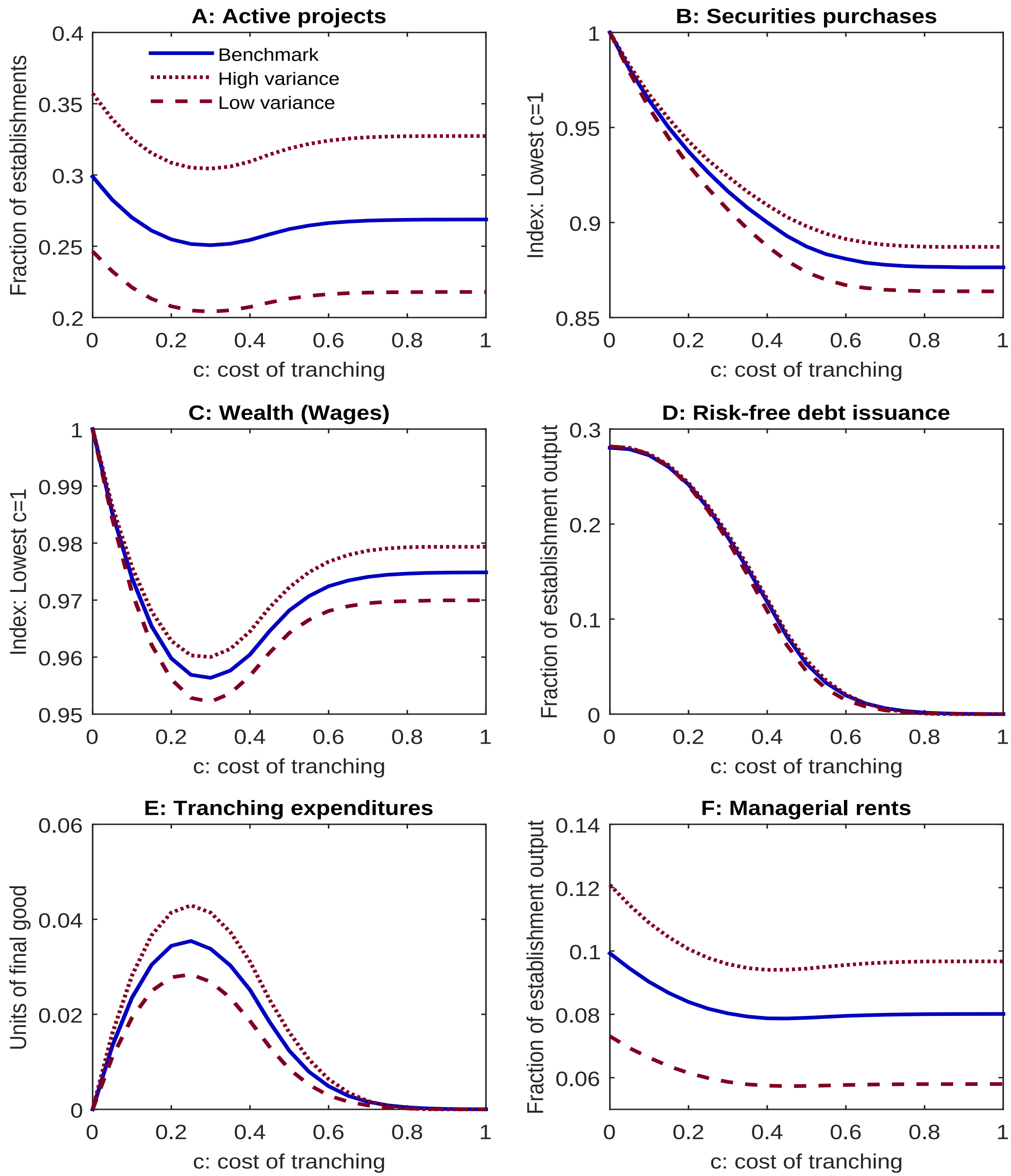

Figure 7: **Varying tranching costs: outcomes II**

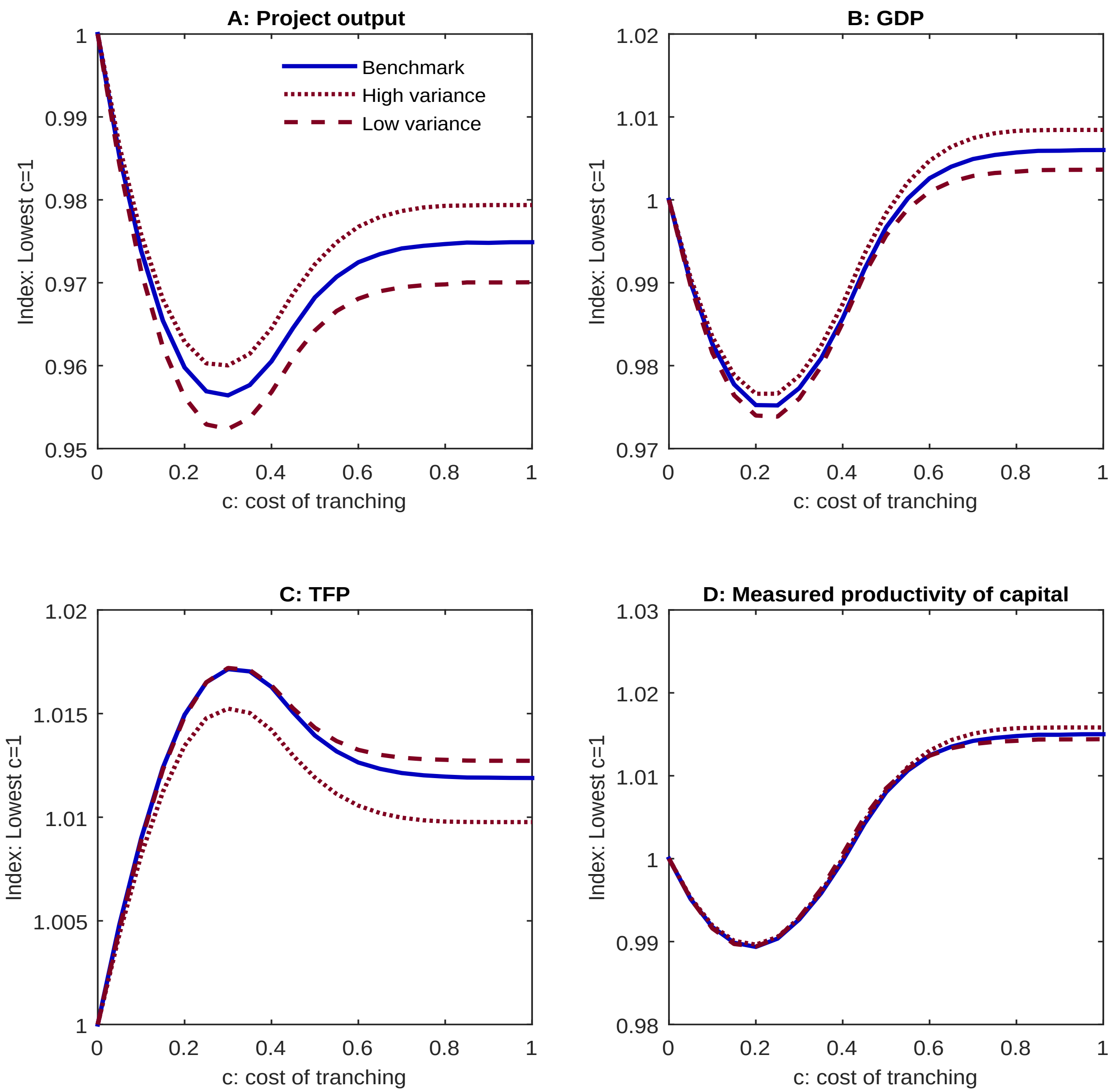

Figure 8: **Spending on securities and economic development**

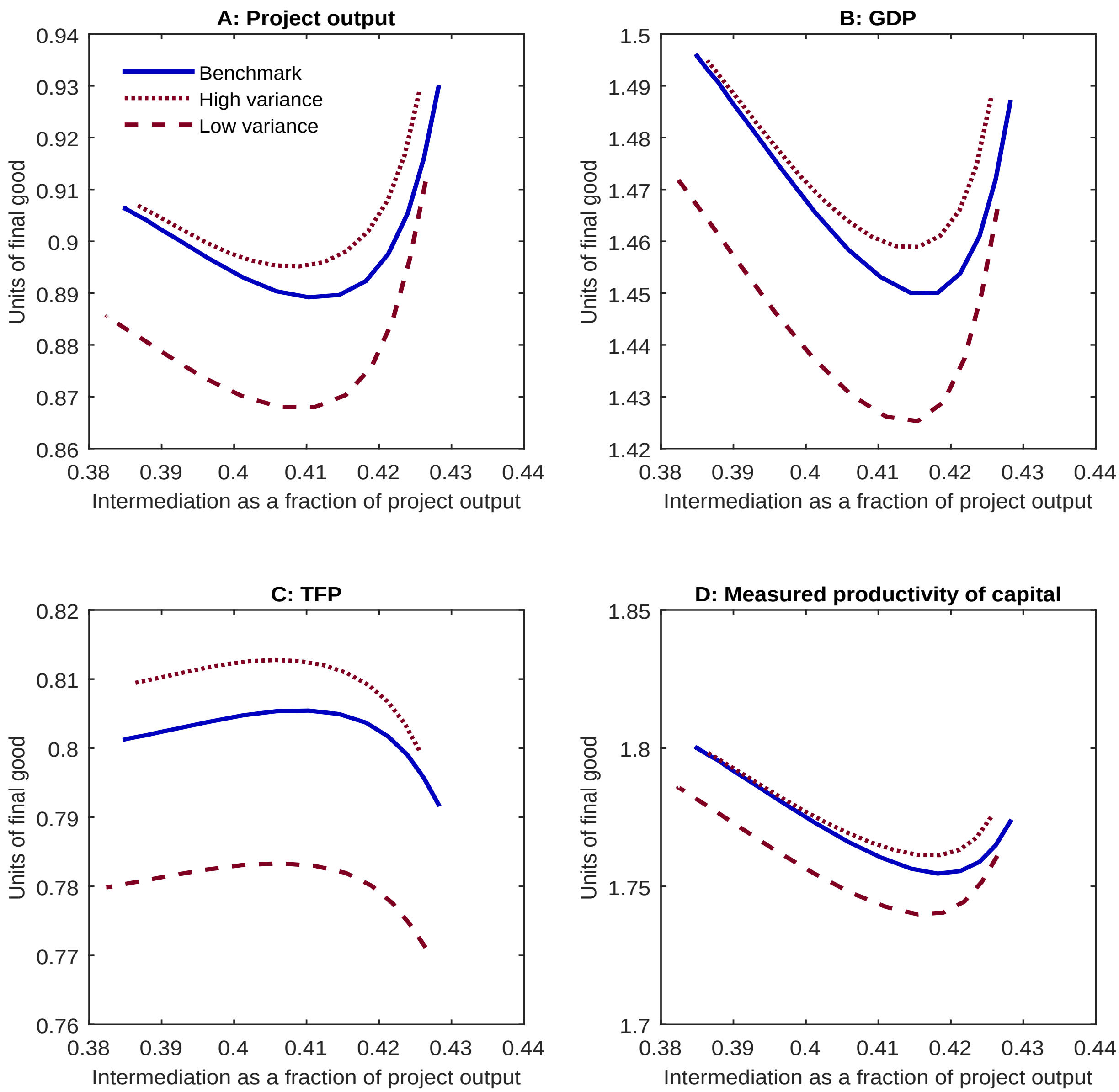

Figure 9: **Enterprise leads, finance follows**