The Joint Determination of TFP and Financial Sector Size

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Summary *(1/2)*

Summary (2/2)

- Effects of the destruction rate
- Effects of the bargaining power
- The degree of product market efficiency
- Example
- TFP and the size of the financial sector
- Conclusions

Introduction

- Misallocation of resources to explain TFP differences across countries.
  - Extensive Margin (too many firms)
  - Intensive Margin (bad firms using too many resources)

  - Hopenhayn..., HsiehKlenow09, RestucciaRogerson08, etc.

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- Search Frictions for modeling non-Walrasian features of investment markets
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  - Information frictions, time usage, creditor-borrower relationships...

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- We build a model of **Misallocation**
  - **Endogenizing** the degree of imperfections in **Capital Markets**
  - via **Search frictions**

Contribution I

- We impose aggregate resource constraints on
  - Capital, and
  - Human Resources
    - for financial intermediation
    - or directly productive activities

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    - A Sacrifice:
      - Resources not used in directly productive activities.
    - A Gain:
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- **Irrelevance of Capital Abundance.** For financial sector size.

Contribution II

Bidirectional relationship between efficiency of finance and production sectors.

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- Credit Market Frictions

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  - Underliying differences in **Product Market Efficiency**

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- To explain cross countries differences in Productivities and GDP (TFP):
  - Underliying differences in **Product Market Efficiency**

- Rich countries are rich **and have a larger financial sector** because they have more efficient **product markets**
  - Not because more efficient financial sector.

Model: General Environment

Two Markets (rooms):

- **Deposit Market:**
  - Walrasian.
  - market return r.
  - Inelastic supply $\bar{k}$
- **Investment Market:**
  - time to find finance.
  - Search frictions
  - heterogeneous projects
  - specific evaluators
    - $\sim$ different beliefs

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Two Professions:

- **Entrepreneurs:**
  - Access to Production projects.
    - $a \sim G(a)$ uncertain.
    - Project: $F(k, a, Y)$
  - No access to capital.
- **Brokers:**
  - Access to Deposit Room
  - Needed for revealing a
  - Only acts at firm formation.

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$\boxed{\text{Entrepreneurs}}$	$\Leftrightarrow$	$\boxed{\text{Brokers}}$	$\Leftrightarrow$	$\boxed{\text{K Owners}}$
	$\uparrow$		$\uparrow$	
	Investment Market		Deposit Market	

Production Function

- $F(k; a, Y)$
  - $F_k(k; a, Y) > 0$, $F_a(k; a, Y) > 0$, $F_{ka}(k; a, Y) > 0$, $F_{kk}(k; a, Y) < 0$
  - Y measure of aggregate demand or market size.
    - We may well have $F_Y = 0$ (neoclassical)
- Each unit of capital gets rent r
- Profit generated by a project
  - $\pi(a, r, Y) = \max_k \{F(k, a, Y) - rk\}$,
  - Capital demand $k^d(a, r)$.
- $F(k, a, Y)$ is log linear in k, a, and Y

$$\begin{aligned}\pi(a, r, Y) &= (1 - e_k)\, e_k^{\frac{e_k}{1-e_k}}\, a^{\frac{e_a}{1-e_k}}\, r^{-\frac{e_k}{1-e_k}}\, Y^{\frac{e_y}{1-e_k}} \\ \frac{rk^d(a, r, Y)}{\pi(a, r, Y)} &= \frac{e_k}{1 - e_k}\end{aligned}$$

  - e_k, e_a and e_y are the (constant) elasticities.

Frictions in the credit market

- Brokers ease frictions in the market
  - the more there are,
    - the less time it takes for a manager to obtain funding.
  - Resource constraint:
    - If they are brokers, they are not entrepreneurs.

- A broker may have relationships with many entreps.
  - Once she meets an entrep. move on to look for another.

- Tightness: $\theta = \dfrac{\text{mass of searching entrepreneurs}}{\text{mass of brokers}}$

- Rate at which entreps. meet brokers: $p(\theta, \nu)$, $\frac{\partial p(\theta,\nu)}{\partial \theta} < 0$
  - e.g., with ν an exog. efficiency parameter $p(\theta, \nu) = \nu\theta^{-\alpha}$

- CRS matching: for brokers $\theta p(\theta, \nu)$

- Jointly learn productivity (a)
  - Threshold productivity b

Bellman Equations

- Death rate δ equals discount (and replacement)

- Entrepreneurs. Two states:

$$
\begin{aligned}
\delta V_0 &= p(\theta) \int_b^\infty [V_1(a) - V_0]\, dG(a) \\
\delta V_1(a, r, Y) &= \pi(a, r, Y) - \rho(a, r, Y)
\end{aligned}
$$

  - $\rho(a, r) \equiv$ annuity of the payment to broker.

- continuation value of being a broker (B) solves:

$$
\delta B = \theta p(\theta) \int_b^\infty \Gamma(a)\, dG(a),
$$

with $\Gamma(a) = \frac{\rho(a,r,Y)}{\delta}$.

- If $a > b$: Bilateral Monopoly. Nash bargaining
  - entreps.' bargaining weight $\beta \in (0,1)$

$$\begin{aligned} \beta S(a) &= V_1(a) - V_0 \\ (1-\beta) S(a) &= \Gamma(a) \end{aligned}$$

- Outside options
  - Broker: zero
    - No satiation
    - Looks for new customer indep. of bargaining result.
  - Entrepreneur: Get new project
    - can NOT use the info acquired from broker.
    - Bargain on "schedule" ex-ante.
- This gives payment: $\rho(a, r, Y) = (1-\beta)\{\pi(a, r, Y) - \delta V_0\}$
- Broker accesses deposit market & extracts capital for project.
  - The **efficient** capital demand.

Bargaining *(2/2)*

- $V_0 \equiv$ PDV of future income.

$$\delta V_0 = \frac{p(\theta)\,[1-G(b)]}{\delta + p(\theta)\,[1-G(b)]} \times \frac{\frac{\beta}{1-\beta}}{\frac{\beta}{1-\beta} + \frac{\delta}{\delta+p(\theta)[1-G(b)]}} \times \int_b^\infty \pi(a,r,Y)\frac{dG(b)}{1-G(b)} \tag{1}$$

- $\left(\frac{\delta}{\delta+p(\theta)[1-G(b)]}\right)$ percentage of time searching
- $\left(\int_b^\infty \pi(a,r,Y)\frac{dG(b)}{1-G(b)}\right)$ expected income flow of project with $a > b$.
- $\left(\frac{\frac{\beta}{1-\beta}}{\frac{\beta}{1-\beta}+\frac{\delta}{\delta+p(\theta)[1-G(b)]}}\right)$ share of this income for entrepreneur.
- The value of a broker:

$$\delta B = \frac{\theta p(\theta)[1-G(b)]}{\delta + \theta p(\theta)[1-G(b)]} \frac{\frac{1-\beta}{\beta}}{\frac{1-\beta}{\beta} + \frac{\delta}{\delta+\theta p(\theta)[1-G(b)]}} \times \int_b^\infty \pi(a,r,Y)\frac{dG(b)}{1-G(b)}$$

Equilibrium Conditions

- $m \equiv$ number of entrepreneurs.

- endogenous variables: $\{\theta, m, r, b, Y\}$.

- The equilibrium conditions:
  - **Human Resource Constraint**: $\theta = \frac{\text{searching entrep}}{1-m}$
  - **No Arbitrage between professions**: $V_0 = B$
  - **Threshold of Productivity**: $b : S(b) = 0$
  - **Capital Market Clearing**: $K^d(r, b, m) = \bar{k}$
  - **Output determination** Aggregate demand equals output.

Human Resource Constraint

- $\theta = \frac{\delta}{\delta + p(\theta)[1-G(b)]} \frac{m}{1-m}$. Substituting:

$$1 - m = \frac{\delta}{\theta \left[\delta + p(\theta, \nu)\left(1 - G(b)\right)\right] + \delta}$$

- more human resources devoted to financial activities $\Rightarrow$ larger b.

- Given θ, if b increases, the number of rejections also increases,
  - the share of *searching* entrepreneurs also increases,
  - increase in size of the financial sector to keep θ constant.

- Larger financial sector allows society to be pickier in quality of projects

  Finance does not produce output directly,
  - Allows to improve productivity of firms
  - by reducing the opportunity cost of searching for better projects.

No Arbitrage between professions

No arbitrage between professions pins down credit market tightness

$$\boxed{V_0 = B \quad \Rightarrow \quad \theta = \frac{\beta}{(1-\beta)}}$$

- θ depends only on the bargaining power. Independent of b
- Entrepreneur and broker care only about **expected** incomes.
  - Time searching compensates for **share** of the deal
  - Independently of **size** of the deal
- More (β), better for entrep.
  - Longer search to equalize value across activities.
- 2 ways of decreasing θ (ratio searching entrepreneurs to brokers).
  - Increasing the number of brokers (more finance/GDP)
  - Increasing the threshold of productivity
    - Smaller numerator via more rejections.

Threshold of Productivity *(1/2)*

- b : $\quad S(b) = 0 \quad \Leftrightarrow \quad \delta V_1(b) = \delta V_0$
  - because continuation value of broker independent of events in match

$$\delta V_1(a) = \delta V_0 + \beta \left[\pi(a, r, Y) - \delta V_0\right]$$

- projects accepted if profits that they generate are larger than the value of going back into search.

- b is such that $\pi(b, r, Y) = \delta V_0$

$$\frac{\pi(b, r, Y)}{\int_b^\infty \pi(a, r, Y) \frac{dG(b)}{1 - G(b)}} = \frac{p(\theta)\left[1 - G(b)\right]}{\delta + p(\theta)\left[1 - G(b)\right]} \times \frac{\frac{\beta}{1-\beta}}{\frac{\beta}{1-\beta} + \frac{\delta}{\delta + p(\theta)[1 - G(b)]}}$$

- $$\frac{\pi(b,r,Y)}{\int_b^\infty \pi(a,r,Y)\frac{dG(b)}{1-G(b)}} = \frac{p(\theta)[1-G(b)]}{\delta+p(\theta)[1-G(b)]} \times \frac{\frac{\beta}{1-\beta}}{\frac{\beta}{1-\beta}+\frac{\delta}{\delta+p(\theta)[1-G(b)]}}$$

- RHS: PDV of the share of the income that goes to the entrepreneurs.
  - decreasing in b, and equals zero as it approaches its upper limit.

- LHS: **ratio of marginal to average profits.**

$$H(b,\epsilon) \equiv \frac{\pi\,(b,r,Y)}{\int_b^\infty \pi\,(a,r,Y)\,\frac{dG(a)}{1-G(b)}} = \frac{(b)^\epsilon}{\int_b^\infty (a)^\epsilon\,\frac{dG(a)}{1-G(b)}} \in (0,1)$$

where ϵ is the elasticity of profits to a: $\epsilon = \frac{e_a}{1-e_k}$

- Intuitive $H(b,\epsilon)$ to be non-decreasing in b. Thus, assumption on $G(.)$
  - H is a non-decreasing function of b: $\frac{\partial H(b,\epsilon)}{\partial b} \geq 0$
  - Includes many (if not all) of the commonly used distributions.

- $K^d(r, b, m) = \bar{k}$.

$$\frac{p(\theta)[1 - G(b)]}{\delta + p(\theta)[1 - G(b)]} m \int_b^{\infty} k^d(a, r) \frac{dG(a)}{1 - G(b)} = \bar{k}$$

$$\frac{p(\theta)[1 - G(b)]}{\delta + p(\theta)[1 - G(b)]} m \int_b^{\infty} \frac{e_k}{1 - e_k} \pi(a, r, Y) \frac{dG(a)}{1 - G(b)} = r\bar{k} \tag{2}$$

Output determination

- average lifetime income equals the annuity of the profit of the marginal firm: $\delta V_0 = \pi(b, r)$

$$\delta V_0 = \frac{\beta p(\theta)[1 - G(b)]}{\delta + \beta p(\theta)[1 - G(b)]} \int_b^\infty \pi(a, r) \frac{dG(a)}{1 - G(b)} \tag{3}$$

$$Y = r\bar{k} + \frac{1}{\delta}\pi(b, r, Y) \tag{4}$$

Equilibrium Characterization and Solution *(1/2)*

The solution algorithm:

- Arbitrage pins down θ.
- Optimal Threshold pins b
- $1 - m$ is obtained from the human resource constraint
- r and Y are residuals

Result: *The threshold of productivity b is the unique solution of:*

$$\frac{(b)^{\epsilon}}{\int_b^{\infty}(a)^{\epsilon}\frac{dG(a)}{1-G(b)}} = \frac{p(\theta,\nu)\,[1-G(b)]}{\delta + p(\theta,\nu)\,[1-G(b)]} \times \frac{\frac{\beta}{1-\beta}}{\frac{\beta}{1-\beta} + \frac{\delta}{\delta + p(\theta,\nu)[1-G(b)]}} \tag{5}$$

Result: *Given the value of b determined in result . The number of brokers in the economy (and the share of finance in GDP) is:*

$$1 - m = (1-\beta)\,(1 - H(b,\epsilon)) \tag{6}$$

Result: *Given b from result*

$$\begin{aligned} r\bar{k} &= \frac{e_k}{1-e_k}\pi(b,r,Y) \\ Y &= \left[\frac{e_k}{1-e_k} + \frac{1}{\delta}\right]\pi(b,r,Y) \end{aligned} \tag{7}$$

Furthermore, **both r and Y are maximized whenever b is maximum**

Capital Irrelevance

Result: *The allocative decisions of the economy θ, m and b are independent of $\bar{k}$.*

- To have more or less K (and thus r) does not affect the marginal to average profit ratio ($H(b, \epsilon)$),
- correlation across countries of income and financial sector size
  - can not be simply because relative capital abundance.

Effects of frictions in the investment sector

Result: *b and output are both increasing in the efficiency of the search process in the investment sector (ν). Furthermore, as ν approaches infinity the limit of b is its maximum possible value (or infinity if it is unbounded).*

The number of brokers, $(1 - m)$ is decreasing with ν.

- Less frictions, More picky
  - smaller opportunity cost of back to search.
- Less frictions, Less brokers
  - They are not needed. Few get many matches.
- Walrasian Limit: $b = \bar{a}$, $m = 1$

Effects of the destruction rate

Result: *b is not increasing in δ, and strictly* **decreasing** *if $H(b,\epsilon)$ is strictly increasing in b.*

The number of entrepreneurs does no decrease with δ, and strictly **increase** *if $H(b,\epsilon)$ is strictly increasing in b.*

- Less time before death ($\uparrow \delta$). Less picky
- but increase in brokers... because many newborns.
- Large destruction rate demands large finance sector.

Effects of the bargaining power

Result: *There exists a value of β called $\widehat{\beta}$: $1-\widehat{\beta} = -\frac{\theta}{p(\theta,\nu)}\frac{\partial p(\theta,\nu)}{\partial \theta}$ such that $\widehat{\beta}$ maximizes b (and thus, Y). If $\beta < \widehat{\beta} \rightarrow \frac{db}{d\beta} > 0$, and if $\beta > \widehat{\beta} \rightarrow \frac{db}{d\beta} < 0$.*

An increase of β decreases $1-m$ if $\beta < \widehat{\beta}$. If the value of β is much larger than $\widehat{\beta}$, it is possible than an increase of β might increase $1-m$

- β, contractual arrangements...

- β has two effects:
  - More "share" to entrep.
  - but increases her waiting time.
    - Get later
    - and less (outside option)

- like HOSIOS... it IS Hosios.
  - Congestion in search pool, interiorized if $\beta = \widehat{\beta}$

The degree of product market efficiency *(1/3)*

Result: *The minimum productivity threshold b (and consequently Y) are increasing in the elasticity of profits to talent (ϵ), irrespectively of the shape of $H(b, \epsilon)$.*

The number of brokers increases with ϵ.

- Productivity more important.
  - You are more picky about the quality of the projects you start.
  - More option value of looking for a better project.

- More picky. More projects rejected.

- More *searching* entrepreneurs

- More Brokers to service them (θ constant)

- Consider tax and transfer scheme (Benabou, 2002). The net profits of a firm are:

$$\hat{\pi}(a,r) = \pi(a,r)^{1-\tau}\,\tilde{\pi}^{\tau}$$

  - τ : measures progressive redistribution between efficient and non-efficient firms
  - $\tilde{\pi}$ is perceived by the agents as lump-sum

- Clearly, balanced budget requires:

$$\int_b^{\infty} \pi(a,r)\frac{dG(a)}{1-G(b)} = \int_b^{\infty} \hat{\pi}(a,r)\frac{dG(a)}{1-G(b)}$$

- In our environment τ measures allocative inefficiencies in the economy.
  - Higher τ transfers profitability from efficient to inefficient firms

- τ decreases elasticity of profits to productivity:

$$H(b,\epsilon,\tau) = \frac{\hat{\pi}(b,r)}{\int_b^\infty \hat{\pi}(a,r)\frac{dG(a)}{1-G(b)}} = \frac{(b)^{\epsilon(1-\tau)}}{\int_b^\infty a^{\epsilon(1-\tau)}\frac{dG(a)}{1-G(b)}}$$

Result: *A decrease of the allocative inefficiencies of the product sector (decrease of τ) produces larger steady state values of b and Y and a decrease of m*

- More efficient treatment of firms. More Picky

- ... and more brokers.

- $F(a, K, Y) = 2\sqrt{aK}$
- $1 - \tau$ measures the efficiency of the productive sector.
- a follows a Pareto with minimum value $\underline{a}$ and parameter γ

$$\pi(a,r) = \frac{a}{r}; \quad k^d(a,r) = \frac{a}{r^2}; \quad \hat{\pi}(a,r) = \left(\frac{a}{r}\right)^{1-\tau} \tilde{\pi}^{\tau}; \quad \tilde{\pi} = \left(\frac{\gamma - (1-\tau)}{\gamma - 1}\right)^{\frac{1}{\tau}} b$$

$$\left(H(b, 1-\tau) = \frac{\gamma - (1-\tau)}{\gamma}\right)$$

Example *(2/4)*

Result:

There exists a level of taxes $\tilde{\tau} = \dfrac{1-(\gamma-1)\frac{1}{\beta}\frac{\delta}{p(\frac{\beta}{1-\beta},\nu)}}{1+\frac{1}{\beta}\frac{\delta}{p\left(\frac{\beta}{1-\beta},\nu\right)}} \in (0,1)$ *such that*

$$\begin{aligned}
1-G(b) &= \begin{cases} 1+\frac{1}{\beta}\frac{\delta}{p\left(\frac{\beta}{1-\beta},\nu\right)}\frac{\tau+\gamma-1}{1-\tau} & if \quad \tau \leq \tilde{\tau} \\ 1 & if \quad \tilde{\tau} \leq \tau \end{cases} \\
b &= \begin{cases} \underline{a}\left[\beta^{\frac{p\left(\frac{\beta}{1-\beta},\nu\right)}{\delta}}\frac{1-\tau}{\tau+\gamma-1}\right]^{\frac{1}{\gamma}} & if \quad \tau \leq \tilde{\tau} \\ \underline{a} & if \quad \tilde{\tau} \leq \tau \end{cases} \qquad (8) \\
1-m &= \begin{cases} (1-\beta)\frac{1-\tau}{\gamma} & if \quad \tau \leq \tilde{\tau} \\ (1-\beta)\frac{1}{1+\beta^{\frac{p\left(\frac{\beta}{1-\beta},\nu\right)}{\delta}}} & if \quad \tilde{\tau} \leq \tau \end{cases}
\end{aligned}$$

From where TFP, r and income:

$$A = \begin{cases} b\left(1+\frac{\tau}{\gamma-1}\right) = \underline{a}\left[\beta^{\frac{p\left(\frac{\beta}{1-\beta},\nu\right)}{\delta}}\frac{1-\tau}{\tau+\gamma-1}\right]^{\frac{1}{\gamma}}\left(1+\frac{\tau}{\gamma-1}\right) & if \quad \tau \leq \tilde{\tau} \\ \underline{a}\,\frac{\gamma}{\gamma-1}\frac{\beta^{\frac{p\left(\frac{\beta}{1-\beta},\nu\right)}{\delta}}}{1+\beta^{\frac{p\left(\frac{\beta}{1-\beta},\nu\right)}{\delta}}} & if \quad \tilde{\tau} \leq \tau \end{cases}$$

$$\begin{aligned} r &= \frac{\sqrt{A}}{\sqrt{\bar{k}}} \\ Y &= 2\sqrt{A}\sqrt{\bar{k}} \end{aligned}$$

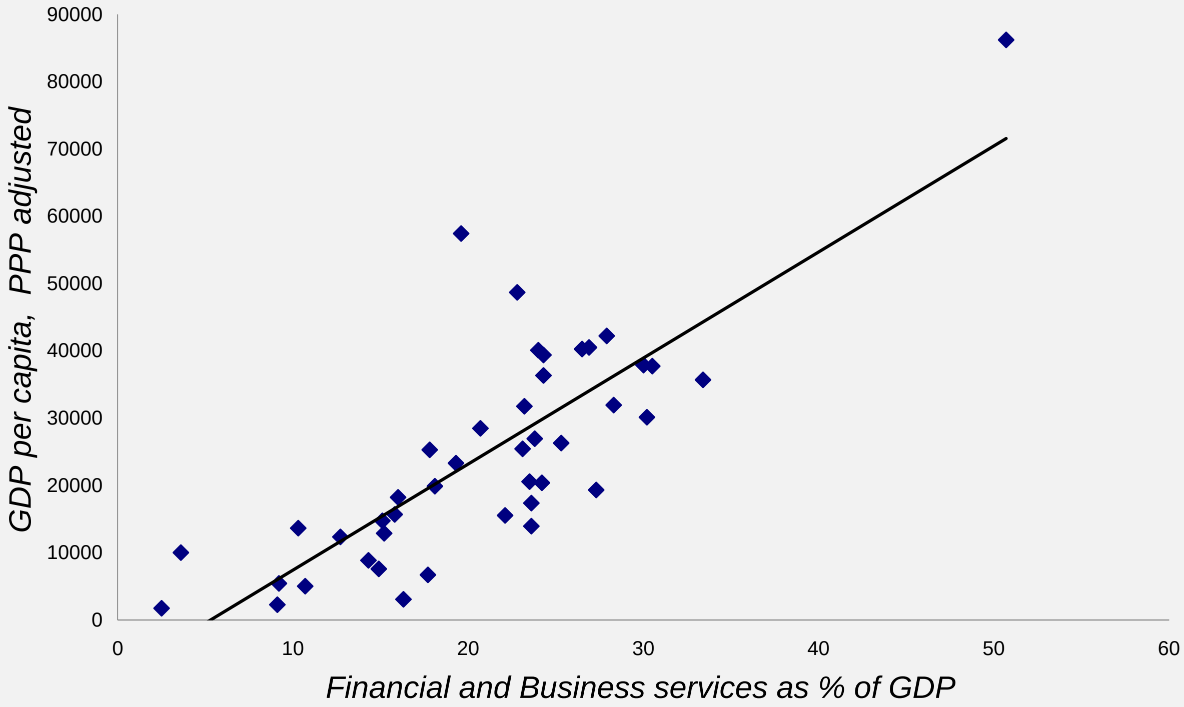
Example (4/4)

$$A = \begin{cases} b\left(1+\frac{\tau}{\gamma-1}\right) = \underline{a}\left[\beta^{\frac{p\left(\frac{\beta}{1-\beta},\nu\right)}{\delta}}\frac{1-\tau}{\tau+\gamma-1}\right]^{\frac{1}{\gamma}}\left(1+\frac{\tau}{\gamma-1}\right) & if \quad \tau \leq \tilde{\tau} \\ \underline{a}\,\frac{\gamma}{\gamma-1}\frac{\beta^{\frac{p\left(\frac{\beta}{1-\beta},\nu\right)}{\delta}}}{1+\beta^{\frac{p\left(\frac{\beta}{1-\beta},\nu\right)}{\delta}}} & if \quad \tilde{\tau} \leq \tau \end{cases}$$

- Less frictions in finance, $\uparrow \nu \;\rightarrow \uparrow A$ via two different mechanisms.
  - More efficient firms ($\uparrow b$),
  - but also makes them smaller ($\uparrow m$) $\rightarrow \uparrow$ productivity of capital.
- More efficient product sector ($\downarrow \tau$): effects in opposite directions.
  - $\uparrow b \Rightarrow \uparrow A$ via selection.
  - But, $\downarrow m \;\Rightarrow$ Larger firms $\Rightarrow$ More capital per firm $\Rightarrow \downarrow A$
  - First effect dominates, **always**.

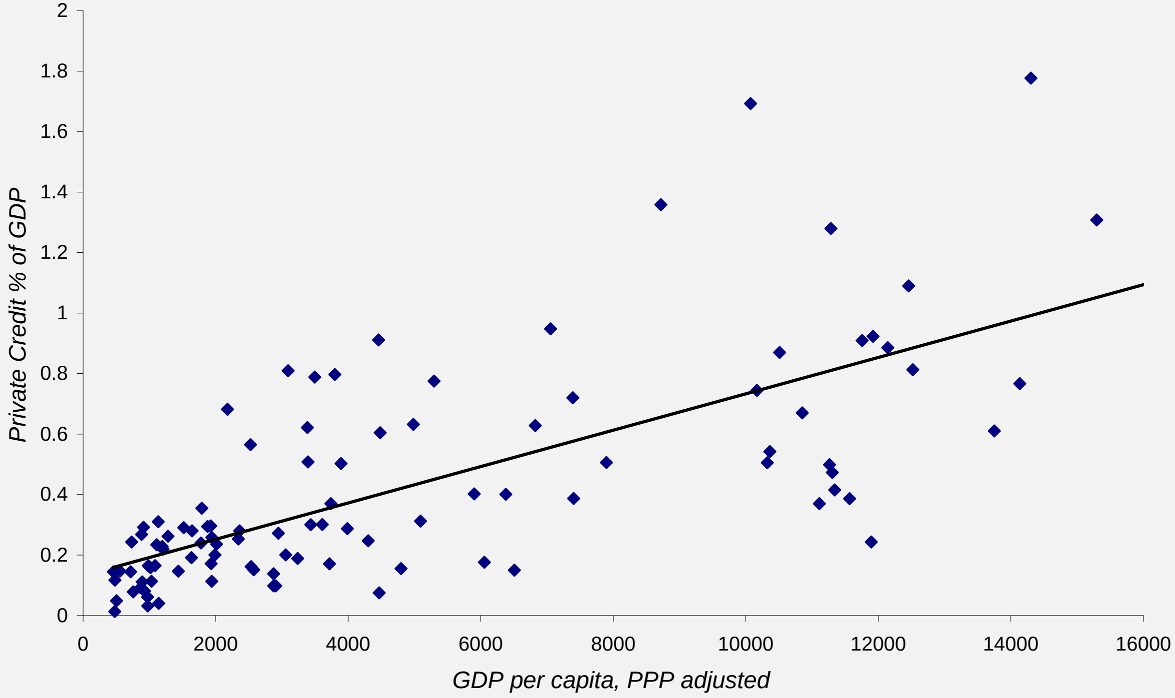
- Cross country evidence: Positive correlation $(1 - m)$ with A.

- Traditional Explanation: Shchumpeterian, King and Levine (1993)
  - Better finance, more growth



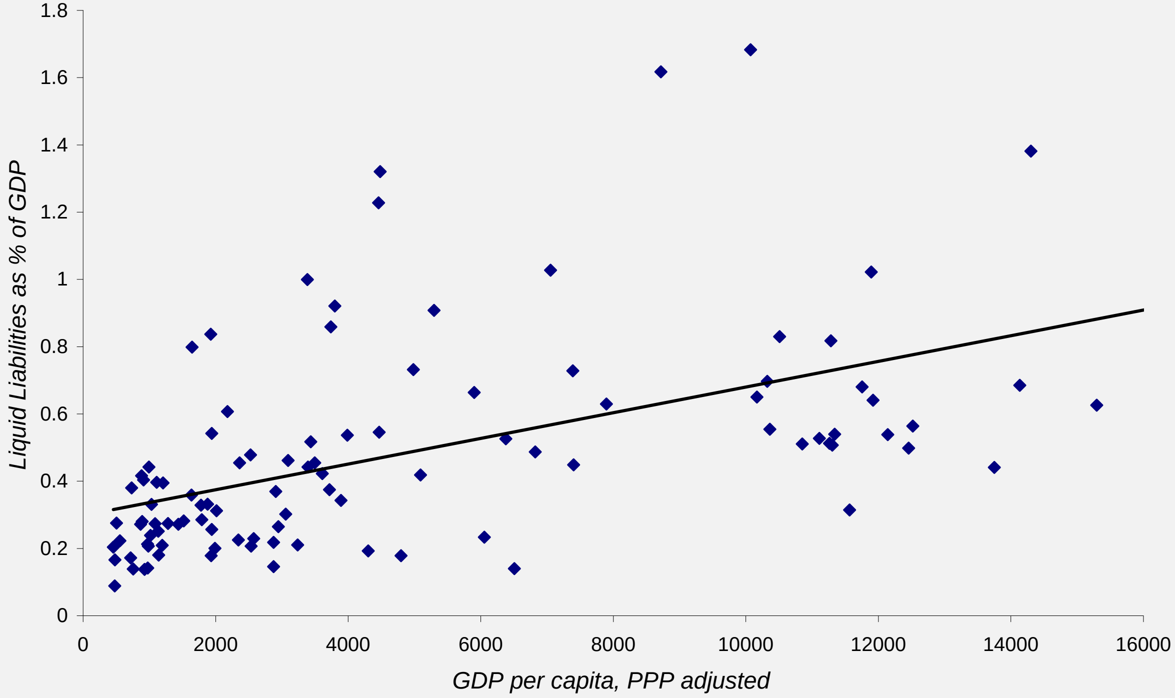
[Financial and Business Services as % of GDP.]

TFP and the size of the financial sector *(3/9)*

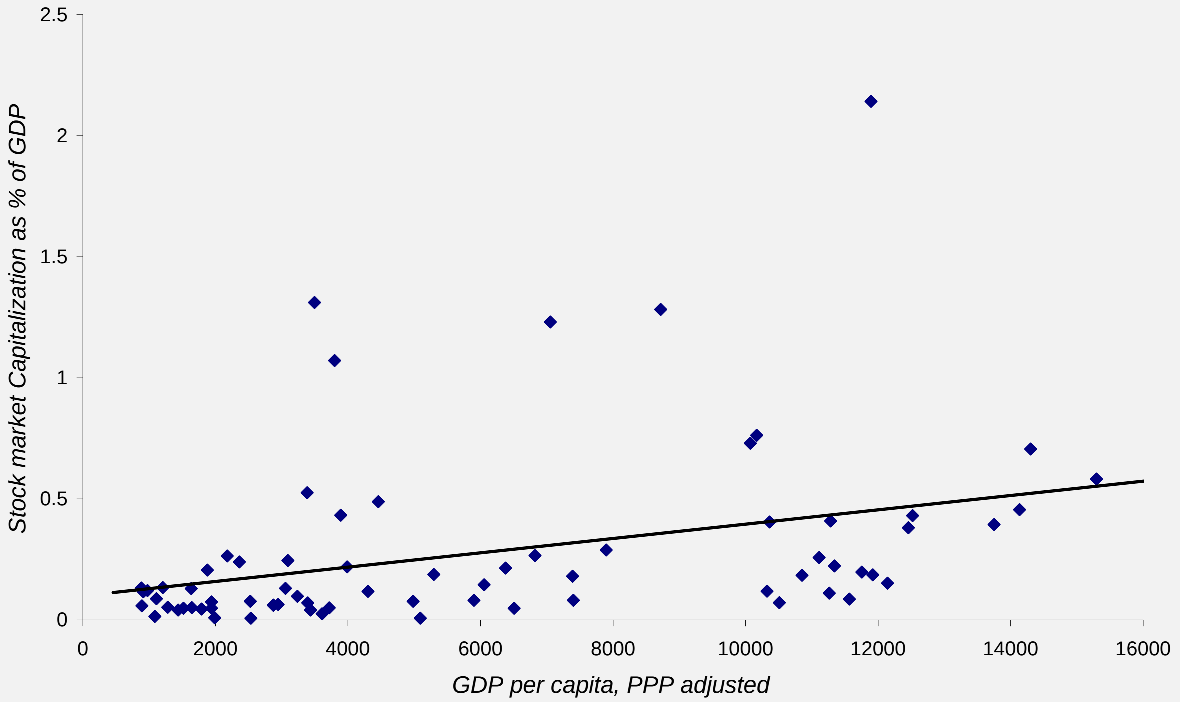


[Claims on private sector by deposit money banks and other financial institutions as % of GDP]

TFP and the size of the financial sector *(4/9)*

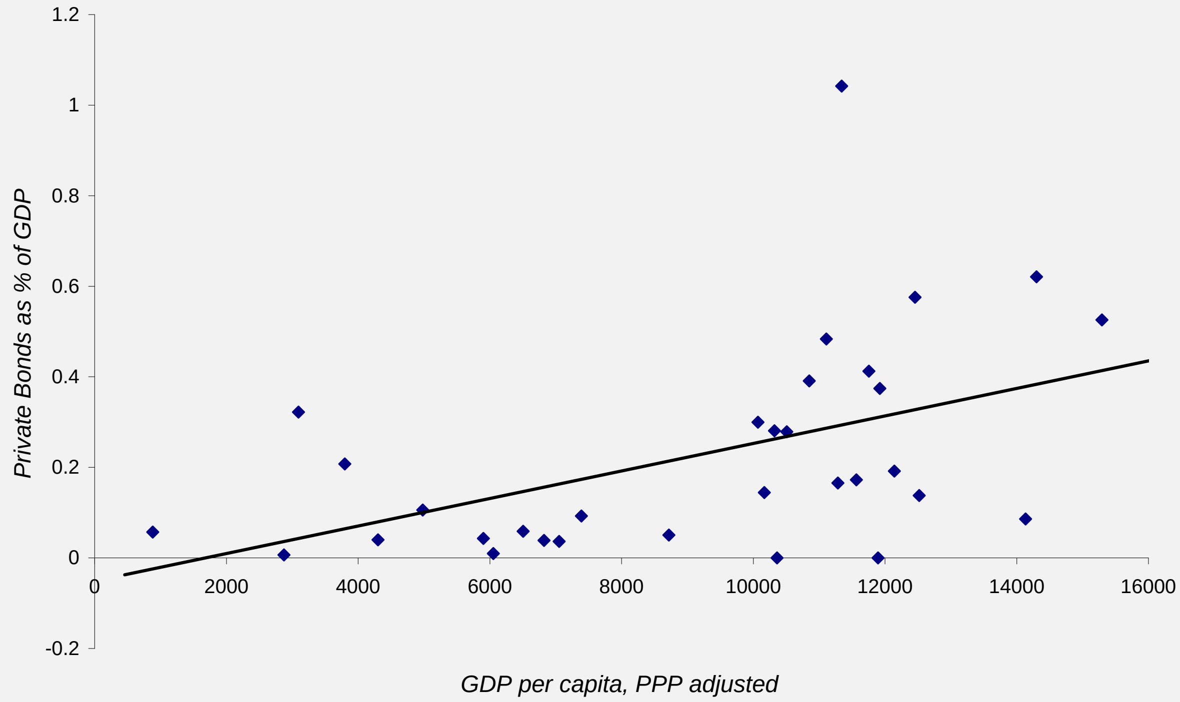


[Liquid liabilities as % of GDP]

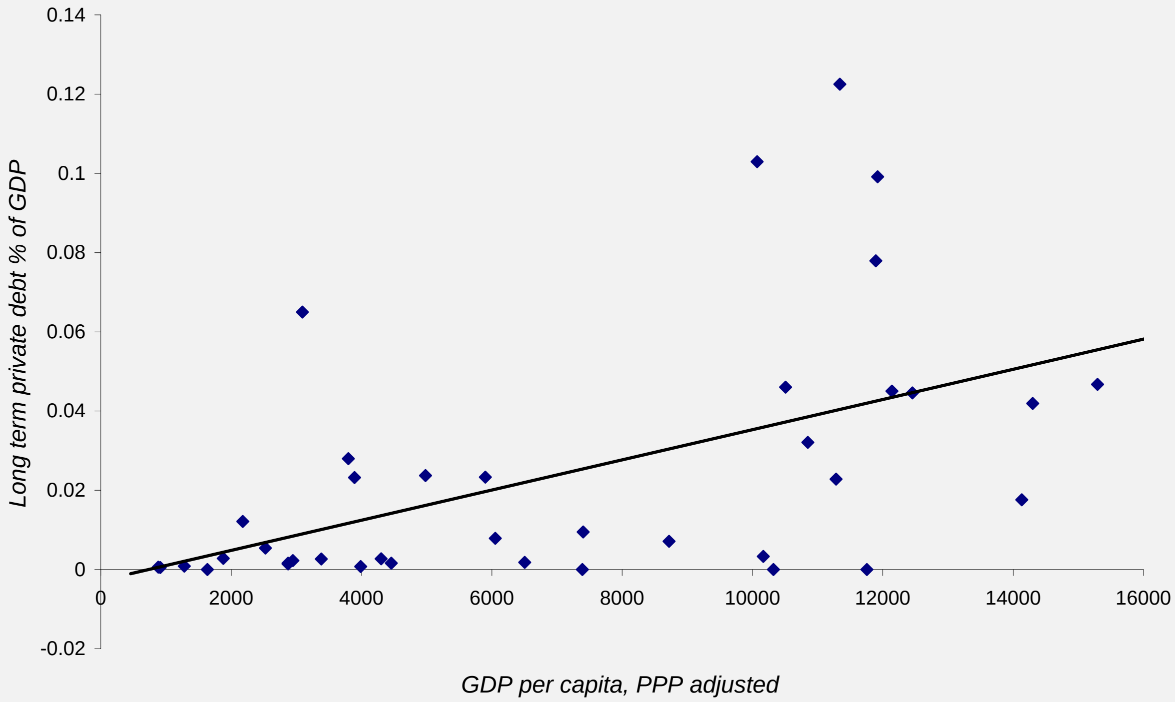


[Stock Market capitalization as % of GDP]

TFP and the size of the financial sector *(6/9)*



[Outstanding domestic debt securities issued by private domestic entities divided by GDP]



[Total private long-term debt issues as % of GDP]

TFP and the size of the financial sector *(8/9)*

- The level of capital does not seem to affect the relationship

- Neusser and Kugler (1998)
  - Finance size cointegrated with TFP in manufacturing
    - not with output
  - They find evidence of reverse causality.

- In our model:
  - Differences in ν would produce **negative** correlation.
  - Differences τ would produce positive correlation.
  - Contractual inefficiencies (β) can explain both only if they mean that there is too little power to brokers, and not in Pareto-World

Result: *Model suggest that the rich countries are rich and have a larger financial sector because their product sectors have more allocative efficiency, not because they have a more efficient financial sector.*

Conclusions

- Tractable model.
  - Capital Irrelevant.

- Less frictions in financial markets
  - More income
  - Less dispersion of firm characteristics
  - LESS financial sector

- More destruction (here not creative, but perhaps...)
  - Less income.
  - More dispersion
  - More financial sector.

- There can be Too much or too little contractual power into finance.

- Efficiency in Product Market delivers
  - More income
  - Less dispersion
  - More finance

- Compatible with data if differences across countries are derived mostly from inefficiencies in product markets, not in financial markets.

The Joint Determination of TFP and Financial Sector Size

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