# INDUSTRY UPGRADING AND FINANCIAL SERVICES

HU, XIAOXIAO and ZHOUFEI, SCORPIA*

**ABSTRACT**

This paper is intended to sort out a potential channel to account for the relative size switch of financial services, majorly from either banks or stock markets, as the economy develops. Especially as industry structure upgrades. One major finding of existing empirical literature is that countries with more intensive technology development generally have larger scale of stock market compared to their banking system. By simultaneously introducing in physical capital and human capital accumulation into the industry upgrading framework, we are able to capture how bank contract outperforms in accumulating physical capital and how equity contract betters at recognizing human capital stock level. A natural inclination towards one of them at each industry developing stage then comes along with the dynamic industry upgrading process.

*Xiaoxiao Hu: Department of Economics, Clear Water Bay, HKUST, Hong Kong, xiaoxiao.hu@ust.hk, Scorpia Zhoufei: Department of Economics, Clear Water Bay, HKUST, Hong Kong, zhoufei1115@gmail.com. We thank Professor Yong Wang, Pengfei Wang, Kai Li, Nan Li, Pompeo Della Posta for helpful comments. We also want to thank Sichuang Xu, Jing Zhou, Ti Zhou for their useful discussion. All errors are our own.

# 1 Introduction

Debates have never ceased over the past decades concerning the relative viability of banking system and stock market. And issues regarding why stock market is more heavily relied upon as a modern financing and investing channel remained unclear.

Some sheer empirical evidences motivated our interest in investigation into this matter. For example, Beck and Demirguc-Kunt (2009) documented the financial institution structure across countries and over time. Their database reveals that " a deepening of both financial markets and institutions, a trend concentrated in high-income countries and more pronounced for markets than for banks."

Here to give readers some intuitions, we reproduced two graphs from Beck and Demirguc-Kunt (2009) original paper.

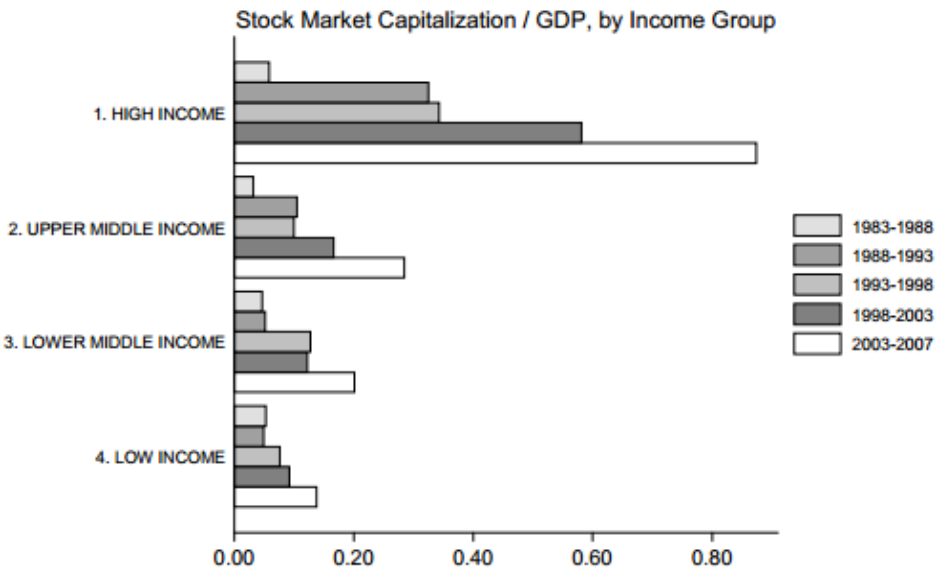


**Figure 1 (Cited from Figure 26 of Beck and Demirguc-Kunt (2009)): Stock Market Caplitalization - Median Values by Income Group Over Time (1983-2007)**

Figure 1 shows that once grouped the countries by income/GDP per capita, the stock market cap-

italization, represented by median values, are generally intensified over 1983-2007 period, whereas this trend is especially pronounced for high income countries.

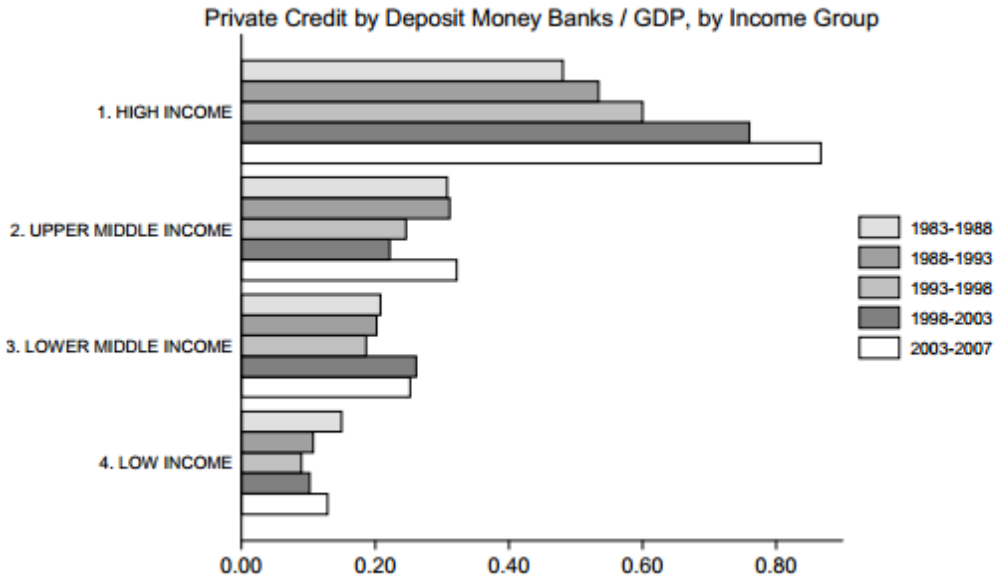


**Figure 2 (Cited from Figure 28 of Beck and Demirguc-Kunt (2009)): Private Credit by Deposit Money Banks - Median Values by Income Group Over Time (1983-2007)**

After grouping countries by income level as we did before, Figure 2, on the other hand, regenerates the bank credit dispersion, also using median values to show the trend in 25 years. Apparently, high income countries once again lead in bank service deepening. Whereas other groups only see small expansion in banking credit, even negative expansion from 1988-2003.

Finally, since they all use percentage in GDP per capita as their measurement, we can take these two figures in comparison horizontally. The relative size of stock market capitalization over bank credit expansion is growing, but much more dramatic in relative high income countries. This aroses our curiosity over how and why relative size of two competing financial systems relate to income level and development stage of a country.

The viability of different institutional arrangements of financial services has long been a controversial

research area for decades. Equity contract seems to be the most natural and undistorted choice for the economy. So the more heated debate falls upon the viability of the bank.

One important breakthrough regarding the advantage of bank is that bank can allow a better risk sharing scheme amongst creditors. Starting from 1893, Diamond and Dybvig have developed a theoretical framework that enables us to look into matters like how bank deposit contract can help achieve first best and how suspension of convertibility or government insurance can prevent the bank runs. Though four years later, Jacklin (1897) brought up the known "Jacklin critique" which questions in this very risk sharing ability of the bank deposit contract, seeing once trade in equity is possible for all creditors, competitive market can do just as well as, if not better than, bank deposit contract arragement. Later in 1998, by introducing the possibility of agents' direct investments in the market, Von Thadden argued that the incentive-compatible deposit contracts became a second-best mechanism to provide liquidity. Especially, the liquidity provision is negatively correlated with the irreversibility of the market investment opportunity. Von Thadden took a continuous-time approach, as with what He and Xiong did in 2012: they characterized the roles of fundamental volatility, credit lines and debt maturity in driving the runs. Their findings applies to debt contract in general rather than just bank contract.

Another line of research took the perspective of bank-firm relationship. Bank and firm interact mainly through balance sheet transaction. Apart from this general credit-providing role, bank to some extent also acts as "quasi-insider". Boot, Thakor and Udell (1991) justified the bank as an organizational solution to market breakdown due to unenforceable contracts. As Gorton and Kahn (1993) put it, bank uniqueness is related to how the design of bank loan contracts allows banks to affect borrowers' choice of project risk. Hereby moral hazard issue can be more efficiently resolved. Of course, the bank loan has influence over corporate financing decision as well as on their investing decision. That is, bank may possess information monopolies to renegotiate interest rate with firms. Higher interest rate may japerdise the capital accumulation of the firm. Appearently, if bank has too much control power over the firm's decision, this may also lead to bank's gambol behavior– seeing a loss occured in projects invested, bank with too much stake involving may want to invest more to save the losing cause.

These pretty much summarize the research progress regarding the debate over equity contract and

bank contract.

## 2 Motivation

Empirical evidence suggests that high income countries generally have more extensive stock market, whereas countries of relatively low income tend to be more keen on developing bank system. Despite the fact that high income countries have both bank system and stock market better developed, the relative ratios of these two financial mechanisms are distinctly different in high income and low income countries. And high income countries have higher ratio of stock market size to bank system size. This phenomenon intrigues us to explore why such split of choices should exist.

In any economy, financial services are created to mobilize savings, to better allocate capital to those pomising production project, and to diversify and spread the risk over the whole economy. In the end, financial services should be designed to best facilitate the industry need in order to achieve the intended economy growth.

By incorporating industry upgrading framework, we can roughly model different income country group as in discrete industry upgrading stages. In the static model, factor endowments of physical capital and human capital will determine the optimal industry structure. Here, we intentionally leave out raw labor since raw labor does not play a role in our industry upgrading framework. And this in turn decides the appropriate financial services arrangements. In dynamic model, we allow each endowed factor to accumulate over time, firms choose optimal debt amount or equity issuance to maximize expected firm values. Such choices of firms are stage-specific and switch overtime, thus can account for the change of relative financial service sizes from a demand side perspective. On the other hand, different choices of financial services will also affect the speed of factor accumulation, thus influence the timing of industry upgrading.

Now it is critical to identify both financial contracts' advantages and disadvantages in facilitating the industry upgrading. Since bank contract has relative fixed and small amount of money to pay back to creditors so each period more physical capital can be left inside the firm and further used to accumulate capital. While the equity contract used to capture the feature of the stock market where vast number

of individuals cast different opinions regarding the same project, and the investment is less conservative comparing to bank contract. One major feature of equity contract is that it takes into account of the intangible asset of a project which has been overlooked by bank contract as bank usually demands for the tangible colleteral. Thus in equity contract, investors tend to better appreciate the intangible asset, in this case human capital of a project, so equity financing is better for human capital accumulation.

# 3 Model

## 3.1 Industry Upgrading

### 3.1.1 Two factors in production function

In this model, there are 2 factors endowed to this economy. Respectively, they are physical capital denoted as $K$ and human capital denoted as $H$. One subset of $H$ used in production is denoted as $H_Y$. Here we abstract away raw labor. Including raw labor does not give us more insight but only complicate the model. Physical capital has two features. It can be used as colleteral as well as depreciable. Here to make things easier, we assume the price of such physical capital is the same as the final good for consumption. We also want to mention that here human capital is regarded as the vehicle that carries know-how technology. So that the knowledge in this economy is endowed in human capital.

At the beginning of the industry upgrading, the initial endowment is $K_0, H_0$.

### 3.1.2 Production function

Here we adopt the production function of cobb-douglas form. Since technology has already been incorporated in the human capital, so we leave the total factor productivity $A$ out of our production function. We seperate the industry upgrading into four developing stages by different industry structures.

$$F_i\left(K, H_Y\right) = H_{iY}^{\alpha} K_i^{1-\alpha} \equiv Y_i$$

Note that we assume constant return to scale in forming production function. $\alpha$ is the parameter used to charaterize the relative elasticity of marginal substitution in productivity of human capital and

physical capital. In this paper, we temporarily attach some deterministic feature to the parameter in order to get some preliminary and intuitive result out of the analysis.

To further simplify the analysis, we only include two industries with different Human Capital intensity, $\alpha_1$ and $\alpha_2$,with $\alpha_1 < \alpha_2$.From industry 1 to 2, the relative productivity weight on physical capital and human capital change overtime. This process represents the industry upgrading that a typical economy would go through. In stage I, representative firms include some capital intensive firms (industry 1). In this stage, physical capital $K$ and human capital $H$ simultaneously grow, and push the industry upgrading to the next stage. In stage II, industry 1 and industry 2 coexist. For industry 2, human capital constitutes an essential part, more important than physical capital. Such human capital intensive industry has representive firms like internet firms (Google, Alibaba etc.) and consulting firms alike. When $K$ and $H$ continue to accumulate, in stage III, only industry 2 survives.

The industry upgrading stages could be categorized by the following graph.

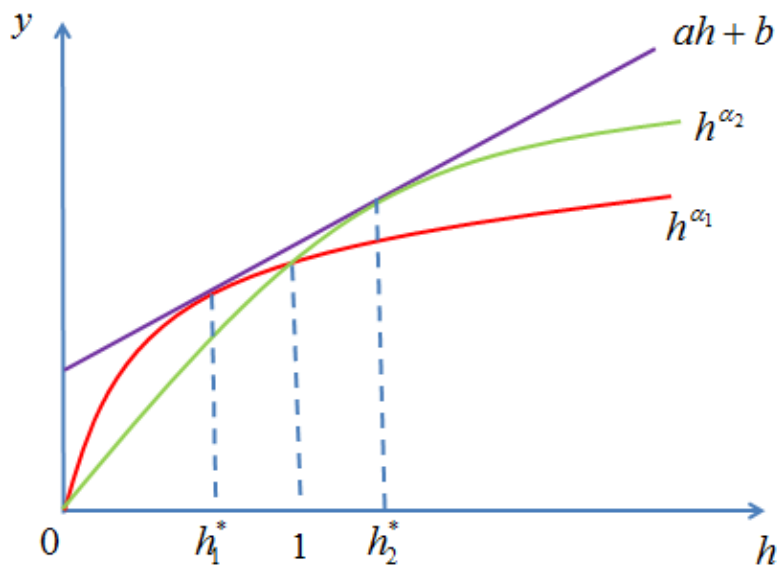


**Figure 3: Industry upgrading stages**

In Figure 3, we denote $y = \frac{Y}{K}$, and $h = \frac{H_Y}{K}$. The whole economy's production frontier consists of three parts– first part $h \in [0, h_1^*]$, only first industry prevails in this economy because physical capital is abundance while human capital is scarce. So the economy's production frontier mimicks the industry 1's production curve. The second part of economy's production frontier where $h \in [h_1^*, h_2^*]$, is the common tangent for industry 1 and 2's production curve. In this part, the two industries coexist, but as $h$ evolves, the relative ratio of industry 2 to 1 also rises. The third part of economy's production frontier where $h \in [h_2^*, \infty]$ mimicks the industry 2's production curve for the same argument before.

The cutoff point $h_1^*$ and $h_2^*$ can be calculated as follows:

$$\begin{aligned} h_1^* &= \left[ \left( \frac{\alpha_1}{\alpha_2} \right)^{\alpha_2} \left( \frac{1-\alpha_1}{1-\alpha_2} \right)^{1-\alpha_2} \right]^{\frac{1}{\alpha_2 - \alpha_1}} \\ h_2^* &= \left[ \left( \frac{\alpha_1}{\alpha_2} \right)^{\alpha_1} \left( \frac{1-\alpha_1}{1-\alpha_2} \right)^{1-\alpha_1} \right]^{\frac{1}{\alpha_2 - \alpha_1}} \end{aligned}$$

The total output is the linear combination of these two products' output, specially we have

$$F(K, H_Y) = \sum_{i=1}^{2} F_i(K, H_Y)$$

In stage II, when industry 1 and industry 2 coexist, we could obtain the relative size of the two industries through factor price equalization conditions and the following two market clearing conditions:

$$\begin{aligned} K_t &= K_{1t} + K_{2t} \\ H_{Yt} &= H_{Y1t} + H_{Y2t} \end{aligned}$$

Here we define size of the two industries by their output level. At each time $t$, we could obtain $\frac{F_1(K_{1t}, H_{Y1t})}{F_2(K_{2t}, H_{Y2t})}$. The relative size of bank system ($B_t$) and equity market ($S_t$) could thus be pined down.

### 3.1.3 Industry structure

We first assume the utility function of household is of constant relative risk averse.

$$U\left(C_t\right) = \max \sum_{i=0}^{\infty} \beta_H^{t+i} \left[ \frac{C_{t+i}^{1-\gamma} - 1}{1-\gamma} - \varphi H_{Yt} \right]$$

$\beta_H$ denotes the subjective discount factor of the household.

Now we have to find the accumulation processes of physical capital and human capital. Physical capital follows the low of motion equation below:

$$K_{t+1} - K_t = I_t - \delta_k K_t$$

where $\delta_k$ denotes depreciation of physical capital, and $I_t$ is defined as follows:

$$I_t = \phi \left( \frac{Q_t}{K_t} \right) K_t$$

Here K is the apparatus, can be measured in final consumption good. And we normalize price of final consumption good to be 1. $I_t$ is the investment measured in terms of physical capital and $Q_t$ is that measured in final good. The discrepancy between the two is the investment adjustment cost.

As for human capital growth law, we adopt learning by schooling approach. Notice that $H_{Yt} = u_t H_t$ which is the human capital used in production, $H_{St} = (1 - u_t) H_t$ which is the human capital goes to school, and following lucas (1988)'s convention, we have the law of motion of human capital level $h_t$ described by

$$H_{t+1} - H_t = \eta \left[1 - u_t\right] H_t - \delta_h H_t + \varepsilon_t H_t$$

In the above equation, $u_t$ is the proportion of human capital that directly participates in production activity. This leaves $1-u_t$ proportion to go to school thus to further accumulate human capital. $\eta$ denotes the efficiency of such accumulation process. $\delta_h$ is the depreciation of human capital. A stochastic component ($\varepsilon_t$) is added in the accumulation process to realistically capture the risk associated with

human capital accumulation. $\varepsilon_t$ is log normal distributed:

$$\ln \varepsilon_t \sim N\left(0, \sigma_\varepsilon^2\right)$$

We calculate the growth rate of $K_t$ and $H_t$ as follows:

$$g_t^K = \frac{K_{t+1} - K_t}{K_t} = \phi\left(\frac{Q_t}{K_t}\right) - \delta_k$$

$\phi\left(\frac{Q_t}{K_t}\right)$ increases in $K_t$, so growth rate of physical capital slows down period by period, and we further assume that the growth rate eventually converges to zero.

$$g_t^H = \frac{H_{t+1} - H_t}{H_t} = \eta\left[1 - u_t\right] - \delta_h + \varepsilon_t$$

The growth rate of human capital is not constrained. So the growth rate of human capital will finally surpass that of capital.

Thereby, we have industry side dynamic system fully captured.

## 3.2 Financial institution

There are two set of institution arrangements of financial service. One is bank or bank-like contract arrangement, from a broader point of view, also can be deemed as debt contract. The other is stock market, where even firm with quite low physical asset may be able to raise some capital, because stock market has no colleteral requirement. In this paper, bank contract also includes most investment bank product. Equity contract also includes corporate bond market.

Firms in each industry could choose financial institutions in each stage. That is, Firms in industry 1 make one choice in stage I, and when industry upgrades to stage II with the coexistance of two industries, firms in industry 1 make another choice. Similarly, Firms in industry 2 make one choice in stage II and another one in stage III. When firms are making such choices, we assume that firms could choice either bank contract or issurance of equity, but not a combination of both. We further assume that when firms

optimize, they could not foresee the industry upgrading process so they maximize firm value over infinite time horizon, presuming that they would stay in the same stage forever.

### 3.2.1 Borrowing from bank

**Firm** We first assume firm only have one channel to raise capital, that is to borrow from the bank. Under such environment, firm maximize its own value by choosing $K_t, H_t$ and additionally, $B_t$, which denotes the amount borrowed from the bank at period $t$.

Firm maximizes expected firm value, which is the present value of all future profit. Firm's problem is

$$\max E_0 \sum_{t=0}^{\infty} \beta_F^t \frac{U'(C_t)}{U'(C_0)} \pi_t$$

$\beta_F$ is the discount factor of the firm. We assume $\beta_H < \beta_F$, that is, the household is less patient than the firm.

Using dynamic programming, define the firm's ante-dividend value to be $V_t$,

$$V_t(K_t, B_t) = \max \left[ \pi_t + \beta_f E_t \frac{U'(C_t)}{U'(C_{t-1})} V_{t+1} \right]$$

where

$$\begin{aligned} \pi_t &= F(K_t, H_{Yt}) - w_{Ht} H_{Yt} - Q_t + \left( \frac{B_{t+1}}{R_{ft}} - B_t \right) \\ K_{t+1} &= (1 - \delta_k) K_t + \phi \left( \frac{Q_t}{K_t} \right) K_t \\ \text{and } Q_t &= F(K_t, H_{Yt}) - C_t \end{aligned}$$

$Q_t$ is the total amount of output the economy used to create new capital. $\beta_f$ is the discount factor of the firm.

The borrowing constraint on the other hand is

$$B_{t+1} \leq E_t P_{K,t+1} K_{t+1}$$

where $P_{K,t+1}$ is price of capital.

Thus the lagrangian dynamic programming can be written into,

$$V_t(K_t, B_t, H_t) = \max \left\{ \begin{array}{c} \pi_t + \beta_F E_t \frac{U'(C_{t+1})}{U'(C_t)} V_{t+1}(K_{t+1}, B_{t+1}, H_{t+1}) + q_t \left[ (1-\delta_k) K_t + \phi \left( \frac{Q_t}{K_t} \right) K_t - K_{t+1} \right] \\ + \mu_t \left[ (1 - \delta_h + \eta(1-u_t) + \varepsilon_t) H_t - H_{t+1} \right] + \Omega_t \left[ B_{t+1} - P_{K,t+1} K_{t+1} \right] \end{array} \right\}$$

$q_t$ is the additional value created from one extra investment.

In order to calculate the risk free rate $R_{f,t+1}$, we adopt the consumption CAPM model (Breeden 1979).

$$\begin{aligned} R_{f,t+1} &= \frac{1}{E_t \left( \beta_F \frac{U'(C_{t+1})}{U'(C_t)} \right)} \\ &\Rightarrow \quad r_{f,t+1} = \gamma E_t(g_{t+1}) - \log \beta - \frac{1}{2} \gamma^2 \sigma_g^2 \end{aligned}$$

where $r_{f,t+1} = \ln R_{f,t+1}$, $g_{t+1} = \ln \left( \frac{C_{t+1}}{C_t} \right)$, $\sigma_g^2 = var(g_{t+1})$.

$$
\begin{aligned}
\text{FOC } [K_{t+1}] &: \beta_F E_t\left[\frac{U'(C_{t+1})}{U'(C_t)}\frac{\partial V_{t+1}}{\partial K_{t+1}}\right] = q_t + \Omega_t E_t\left[P_{K,t+1}\right] \\
[B_{t+1}] &: E_t\left[\frac{1}{R_{f,t+1}}\right] + \beta_F E_t\left[\frac{U'(C_{t+1})}{U'(C_t)}\frac{\partial V_{t+1}}{\partial B_{t+1}}\right] + \Omega_t = 0 \\
[I_t] &: -Q_I\left(K_t, I_t\right) + q_t = 0 \\
[H_{t+1}] &: \beta_F E_t \frac{U'(C_{t+1})}{U'(C_t)}\frac{\partial V_{t+1}\left(K_{t+1}, B_{t+1}, H_{t+1}\right)}{\partial H_{t+1}} - \mu_t = 0 \\
[u_t] &: \frac{\partial F\left(K_t, u_t H_t\right)}{\partial u_t} - w_t H_t - \mu_t \eta H_t = 0 \\
\text{Envelope Theorem } [K_t] &: \frac{\partial V_t}{\partial K_t} = \frac{\partial F\left(K_t, H_{Yt}\right)}{\partial K_t} + q_t\left[(1-\delta_k) + \phi\left(\frac{Q_t}{K_t}\right) - \frac{1}{K_t}\phi'\left(\frac{Q_t}{K_t}\right)\right] \\
[B_t] &: \frac{\partial V_t}{\partial B_t} = -1 \\
[H_t] &: \frac{\partial V_t}{\partial H_t} = \frac{\partial F\left(K_t, u_t H_t\right)}{\partial H_t} - w_t u_t + \mu_t\left[1 - \delta_h + \eta\left(1 - u_t\right) + \varepsilon_t\right]
\end{aligned}
$$

**Consumers** Conditional on the consumers choosing bank contract, the consumers are constrained by the following budget constraint:

$$
wH_{Yt} + B_t = C_t + \frac{B_{t+1}}{R_{ft}}
$$

Lagrangian of consumer problem is as follows:

$$
\begin{aligned}
L &= \max_{C_t, B_{t+1}, u_t} E_0 \sum_{t=0}^{\infty} \beta_H^t \left[\frac{C_t^{1-\gamma} - 1}{1-\gamma} - \varphi H_{Yt} + \lambda_t\left(wH_{Yt} + B_t - C_t - \frac{B_{t+1}}{R_{f,t+1}}\right)\right] \\
\text{FOC } [C_t] &: C_t^{-\gamma} = \lambda_t \\
[B_{t+1}] &: E_t\left[\beta_H R_{f,t+1}\right] = E_t\left[\frac{\lambda_t}{\lambda_{t+1}}\right] \\
[u_t] &: E_t\left[u_{t+1}\right] = E_t\left[\frac{\lambda_t w_t - \varphi}{\beta\left(\lambda_{t+1} w_{t+1} - \varphi\right)\eta}\right]
\end{aligned}
$$

From Firm FOC $[B_{t+1}]$ and envelop theorem for $[B_t]$ we could obtain

$$
E_t\left[\frac{1}{R_{f,t+1}}\right] - \beta_F E_t\left[\frac{U'(C_{t+1})}{U'(C_t)}\right] + \Omega_t = 0
$$

From household FOC

$$E_t\left[\frac{1}{R_{f,t+1}}\right] = \beta_H E_t\left[\frac{U'(C_{t+1})}{U'(C_t)}\right]$$

$$\Omega_t = (\beta_F - \beta_H) E_t\left[\frac{U'(C_{t+1})}{U'(C_t)}\right] > 0$$

Therefore, the borrowling constraint always binds.

In equilibrium, we have market clearing conditions for both good market and bond market. And Household's choice of $u_t$ also coincide with firm's.

### 3.2.2 Issuing equity to investors

**Firm** Firm still maximize expected firm value. Here we assume that even though firm issue equity so that outside investor can become shareholders and influence firm's choices, the agency cost problem exists all the time. Firm manager maximize present value of profit left,

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \frac{U'(C_t)}{U'(C_0)} \theta_t \pi_t$$

Where

$$\begin{aligned} \pi_t &= F(K_t, H_{Yt}) - w_{Ht} H_{Yt} - Q_t + P_t S_{t+1} - (P_t - D_t) S_t \\ \text{and } Q_t &= F(K_t, H_{Yt}) - C_t \end{aligned}$$

$P_t$ and $P_{t+1}$ denotes the price of share at time $t$ and $t+1$. $S_t$ and $S_{t+1}$ denotes total shares outstanding at time $t$ and $t+1$. Here $\theta_t$ denotes the outside investor's equity share over the firm. Since after initial investment into the firm the manager makes no further investment, the value share of the manager dilutes once he chooses to issue more equity. The following equation of equity share and total share value holds:

$$\theta_t = \frac{S_0}{S_t}$$

where $S_0$ denotes the initial value of share held by the manager.

In order to calculate $P_t$ and $P_{t+1}$, we incorporate Q theory of investment (Tobin 1969).

Return on investment

$$\begin{aligned} R_{I,t+1} &= \frac{F_K\left(K_{t+1}.H_{t+1}\right) - Q_K\left(I_{t+1}, K_{t+1}\right) + q_{t+1}\left(1-\delta\right)}{q_t} \\ \text{where } I_{t+1} &= K_{t+1} - \left(1-\delta_k\right)K_t \end{aligned}$$

Aggregate shock return

$$R_{a,t+1} = \frac{P_{t+1} + D_{t+1}}{P_t}$$

It can be proven that

$$R_{I,t+1} = R_{a,t+1}$$

Thus the lagrangian dynamic programming for firm's value maximization problem can be written into,

$$\begin{aligned} V_t\left(K_t, S_t, H_t\right) = \max_{K_{t+1}, S_{t+1}, I_t, H_{t+1}, u_t} & \frac{S_0}{S_t}\pi_t + \beta_F E_t \frac{U'(C_{t+1})}{U'\left(C_t\right)} V_{t+1}\left(K_{t+1}, S_{t+1}, H_{t+1}\right) \\ & + q_t\left[\left(1-\delta_k\right)K_t + \phi\left(\frac{Q_t}{K_t}\right)K_t - K_{t+1}\right] \\ & + \mu_t\left[\left(1-\delta_h + \eta\left(1-u_t\right) + \varepsilon_t\right)H_t - H_{t+1}\right] \end{aligned}$$

Now we can get first order conditions for the firm's problem stated above,

$$
\begin{aligned}
\text{FOC}\left[K_{t+1}\right] &: -\frac{S_0}{S_t}E_t\left[\frac{S_{t+1}P_{t+1}q_t\left[F_{kk}\left(K_{t+1},H_{Y,t+1}\right)-Q_{kk}\left(I_{t+1},K_{t+1}\right)\right]}{\left[F_K\left(K_{t+1},H_{Y,t+1}\right)-Q_K\left(I_{t+1},K_{t+1}\right)+q_{t+1}\left(1-\delta\right)\right]^2}\right]+\beta_F E_t\frac{U'(C_{t+1})}{U'\left(C_t\right)}\frac{\partial V_{t+1}}{\partial K_{t+1}}=q_t\\
\left[S_{t+1}\right] &: \frac{S_0}{S_t}E_t\left[\frac{P_{t+1}q_t}{F_K\left(K_{t+1}.H_{t+1}\right)-Q_K\left(I_{t+1},K_{t+1}\right)+q_{t+1}\left(1-\delta\right)}\right]+\beta_F E_t\frac{U'(C_{t+1})}{U'\left(C_t\right)}\frac{\partial V_{t+1}}{\partial S_{t+1}}=0\\
\left[I_t\right] &: \frac{S_0}{S_t}\left\{E_t\left[\frac{S_{t+1}P_{t+1}q_tQ_{kI}\left(I_{t+1},K_{t+1}\right)}{\left[F_K\left(K_{t+1}.H_{t+1}\right)-Q_K\left(I_{t+1},K_{t+1}\right)+q_{t+1}\left(1-\delta\right)\right]^2}\right]-Q_I\left(I_t,K_t\right)+q_t\right\}=0\\
\left[H_{t+1}\right] &: E_t\left[\begin{array}{c}-\frac{S_0}{S_t}\frac{S_{t+1}P_{t+1}q_t}{\left[F_K\left(K_{t+1},H_{Y,t+1}\right)-Q_K\left(I_{t+1},K_{t+1}\right)+q_{t+1}\left(1-\delta\right)\right]^2}\\ \left[\frac{\partial F_k\left(K_{t+1},u_{t+1}H_{t+1}\right)}{\partial H_{t+1}}\right]+\beta_F E_t\frac{U'(C_{t+1})}{U'(C_t)}\frac{\partial V_{t+1}\left(K_{t+1},S_{t+1},H_{t+1}\right)}{\partial H_{t+1}}\end{array}\right]=\mu_t\\
\left[u_t\right] &: \frac{S_0}{S_t}\left\{\frac{\partial F\left(K_t,u_tH_t\right)}{\partial u_t}-wH_t-\mu_t\eta H_t=0\right\}\\
\text{Envelope}\left[K_t\right] &: \frac{\partial V_t}{\partial K_t}=\frac{S_0}{S_t}\frac{\partial F\left(K_t,u_tH_t\right)}{\partial K_t}+q_t\left(1-\delta_k\right)=0\\
\left[S_t\right] &: \frac{\partial V_t}{\partial S_t}=-\frac{S_0}{S_t^2}\left[F\left(K_t,H_{Yt}\right)-w_{Ht}H_{Yt}-Q_t+\left(\frac{P_{t+1}S_{t+1}}{R_{a,t}}-P_tS_t\right)\right]-\frac{S_0}{S_t}P_t=0\\
\left[H_t\right] &: \frac{\partial V_t}{\partial H_t}=\frac{S_0}{S_t}\frac{\partial F\left(K_t,u_tH_t\right)}{\partial H_t}-wu_t+\mu_t\left[\eta\left(1-u_t\right)+\varepsilon_t\right]=0
\end{aligned}
$$

Where investment adjustment has some cost,

$$
\begin{aligned}
I_t &= K_t\Phi\left(\frac{Q_t}{K_t}\right)\\
Q_t &= K_t\Phi^{-1}\left(\frac{I_t}{K_t}\right)\\
Q_{kt} &= \frac{\partial Q_t}{\partial K_t}=\Phi^{-1}\left(\frac{I_t}{K_t}\right)-\frac{I_t}{K_t}\frac{1}{\Phi'\left(\frac{I_t}{K_t}\right)}
\end{aligned}
$$

**Households** Conditional on the consumers choosing bank contract, the consumers are constrained by the following budget constraint:

$$
wH_{Yt}+\left(P_t-D_t\right)S_t=C_t+P_tS_{t+1}
$$

Lagrangian of consumer problem is as follows:

$$\begin{aligned}
L &= \max_{C_t, B_{t+1}, u_t} E_0 \sum_{t=0}^{\infty} \beta_H^t \left[ \frac{C_t^{1-\gamma} - 1}{1-\gamma} - \varphi H_{Yt} + \lambda_t \left( w H_{Yt} + (P_t - D_t) S_t - C_t - P_t S_{t+1} \right) \right] \\
\text{FOC } [C_t] &: C_t^{-\gamma} = \lambda_t \\
[S_{t+1}] &: E_t \frac{\lambda_{t+1}}{\lambda_t} \beta_H R_{a,t+1} = 1 \\
[u_t] &: u_{t+1} = E_t \frac{\lambda_t w_t - \varphi}{\beta \left( \lambda_{t+1} w_{t+1} - \varphi \right) \eta}
\end{aligned}$$

In equilibrium, we have market clearing conditions for both good market and equity market. And Household's choice of $u_t$ also coincide with firm's.

One advantage of using the equity financing is that the amount of capital raised has a higher upper bound. The reason is that instead of merely looking at the physical capital and take it as colleteral and limit the boundary of borrowing amount, stock market is less conservative due to the larger pool of different people's opinions. Thus intangible assets of a firm can be better appreciated in the stock market. So the borrowing constraint can be eliminated.

# 4 Solution path

From above settings about industry upgrading stage, industry structure, and different financial services features, we have set up a dynamic system. In other words, we can solve for the cutoff points regarding $h^*$ ($h_1^*$ and $h_2^*$) , where industry upgrades.

And when deciding which financial service prevails in each stage of developing, the only economic agent who needs to make the choice is the firm. So at each industry upgrading stage, the firm is going to either choose $K_t, H_{Yt}, H_t$ under bank dominant system, or choose $K_t, H_{Yt}, S_t$ under the stock dominant system. Note that we adopted a simple "switch it all" strategy, so that firm has to either choose bank contract or choose equity issurance, there's no in between. Firm's management team compares the expected firm values under both situations and choose one institution arrangement that best fits their need.

Since the investment adjustment costs is present, physical capital accumulation must slow down

and eventually the accumulation speed converges to zero. However, human capital accumulation is not bounded. Thus, at some point, the stock and the accumulation speed of human capital must both exceed those of physical capital. Naturally, firms will switch to stock issurance in order to acquire more funding.

We could obtain that for firms in industry 1, the relatively physical capital intensive industry, choosing bank system maximizes their expected value of the firm in both stages where industry 1 exists. However, firms in industry 2, the relatively human capital intensive industry, they would choose stock issurance as their financing mathed. Since in stage II, the relative size of industry 1 becomes smaller and smaller, and industry 1 eventually dies out. Thus, we could observe the following phenomenon of the financial services. In stage I, we have bank system prevail. In stage II, the financing method gradually moves from bank system to equity issurance. In stage III, all firms finance in the equity market.

# 5 Interpretation of the result

Intuitively, bank contract requires the firm to pay back fixed amount of money to creditors, and the required rate of return is normally just conditional physical capital, so that the amount is relatively small, and this gives rise to physical capital rapid accumulation because less capital flows out of the firm for paying financing cost. The relative small amount of debt financing return rate to equity financing return rate is the famous equity premium puzzle in economic and finance academia. Vast number of paper were written aiming at resolution of equity premium puzzle/ risk-free rate puzzle. In the model, we incorporate risk into human capital to capture this feature.

Contrarily, if firm signs an equity contract, it has to pay pro rata return from its each period profit. The required rate of return works for physical capital and human capital alike. Which means, investors also demand a return coming from intangible asset. So the cost of equity contract is relatively high. However, in equity contract, investors fully take into account the value of intangible asset, so they are willing to endow firm more financing capital thus loosen the financial constraint faced by firm in the previous contract. Jointly, the equity contract is a more sensible choice for the firms of high human capital. And it encourages those high human capital industry to grow.

# 6 Conclusion

We start this study observing the relative size switch between financial institutions and financial markets. Despite the growing intervention between these two kinds of financial services, we still can clearly see that a institutes-based financial system gradually become a more and more market-based one. This puzzling fact is explained from a growth theory perspective in our paper, especially in our model we emphasized a demand side story, featuring the financing need from the firms. By introducing in two accumulation processes of physical capital and human capital respectively, we can model a industry upgrading framework. At each different industry upgrading stage, firm has different level of endowment. In order to maximize the firm value, firm choose over financing methods. Bank and equity has seperate advantage and disadvantage which cater for firms' need at different stages. By comparing managers' value achieved under these two financial services, we draw a conclusion that financial system also switch overtime from bank-based to market-based.

In the above discussion, we used the learning by schooling method to accumulate the human capital. But consider, even though most technology-intensive countries have very extensive equity market, (Japan, US, Hong Kong, UK, China, Germany etc. top at stock market capitalization size list), There are some exceptionals. We observed that Japan and Germany have even larger bank system compared with their equity market. One major difference between countries like Japan and Germany and innovating countries like US and UK is that the former accumulate their human capital by "learning by doing" approach while the latter mainly rely on "learning by schooling". So we suggest that replacing the human capital accumulation mothod may cause the choice over bank or stock to change. This may account for importance of bank system in countries like Japan and Germany. Also, one potential extension to our model is to look at the optimal bank contract size to equity issuance size ratio for a representative firm in both industries. Such extension can better capture the reality where firms usually have access to both financial institutions like banks as well as financial markets like stock market. We also ecourage further research relaxing assumptions like firms only plan within industry upgrading stage, to incorporate plan across different upgrading stages (for industry 1 upgrading from stage I to stage II, for industry 2 upgrading from stage II to III).

# References


[1] Beck, Thorsten, Aslı Demirguc-Kunt, and Ross Levine. 2010. "Financial Institutions and Markets Across Countries and Over Time: The Updated Financial Development and Structure Database" The World Bank Economic Review, 24(1): 77-92.

[2] Beck, Thorsten and Ross Levine. 2002. "Industry Growth and Capital Allocation:: Does having a Market-Or Bank-Based System Matter?" Journal of Financial Economics, 64(2): 147-180.

[3] Bernanke, Ben S., Mark Gertler, and Simon Gilchrist. 1999. "The Financial Accelerator in a Quantitative Business Cycle Framework" Handbook of macroeconomics, 1: 1341-1393.

[4] Breeden, Douglas T. 1979. "An Intertemporal Asset Pricing Model with Stochastic Consumption and Investment Opportunities" Journal of Financial Economics, 7(3): 265-296.

[5] Demirguc-Kunt, Aslı and Vojislav Maksimovic. 2002. "Funding Growth in Bank-Based and Market-Based Financial Systems: Evidence from Firm-Level Data" Journal of Financial Economics, 65(3): 337-363.

[6] Diamond, Douglas W. and Philip H. Dybvig. 1983. "Bank Runs, Deposit Insurance, and Liquidity" The journal of political economy: 401-419.

[7] Fama, Eugene F. 1985. "What's Different about Banks?" Journal of Monetary Economics, 15(1): 29-39.

[8] Gorton, Gary and James A. Kahn. 1993. The design of bank loan contracts, collateral, and renegotiation.

[9] Ju, Jiandong, Justin Y. Lin, and Yong Wang. 2011. "Marshallian Externality, Industrial Upgrading, and Industrial Policies" .

[10] Kiyotaki, Nobuhiro and John Moore. 1995. Credit cycles.

[11] Krebs, Tom. 2003. "Human Capital Risk and Economic Growth" The Quarterly Journal of Economics: 709-744.

[12] Levine, Ross. 2002. "Bank-Based Or Market-Based Financial Systems: Which is Better?" Journal of financial intermediation, 11(4): 398-428.

[13] Lin, Justin Y., Xifang Sun, and Ye Jiang. 2009. "Toward a Theory of Optimal Financial Structure" .

[14] Lucas, RE. 1998. "On the Mechanics of Economic Development" ECONOMETRIC SOCIETY MONOGRAPHS, 29: 61-70.

[15] Myers, Stewart C. and Nicholas S. Majluf. 1984. "Corporate Financing and Investment Decisions when Firms have Information that Investors do Not have" Journal of Financial Economics, 13(2): 187-221.

[16] Tobin, James. 1969. "A General Equilibrium Approach to Monetary Theory" Journal of Money, Credit and Banking, 1(1): 15-29.

[17] Wang, Yong. "Market Structure, Factor Endowment and Technology Adoption!" .