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Capital Heterogeneity, Entrepreneurship, and Two-way Capital Flows

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Abstract: This paper analyzes the drivers of Two-way Capital Flow Phenomenon in many developing countries where flows of Portfolio Investment and Direct Investment across borders demonstrate opposite directions. The paper attempts to argue that the scarcity of entrepreneurs in less developed countries, who enhance firm productivity through unobservable (and thus not contractible) entrepreneurship effort, is an essential source of two-way capital flows. Building upon the framework of venture capital studies, this paper shows in a simple model that the lack of entrepreneurs would leave some domestic investment opportunities forgone, resulting in lower investment, lower interest rate, and lower savings compared optimality. Allowing foreign entrepreneurs to raise money from the domestic financial market in the form of portfolio investment outflow and then to invest in the domestic firms in the form of direct investment inflow would help alleviate the situation. In this regard, two-way capital flows bring domestic economy benefit of learning through opening-up.

Keywords: Entrepreneurship, Two-way Capital Flows, Portfolio Investment, Direct Investment

1. Introduction

Two-way capital flows, namely the opposite directions of direct investment and portfolio investment across borders, are uncanny phenomena under the neoclassical macro framework. It can also be treated as a derived problem of the capital allocation puzzle. The discussion of the allocation puzzle treats capital as homogeneous, focusing on the net flow of Balance of Payment. However, research on two-way capital flows captures the structure of cross-border capital flows.

Empirical work done so far on the issue are mainly stylized fact summaries, showing that two-way capital flows are common and significant phenomena, especially in developing countries. Basu and Chau calculated the per capital flight and inward FDI for East Asian and Pacific countries and Latin America and Caribbean from 1989 to 1999 [1]. Ju and Wei used the data of developed countries, emerging market economies and other developing countries from 1990 to 2004 to show that a typical emerging market economy imports net FDI of $1671 per capita while exports net financial capital of $5556 per capita in the year of 2004 [2]. Wang, Wen, and Xu focuses on the Sino-US capital flows, claiming that China accumulated net financial capital outflow of 50% GDP while importing FDI of 20% GDP in 2010 [3].

Theoretical explanation of heterogeneous capital flow, or the "Cross-Hauling Problem" was motivated by the paper written by Jones, Neary, and Ruane in 1983. They first discussed the opposite direction of capital in different sectors and explained the phenomena by assuming some international capital can only produce non-tradable goods, capturing the heterogeneity of capital in its production ability [4]. Later research provides clearer definition of two-way capital flows as "the flight of relatively liquid capital and productive assets that could have contributed to indigenous economic growth, and the inflow of foreign direct investment that shifts the benefits of ownership of local production units onto the hands of foreign entrepreneurs.", and argues that with decreasing absolute risk aversion, entrepreneurs in wealthy countries prefer risky projects in developing countries (see [1] for an example).

Later research on two-way capital flows focused on the opposite direction of Foreign Direct Investment and Portfolio Investment, and try to explain the phenomenon by financial market heterogeneity. The first set of research focuses on risk aversion. Mendoza, Quadrini, and Rios-Rull modeled financial heterogeneity by the ability to implement financial contracts [5]. Combined with production risk and risk aversion, the model generated two-way capital flows. The second kinds of paper try to illustrate this topic with agency problems in corporate governance. Ju and Wei found in a standard corporate finance framework with monitor that capital return can be disentangled into pure financial investment return, financial intermediation cost and entrepreneur payment. Thus, a country with an underdeveloped financial market and worse corporate governance may experience two-way capital flow [2]. The third category solves this puzzle with credit constraints. Wang, Wen, and Xu argues that households' credit constraint leads to excess saving, pushing down the portfolio investment return [3]. Meanwhile, credit constraint of firms restrains credit demand, resulting in high capital return. Thus the more the two constraints are, the more severe the two-way capital flows there will be. The last category of related research introduces two-way capital flows to the portfolio choice models. Usually those research would assume that assets from different countries are not entirely substitutable and two-way capital flows are induced by investors' arbitrage in multiple markets [6-7].

Financial frictions, though very important, may not describe the whole picture. Direct investments and portfolio investments are not just two categories of the Balance of Payment system, but two fundamentally different ways of financing. Direct investment, no matter in the form of greenfield, merging or equity purchasing, allow investors to participate in management, applying inalienable and indivisible effort and technology which cannot be separately acquired. Thus explaining two-way capital flow without noticing the role of FDI in the production process may generate biased results.

For illustration, let's make the following mental experiment. Suppose in 1979, the very moment when China shifted its focus to economic development, it got a wonderful financial market where all contracts are forcible, all investors are well protected and no one faces credit constraint. Is it possible that China can develop into the second-largest economy in 30 years without the two-way capital flow phenomenon? In other words, can China acquire a fast growth rate without the involvement of foreign capital? The answer, though hard to prove rigorously, is more likely to be no, for the reason that we simply do not know how to do things. In an ideal world, it is possible to acquire certain experience and technology by patent purchasing and direct hiring of relative stuff. However, there are times when a country is so underdeveloped that they simply do not know whom to employ and what to purchase. Thus, foreign capital is required to provide vital devotion to the production process.

The discussion of technology and FDI has witnessed bulks of research. Antras, Desai, and Foley noted that pulling force, which is the demand for FDI insure the value maximization process is more important than push force, namely the risk of technological expropriation. In their model, foreign investor has better monitor process to ensure the final profit, and thus FDI is demanded even if internal capital is abundant [8]. Holmes, McGrattan, and Prescott studied the Quid Pro Quo policies of developing countries, which forces foreign capital to transfer a certain amount of technology. With Chinese patent data they provided micro-foundations to this type of theory [9]. Many other papers made further endeavors to the topic [10-12]. Those efforts, albeit rigorous and convincing, do not directly discuss the problem of two-way capital flow. Is the demand for foreign capital's technology able to generate portfolio capital outflow simultaneously? That is the core issue we attempt to explore.

Technology is an abstract concept. In the neoclassic framework, it is treated as a residual in the production function. The discussion of technology is usually ad hoc. For instance, Holmes, McGrattan, and Prescott introduced technology capital in their production function, which is not directly substitutable with tangible capital [9]. We try to model the heterogeneity of capital with micro-foundation. Illustrated by Casamatta in a model discussing the role of venture capital, we regard all capital as perfect substitutes in the sense of fundraising [13]. What distinguishes technological capital investors is that they are able to provide some vital but unobservable (and thus not contractible) effort in the production process. They argue that in such circumstances, equity contracts are optimal to provide proper incentives. We extend their model in the following ways. First, we keep the two-state uncertainty structure but nest it with a neoclassical production function. Second, we restrict equity contract to the kind where capital share the residual (namely, after-wage profit) according to equity proportion. Third, we endogenize the amount of investment made by technological capital investors.

In the above static framework, we are able to show that when capital is provided inelastically, two kinds of capital provider earns different returns. The scarcer the technological capital is, the higher wedge it earns, pushing the return on low-tech capital even lower. Thus, if countries with different capital stock structures are financially linked, two-way capital flow will be a natural result.

2. A General Model Framework

In this section, we present a toy model where capital demand is categorized into high-tech and low-tech. We focus on firms' decision and summarize households' behavior as saving and labor supply $S(w,R)$ and $L(w, R)$ where w and R are wage and interest rate, respectively. It is assumed that $S_R(\cdot, R) < 0$.

2.1. Agents

There are two categories of investors, H and L. The number of H is N_H and the number of L is N_L. These investors invest by issuing debt from domestic financial market at the interest rate of R. Each time one investor can only undertake one project. We assume the debts are risk-free in the sense that they would be repaid with investors' own asset should the project fails. The two kinds of investors make decisions separately.

2.2. Technology

Production faces uncertainty. The output is either $F(K,L)$ with probability p or 0, where $F(\cdot,\cdot)$ is a well-behaved neoclassic production function with constant return to scale. The direct summation of two kinds of capital symbolizes perfect substitutability. However, only investor H can devote effort a to the project, enhancing the probability of success to $p = a^\alpha$ with cost $c(K_H, a)$, where K_H is the capital devotion of investor H. We assume that $\alpha < 1$ and

$$c_K(K_H, a) > 0 \; c_a(K_H, a) > 0, c_{Ka}(K_H, a) > 0 \; c(\cdot\,,0) = 0 \quad (1)$$

Thus the expected output is thus $\hat{F}(K, L, a) = a^\alpha F(K, L)$.

2.3. First Best

Pareto optimal is attained by maximizing the expected net return of production.

$$\max_{K_L, K_H, L, a \in [0,1]} a^\alpha F(K_H + K_L, L) - R(K_H + K_L) - wL - c(K_H, a) \quad (2)$$

FOC:

$$a^\alpha F_K - R = 0 \quad (3)$$

$$a^\alpha F_K - R - c_K \le 0, K_H \ge 0, K_H(a^\alpha F_K - R - c_K) = 0 \quad (4)$$

$$\alpha a^{\alpha-1} F(K_H + K_L, L) - c_a = 0 \quad (5)$$

$$a^\alpha F_L - w = 0 \quad (6)$$

So it is obvious that $K_H = 0$ and K_L, a, and L are determined by $a^\alpha F_K(K_L, L) = R$, $a^\alpha F_L(K_L, L) = w$ and $\alpha a^{\alpha-1} F(K_L, L) = c_a(0, a)$.

2.4. Decentralized Equilibrium

We now decentralize the economy to figure out competitive equilibrium. In particular, we assume that each low-tech investor has access to an investment opportunity, but he or she would need the effort of one high-tech investor to make sure the project operate successfully. Since effort is unobservable and thus cannot be written into contracts, the two investors would divide gross profit according to their capital share. The timeline is as follow. First, a low-tech investor study the investment opportunity he or she has access to and decides total scale of capital input, K, and labor employment,L, taking wage (w) and financing cost (R) as given. Then he or she proposes the investment opportunity to a high-tech investor, who decides his or her capital input, K_H, and effort, a, taking K, L, w, R as given. We assume information is complete.

Applying backward induction, we first solve the problem of the high-tech investor.

$$\max_{K_H \le K, a \in [0,1]} \frac{K_H}{K}(a^\alpha F(K, L) - wL) - RK_H - c(K_H, a) \quad (7)$$

FOC:

$$\frac{1}{K}(a^\alpha F(K, L) - wL) - R - c_K(K_H, a) \ge 0, \; K_H \le K \quad (8)$$

$$\frac{K_H}{K} \alpha a^{\alpha-1} F(K, L) - c_a(K_H, a) \ge 0, \; a \le 1 \quad (9)$$

$$K_H\left(\frac{1}{K}(a^\alpha F(K, L) - wL) - R - c_K(K_H, a)\right) = 0 \quad (10)$$

$$(a-1)\left(\frac{K_H}{K} a^{\alpha-1} F(K, L) - c_a(K_H, a)\right) = 0 \quad (11)$$

SOC:

$$-c_{KK}(K_H, a) < 0 \quad (12)$$

$$\frac{K_H}{K}(\alpha - 1)a^{\alpha-2} F(K, L) - c_{aa}(K_H, a) < 0 \quad (13)$$

$$-c_{KK}(K_H, a)\left(\frac{K_H}{K}(\alpha - 1)a^{\alpha-2} F(K, L) - c_{aa}(K_H, a)\right) - \left(\frac{1}{K}\alpha a^{\alpha-1} F(K, L) - c_{Ka}(K_H, a)\right)^2 > 0 \quad (14)$$

From the first order conditions we get that effort and capital investment are jointly decided. To insure inner solution, we need more assumptions on the effort cost function. For now, we assume $c(\cdot,\cdot)$ is convex. Denote the decision of high-tech capital investor as $K_H^*(K, L; w, R)$ and $a^*(K, L; w, R)$. Since we assume complete information, low-capital investor maximize his profit as

$$\max_{K,L} \left(1 - \frac{K_H^*(K,L)}{K}\right)\left(a^*(K, L)^\alpha F(K, L) - wL) - R\big(K - K_H^*(K, L)\big)\right) \quad (15)$$

Denote the decision of low-tech capital investor as $K^*(w,R)$ and $L^*(w,R)$. Aggregate through all the possible investment opportunities we get the total demand for capital and labor as $\kappa(w,R) = N_L K^*(w,R)$, $\kappa_H(w,R) = N_L K_H^*(K, L; w, R)$ and $\iota(w,R) = N_L L^*(w,R)$. The general equilibrium is found when

$$\kappa(w,R) = N_L K^*(w,R) = S(w,R), \iota(w,R) = L(w,R) \quad (16)$$

However, for this equilibrium to feasible, we implicitly assume that high-tech investors and low-tech investors are one-to-one matched. If high-tech investors are relatively scarce, i.e. $\kappa_H(w,R) < N_H K_H^*$, then only N_H number of projects will be conducted. Since

$$N_H K^*(w,R) < N_L K^*(w,R) \quad (17)$$

and $S(w,R)$ is decreasing with R, the equilibrium interest rate will be lower compared to the situation where $N_H = N_L$. Hence there will be $N_L - N_H$ low-tech investors who would like to attract high-tech investors to invest in his or her project but cannot find one.

Under this situation, when the cross-border capital flow is allowed, and suppose there is a surplus of High-tech investors abroad, then there will be $N_L - N_H$ foreign high tech capital investors who hope to cooperate with local low-tech investors. These foreign investors would issue debt to the amount of

$$K_H^F = (N_L - N_H)K_H^* \quad (18)$$

And then invest these funds as Direct Investment. Although these funds may not have to go across borders, but as capital flows are defined as capital transfer between residents and non-residents, the K_H^F is the amount of two-way capital flow across the border.

3. A Concrete Model

In this section we try to solve the model with concrete function forms

$$F(K,L) = AK^\beta L^{1-\beta} \rightarrow f(k) = Ak^\beta, where\ k = \frac{K}{L} \quad (19)$$

$$C(K_H, L, a) = K_H^\gamma L^{(1-\gamma)} a \rightarrow c(k_H, a) = ak_H^\gamma,\ where\ k_H = \frac{K_H}{L} \quad (20)$$

$$\gamma \geq 1\ 0 < \alpha \ll 1\ 0 < \beta \leq 1\ A > 1 \quad (21)$$

First solve the maximization problem of high-tech investors. Note that given L, his problem is equivalent to

$$\max_{k_H \leq k, a\in[0,1]} \frac{k_H}{k}\left(a^\alpha Ak^\beta - w\right) - Rk_H - ak_H^\gamma \quad (22)$$

FOC:

$$\frac{1}{k}\left(a^\alpha Ak^\beta - w\right) = R + a\gamma k_H^{\gamma-1} \quad (23)$$

$$\frac{k_H}{k}\alpha a^{\alpha-1}Ak^\beta = k_H^\gamma \quad (24)$$

From which we derive optimal effort and high-tech capital investment

$$a^*(k,R,w) = \left(\frac{Rk+w}{(1-\alpha\gamma)f(k)}\right)^{\frac{1}{\alpha}} \quad (25)$$

$$k_H^*(k,R,w) = \left[\frac{\alpha}{k}\left(\frac{Rk+w}{1-\alpha\gamma}\right)^{1-\frac{1}{\alpha}} f^{\frac{1}{\alpha}}(k)\right]^{\frac{1}{\gamma-1}} \quad (26)$$

Proposition 1. As long as effort making is difficult, namely, α is sufficiently close to 0, there will be parameters such that an inner solution to the above problem could be obtained. In other words,

$$a^*(k,R,w) \leq 1\ k_H^*(k,R,w) \leq k \quad (27)$$

Proof: To insure a^* is smaller than 1, we need $Rk + w \leq (1-\alpha\beta)f(k)$. Since $Rk + w$ is the required total cost of production per unit of labor and $f(k)$ is total production per unit of labor. Then it is natural to assume that $Rk + w \leq f(k)$. When k is smaller than the first best amount, then $Rk + w < f(k)$. Thus, as long as $(1-\alpha\beta)$ is close to 0, a^* will be smaller than 1 regardless of k, A, and β.

Next, we prove that when a^* is smaller than 1, $k_H^* < K$ is always satisfied. From the expression of k_H^*, we need

$$\left(\frac{Rk+w}{1-\alpha\gamma}\right)^{1-\frac{1}{\alpha}} f^{\frac{1}{\alpha}}(k) \leq k^\gamma \Leftrightarrow \frac{Rk+w}{1-\alpha\gamma}\left(\frac{1}{A+\alpha^{\frac{1}{\alpha}}}\right)^{\frac{1}{1-\alpha}} \leq k^{\frac{\alpha\gamma-\beta}{\alpha-1}} \quad (28)$$

When $a^* \leq 1$, $\frac{Rk+w}{1-\alpha\gamma} \leq f(k) = Ak^\beta$, Then (by $A > 1$)

$$LHS \leq \frac{Ak^\beta}{(A+\alpha^{\frac{1}{\alpha}})^{\frac{1}{1-\alpha}}} < A^{\frac{-\alpha}{1-\alpha}}k^\beta < k^\beta < k^{\frac{\alpha\beta-\beta}{\alpha-1}} < k^{\frac{\alpha\gamma-\beta}{\alpha-1}} = RHS \quad (29)$$

What is left is to check that Second Order Condition is satisfied around the inner solution. Hessian matrix is as follow

$$H = \begin{pmatrix} -a\gamma(\gamma-1)k_H^{\gamma-2} & \frac{\alpha}{k}Ak_\beta - \gamma k_H^{\gamma-1} \\ \frac{\alpha}{k}Ak_\beta - \gamma k_H^{\gamma-1} & \frac{\alpha}{k}a^{\alpha-2}(\alpha-1)Ak^\beta \end{pmatrix} \quad (30)$$

It is evident that $H_{11} \leq 0$ and $H_{22} < 0$. At (a^*, k_H^*), $\frac{\alpha a^{\alpha-1}Ak^\beta}{k} = k^\gamma$ then

$$|H| = (\gamma-1)k_H^2(\gamma-1)(1-\alpha)(1-\alpha\gamma) > 0 \quad (31)$$

Q.E.D.

Take the derivative of K_H^* with regard to k and denote s as the elasticity of k_H^* with regard to k, we have

$$\frac{dK_H^*}{dk} = \frac{1-\alpha}{(\gamma-1)\alpha}\frac{k_H^*}{k}\left(\frac{\beta-\alpha}{1-\alpha} - \frac{Rk}{Rk+w}\right) = s\frac{k_H^*}{k} \quad (32)$$

Substitute a^* and k^* into the low-tech investor's problem.

$$\max_{k,L}(1-\frac{k_H^*}{k})((a^*)^\alpha Ak^\beta - w)L - R(k-k_H^*)L \Leftrightarrow \max_{k,L}\frac{(k-k_H^*)(Rk+w)}{k}L \quad (33)$$

The first order condition and second order condition is

$$\frac{1}{k^2}\left[(1-\frac{dk_H^*}{dk})(Rk+w)k - (k-k_H^*)w\right] = 0 \quad (34)$$

$$(s-1)\frac{k_H^*}{k}[w(s-1) + sRk] > 0 \quad (35)$$

Clearly, the second order condition is satisfied when $s > 1$. That is, when k_H^* increases faster than k will the proportion of low-tech capital owner decreases with k. So the capital demand satisfies

$$(k - sk_H^*(k))Rk = (s-1)wk_H^*(k) \quad (36)$$

which leads to

$$\left(\frac{w^{\alpha(\gamma-1)-\beta}}{R^{\alpha\gamma-\beta}}A\left(\frac{1-\alpha\gamma}{\alpha}\right)^{\alpha-1}\right)^{\frac{1}{\alpha(\gamma-1)}}=\frac{1-\alpha}{(\gamma-1)\alpha}\left(\frac{\beta-\alpha}{1-\alpha}-\frac{1}{1+\frac{w}{Rk}}\right)\left(\frac{w}{Rk}\right)^{\frac{\alpha(\gamma-1)-\beta}{\alpha(\gamma-1)}}\times\left(1+\frac{w}{Rk}\right)^{\frac{\alpha\gamma-1}{\alpha(\gamma-1)}}-\left(\frac{w}{Rk}\right)^{\frac{2\alpha(\gamma-1)-\beta}{\alpha(\gamma-1)}}\left(1+\frac{w}{Rk}\right)^{\frac{\alpha\gamma-\beta}{\alpha(\gamma-1)}} \quad (37)$$

For the sake of notation, denote the optimal k as $k^*(w,R)$.

Now we discuss consumers' behavior. To simplify the problem, here it is adopted a wealth management framework where utility is derived from wealth rather than consumption. Assume that consumers, with population 1, are endowed with a certain amount of time T, which is devoted to capital or labor formation with CES Aggregation in exchange of goods at rate R and w, respectively. The utility is CRRA form. Thus, given R, w and T agents solve the following problem ($\delta > 1$)

$$\max_{K,L} u(RK+WL)=\frac{1}{\eta}(RK+WL)^{\eta} \quad (38)$$

$$s.t. (K^{\delta}+bL^{\delta})^{\frac{1}{\delta}}\le T \quad (39)$$

It is easy to derive that optimally,

$$\frac{R}{w}=\frac{1}{b}\left(\frac{K}{L}\right)^{\delta-1} \quad (40)$$

Therefore, the capital supply K_S satisfies

$$K_S=k_sL=L\left(\frac{Rb}{w}\right)^{\frac{1}{\delta-1}} \quad (41)$$

$$\frac{Rk}{w}=\left(\frac{R}{w}\right)^{\frac{\delta}{\delta-1}}b^{\delta-1} \quad (42)$$

For the convenience of calculation, denote $\left(\frac{R}{w}\right)^{\frac{\delta}{\delta-1}}b^{\delta-1}$ as $\frac{1}{\phi}$ (here ϕ is not a constant) which leads to $w=\phi Rk$. Then investor's optimal policy can be written as

$$k_H^*=\left[A\alpha\left(\frac{(1+\phi)R}{A(1-\alpha\gamma)}\right)^{\frac{\alpha-1}{\alpha}}\right]^{\frac{1}{\gamma-1}}k^{\frac{\beta-1}{\alpha(\gamma-1)}} \quad (43)$$

$$\frac{dk_H^*}{dk}=\frac{1-\alpha}{(\gamma-1)\alpha}\frac{k_H^*}{k}\left(\frac{\beta-\alpha}{1-\alpha}-\frac{1}{1+\phi}\right) \quad (44)$$

$$s>1\Leftrightarrow\frac{1-\alpha}{(\gamma-1)\alpha}\left(\frac{\beta-\alpha}{1-\alpha}-\frac{1}{1+\phi}\right)>1 \quad (45)$$

Here we assume that $\beta>\frac{1}{1+\phi}$, which means labor is costly enough compared to capital (either β is high or ϕ is high), the second order condition will be satisfied. Then the first order condition is simplified to

$$\mathrm{k}^*=\left[\left(\frac{(1+\beta)(1+\phi)-(1-\alpha)}{\alpha(\gamma-1)}\right)^{\gamma-1}\times\left(A\alpha\left(\frac{(1+\phi)R}{A(1-\alpha\gamma)}\right)^{\frac{\alpha-1}{\alpha}}\right)\right]^{\frac{\alpha}{1-\beta+\alpha(\gamma-1)}} \quad (46)$$

Market equilibrium is found by the following equation

$$(k^*L^*N)^{\delta}+(bL^*)^{\delta}=T^{\delta} \quad (47)$$

Similar to previous analysis, then $N_L < N_H$, there will be excess amount of low-tech investors. When cross-border flow is allowed, there will be $N_L - N_H$ amount of foreign high-tech capital investors raising debt at the amount of $(N_L-N_H)k_H^*$ in domestic financial system and then invest in domestic projects as Foreign Direct Investment, creating cross-border capital flows.

4. Conclusions

Open economy not only allows the exercise of comparative advantage through trade, but can also introduce important production factors from abroad. Capital per se is not as important as entrepreneurship. In this paper, we set up a model with heterogeneous capital to rationalize the *Two-way Capital Flow Puzzle*, emphasizing the characteristic of Direct Investment which allows investors to participate in the firm management. In our model, technological capital distinguishes itself in the sense that it is attached with entrepreneurs' vital but unobservable effort to the production process. We claimed that the shortage of productive entrepreneurs in developing countries is an important determinant of two-way capital flows.

With these thinking in mind, we regard the two-way capital flows between developing countries and developed countries, China and the US for instance, is beneficial to both sides. The former provided funding at a lower cost in the form of Portfolio Investment outflows in exchange for the valuable intangible production factors such as entrepreneurship, management experiences, and know-hows attached to Direct Investment inflows. It is a good example illustrating the benefit of economic globalization. In this regard, the current trade disputes among the US, China, and other countries should be properly settled in order to keep the improvement of globalization process, which is good both to the developing countries and the developed countries.

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