Global Imbalances with Safe Assets in Eurozone

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Abstract

In one open two-country economy, a higher domestic productivity level raises both mean and variance of wealth dynamic, and can lead to a greater accumulation of safe assets. The empirical evidences on the 19 countries of Eurozone confirm that the safe assets exchange supports the international risk-sharing across countries. Moreover, in comparison with the risky investments (FDI and Portfolio Equities), the safe assets (Bonds) are the dominant driver of global imbalances within Eurozone.

Keywords: Current Account, Endogenous Portfolio Choice, Safe Assets, Productivity Level.

JEL Classifications: F21, F32, F41.

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1 Introduction.

The global imbalances in Eurozone are featured by three stylized facts.

Fact 1: The net total capital inflows for each country have been increasing from 1990s with the free cross-border movement of capital and have boosted up substantially from 2000s with introduction of one common currency (Panel A).

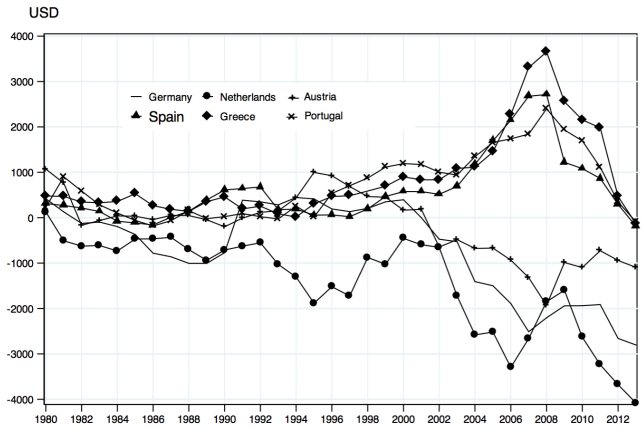
Fact 2: Both exporters (such as Germany, Netherlands, Austria) and importers of capital (such as Spain, Portugal, Greece) are advanced economies. The feature is different to the up-hill capital flows from developing to developed economies postulated by Lucas (1990).

Fact 3: The Debts flows dominate the FDI and Portfolio flows on shaping the pattern of international capital flows. Panel B demonstrates that the net total capital inflows (the solid line) is driven mainly by the net Debts inflows (the solid line) for Germany. The same pattern applies for Spain on Panel C.

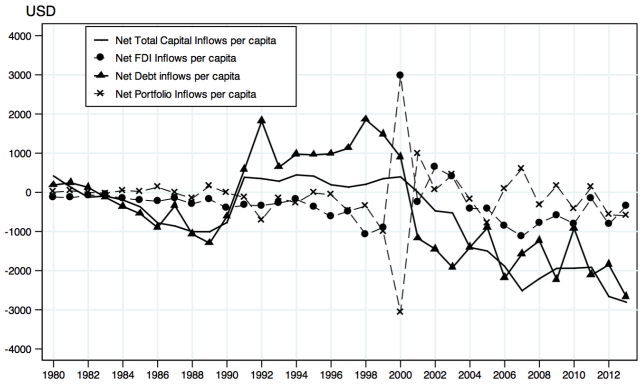
Despite a large body of literature on global imbalances for last decades, there are a few frameworks to analyze these joint phenomena emerged within Eurozone. On theory, the capital can flow out from developing countries with the severe financial friction. Both creditors and debtors in Eurozone, however, have similar financial development level (Panel A). On empirical evidences, the advanced economies can have the valuation gains on the international investment position due to the exchange rate fluctuation and differential rates of returns on international investment. The same currency in Eurozone, however, rules out the exchange rate effect. Furthermore, the dominant role of safe assets on shaping the pattern of capital flows has not been explored yet (Panel B and C).

The paper aims to uncover the mechanism underlying the safe assets accumulation and its implication on the pattern of international capital flows, especially when both foreign assets and liabilities are denominated into one common currency as Eurozone. We employ both theoretical model and empirical analysis to show that the dominant features in Figure (1.0.1) can arise from the interaction between supply of safe assets and productivity level.

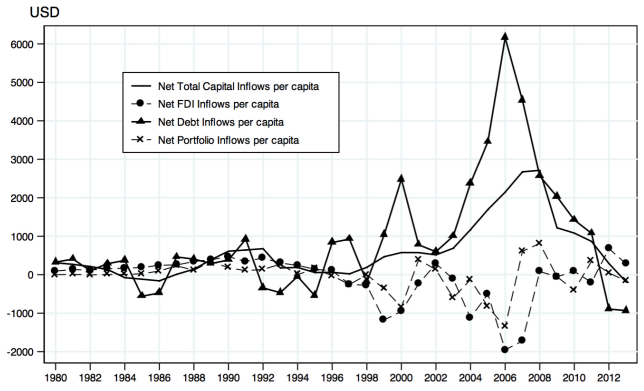
We decompose the net total capital inflows into the risky (FDI and Portfolio) and safe assets (Bonds). By the mean-variance output processes with risk-averse agents, a higher productivity level raises both mean and variance of wealth accumulation. Therefore, it motivates the agents to hold the safe assets to insure against a higher variance. Next, we carry out the empirical analysis on one panel data for 19 countries in Eurozone. The evidences strongly support that a higher productivity level leads to



A. Net Total Capital Inflows per capita (-CApc) by country



B. Decomposition of Net Total Capital Inflows per capita: Germany



C. Decomposition of Net Total Capital Inflows per capita: Spain

Figure 1.0.1: GLOBAL IMBALANCES IN EUROZONE

Sources: Alfaro, KalemliOzcan, and Volosovych (2014)

greater accumulation of safe assets. In brief, the paper sheds the new lights on the flows of both risky and safe assets across countries with the similar fundamentals.

The paper belongs to the literature on the international capital flows within Euro area. Past papers rely on the low saving and high investment rate due to convergence in output per capita (Blanchard and Giavazzi (2002)), on the convergence and growth expectations (Lane and Pels (2012)), on the allocation of imported capital between tradable and non-tradable sectors (Giavazzi and Spaventa (2011)). Some distinguishing elements mark our paper from the aforementioned ones. First, we focus on the exogenous supply of safe assets as the crucial driver of current account adjustment, by separating the risky investments' flows (FDI and portfolio) to the risk-free investments' flows (Bonds) . Second, we emphasize the changes of net foreign assets rather than the conventional current account to measure the the cross-border capital flows. Therefore, the empirical analysis can account for the valuation gains based on the differential rates of returns on cross-border investment.

Our work is also related to the growing macro-finance literature that incorporates endogenous portfolio choice into models of open economy macroeconomy, such as with the asymmetric information (Tille and Wincoop (2010), home bias on equity (Coeurdacier and Rey (2013)). While these papers provide a various approximation technique to analyze current account around the steady state, ours produces an exact closed-form characterization of the equilibrium. This feature is familiar with Pavlova and Rigobon (2010a)'s pure exchange economy with log utility and zero net supply of Bonds. However, we elaborates one open production economy with more general utility function and strictly positive supply of safe assets. Furthermore, the combination of theory and evidences on case of Eurozone is one key feature that differs our paper to most of literature, which do not have the empirical analysis due to the lack of data on the decomposition of cross-border investment.

Our paper is related to the line of research on the role of safe assets within global economy. Farhi and Maggiori (2016) focus on the competition on supplying the risk-free debts as the reserve assets on the international monetary system. Farhi, Caballero and Gourinchas (2008) argue the high supply of financial assets by advanced economies attracts the inflows of capital from the developing economies. He, Krishnamurthy and Milbradt (2016) characterize the safe assets based on the float of sovereign bonds and the fundamentals available to rollover the public debt. However, by taking the supply side as given, we focus on the demand side of safe assets to analyze the pattern of international capital flows.

The paper proceeds as follows. Section 2 presents the theory and characterizes the

role of safe assets on shaping the international risk-sharing and pattern of capital flows. Section 3 shows the evidences to investigate the theory. Section 4 concludes.

2 Theory.

2.1 Economy.

We work with a continuous-time production economy populated by two countries: Home and Foreign. Both countries produce one common free mobile good which can be consumed or accumulated as capital and traded in a perfectly integrated world capital market.

2.1.1 Production And Assets.

The flows of outputs at Home (dy) and at Foreign (dy^*) follow the stochastic linear production functions, using domestic domiciled capitals.

$$\begin{aligned} dy &= akdt + ak\sigma dz \\ dy^* &= a^*k^*dt + a^*k^*\sigma^*dz^* \end{aligned}$$

whereby $(a, k); (a^*, k^*)$ are productivity levels and capital stocks in Home and Foreign respectively. The parameters $(\sigma; \sigma^*)$ are non-negative constants, representing the variance. The terms $(dz; dz^*)$ represent the proportional productivity shocks in Home and Foreign. The set-up features the mean-variance analysis (Turnovsky (1997)) to address important trade-offs between the level of macroeconomic performance and the associated risks.

z and z^* are Wiener processes with the increments that are normally distributed with zero mean ($E[dz] = E[dz^*] = 0$) and variance ($E[dz^2] = E[dz^{*2}] = dt$). The productivity shock is assumed to be country-specific: $Cov(dz, dz^*) = 0$.

Beside the two risky assets, there are also risk-free Bonds, which we define as the safe assets. Their supply is assumed to be exogenous so that the safe interest rate is endogenously determined by the Bond's market clearing condition. Technically, the supply of safe assets can be endogenous or exogenous. Barro, Fernndez-Villaverde, Levintal and Mollerus (2014) employs one model with heterogenous relative risk averse coefficients across countries, in which the more-risk-averse agent issues the Bonds to the less-risk-averse one. However, within our framework, since both Home and Foreign agents have the same risk averse coefficient, there is no motivation for one economy to

issue the safe assets to the other. Therefore, the exogeneity of safe assets is necessary to assure the market clearing conditions. This feature is also employed on Farhi, Caballero and Gourinchas (2008), in which the supply of safe assets is a constant fraction of domestic output.

2.1.2 Preferences And Portfolio Choice.

The Home representative consumer holds three assets: domestic risky capital (k^d), foreign risky capital ($k^{d,*}$) and Bonds as safe assets (b), subject to the wealth (w) constraint.

$$k^d + k^{d,*} + b = w$$

Consumers are assumed to purchase output over the instant dt at the nonstochastic rate cdt out of income generated by their holding of assets. Their objective is to select their portfolio of assets and the rate of consumption to maximize the expected value of lifetime utility

$$E \int_0^\infty \frac{1}{\gamma} c^\gamma e^{-\beta t} dt$$

whereby $(-\infty < \gamma < 1)$ and the discount factor satisfies: $0 < \beta < 1$. The relative risk averse coefficient (i.e,$\frac{-cu''(c)}{u'(c)}$) is contant at $(1-\gamma)$ and satisfies: $0 < (1-\gamma) < \infty$.

The stochastic wealth accumulation equation is:

$$dw = w[n^d dR^k + n^{d,*} dR^{k,*} + n^b dR^b] - cdt \tag{1}$$

whereby, we define

$n^d \equiv \frac{k^d}{w}$ = portfolio share of the domestic risky capital,

$n^{d,*} \equiv \frac{k^{d,*}}{w}$ = portfolio share of the foreign risky capital,

$n^b \equiv \frac{b}{w}$ = portfolio share of safe assets,

dR^i = real rate of return on assets $i = (k, k^*, b)$.

The rates of return on the Home capital, Foreign capital and Bonds are:

$$dR^k \equiv \frac{dy}{k} = adt + a\sigma dz \tag{2}$$

$$dR^{k,*} \equiv \frac{dy^*}{k^*} = a^* dt + a^* \sigma^* dz^* \tag{3}$$

$$dR^b = rdt \tag{4}$$

Plugging (2), (3), (4) into (1), the stochastic optimization problem is the choice of consumption-output ratio (c/w), and the portfolio shares $(n^d, n^{d,*}, n^b)$ to maximize the expected life-time utility:

$$E\int_0^\infty \frac{1}{\gamma}c^\gamma e^{-\beta t}dt \tag{5}$$

subject to the dynamic budget constraint and the wealth constraint:

$$\begin{aligned}
\frac{dw}{w} &= (an^d + a^*n^{d,*} + rn^b - \frac{c}{w})dt + (an^d\sigma dz + a^*n^{d,*}\sigma^* dz^*) &(6)\\
&\equiv (\rho - \frac{c}{w})dt + d\bar{w} \equiv \psi dt + d\bar{w} &(7)\\
1 &= n^d + n^{d,*} + n^b &(8)
\end{aligned}$$

Whereby, we define

$\rho \equiv an^d + a^*n^{d,*} + rn^b$, as the disposable income,

$\psi \equiv \rho - \dfrac{c}{w}$, as the deterministic growth rate of wealth accumulation,

$d\bar{w} \equiv n^d a\sigma dz + n^{d,*}a^*\sigma^* dz^*$, as the stochastic part of wealth accumulation.

Similarly, the Foreign agent chooses the consumption rate and portfolio shares to maximize the lifetime utility:

$$E\int_0^\infty \frac{1}{\gamma}c^{*\gamma} e^{-\beta t}dt \tag{9}$$

subject to the dynamic budget constraint and the wealth constraint:

$$\begin{aligned}
\frac{dw^*}{w^*} &= \psi^* dt + d\bar{w}^*\\
\psi^* &\equiv an^f + a^*n^{f,*} + rn^{b,*} - \frac{c^*}{w^*} \equiv \rho^* - \frac{c^*}{w^*}\\
1 &= n^f + n^{f,*} + n^{b,*} \equiv \frac{k^f}{w^*} + \frac{k^{f,*}}{w^*} + \frac{b^*}{w^*}\\
d\bar{w}^* &\equiv n^f a\sigma dz + n^{f,*}a^*\sigma^* dz^*
\end{aligned}$$

Each country is characterized by the initial wealth and constant productivity level: (w_0, a) for Home, and (w_0^*, a^*) for Foreign. And Home economy is assumed to have a higher productivity level than Foreign one: $(a > a^*)$.

2.2 Equilibrium.

Definition 2.2.1. *The equilibrium is the list of allocation in consumption and investment* $Z := (c, k^d, k^{d,*}, b)$ *for Home agent and* $Z^* := (c^*, k^f, k^{f,*}, b^*)$ *for Foreign agent such that:*

1 Z and Z^* maximize the expected utility (5, 9) subject to the dynamic budget constraints (1,7) respectively.

2 The market clearing conditions on:

2.1 Consumption and investment good: $c + c^* + k + k^* = y + y^*$

2.2 Home capital stock: $k = k^d + k^f$

2.3 Foreign capital stock: $k^* = k^{d,*} + k^{f,*}$

2.4 Bonds: $b + b^* = \bar{b}$

The constrained utility maximization falls into the clasical Samuelson-Merton portfolio choice problem where the agent with the constant-relative-risk-aversion utility function allocates the constant portfolio shares among the risky and risk-free assets, which we summarize in the following proposition

Proposition 2.2.1. *Suppose that productivity shocks are country-specific, then the equilibrium is characterized by the constant portfolio shares, the safe interest rate and the tranversality condition.*

$$\begin{aligned}
n^d &= n^f = \frac{1}{(1-\gamma)}\frac{(a-r)}{a^2\sigma^2} \\
n^{d,*} &= n^{f,*} = \frac{1}{(1-\gamma)}\frac{(a^*-r)}{a^{*2}\sigma^{*2}} \\
n^b &= n^{b,*} = 1 - n^d - n^{d,*} \\
r &= \frac{[1/(a\sigma^2) + 1/(a^*\sigma^{*2})] + (1-\gamma)[\bar{b}/(w+w^*) - 1)]}{1/(a^2\sigma^2) + 1/(a^{*2}\sigma^{*2})} \\
\rho &= \rho* = an^d + a^*n^{d,*} + rn^b \\
\frac{c}{w} &= \frac{c^*}{w^*} = \frac{1}{(1-\gamma)}[\beta - \gamma\rho + \frac{1}{2}\gamma(1-\gamma)\sigma^2_{\bar{w}}] \\
\psi &= \psi^* = \frac{1}{(1-\gamma)}[\rho - \beta - \frac{1}{2}\gamma(1-\gamma)\sigma^2_{\bar{w}}] \\
\sigma^2_{\bar{w}} &= \sigma^2_{\bar{w}^*} = (n^d)^2a^2\sigma^2 + (n^{d,*})^2a^{*2}\sigma^{*2} \\
lim_{t\to\infty}E[w(t)^\gamma e^{-\beta t}] &= 0; lim_{t\to\infty}E[w(t)^{*\gamma}e^{-\beta t}] = 0
\end{aligned}$$

Proof. Appendix □

Merton (1969) shows that the transversality condition implies a strictly positive consumption over wealth ratio. Since the risk aversion coefficient and portfolio shares are the same across countries, the trading of assets is only driven by the difference in initial wealth.

2.2.1 Parameters Restrictions.

We needs the restrictions on parameters for the positive safe interest rate and risk premiums: $(0 < r < a^* < a)$ and the feasible portfolio shares: $(n^d, n^{d,*}, n^b) \in (0, 1)$. Note that by assumption, $(a > a^*)$, then the first condition turns out to be $(0 < r < a^*)$. Then, the portfolio shares are positive. Therefore, the second condition reduces to be: $(n^d, n^{d,*}) < 1$; $(0 < n^b < 1)$.

In particular, the condition for the positive safe interest rate $(r > 0)$ is as following:

$$(1-\gamma)(1-\frac{\bar{b}}{w+w^*}) < \frac{1}{a\sigma^2} + \frac{1}{a^*\sigma^{*2}}$$

This inequality implies that the exogenous supply of safe assets needs to be high enough to meet the demand of safe assets.

$$\frac{\bar{b}}{w+w^*} > 1 - \frac{1/(a\sigma^2) + 1/(a^*\sigma^{*2})}{1-\gamma} \tag{10}$$

Another interpretation is that the agents should have a low enough risk averse coefficient:

$$(1-\gamma) < \frac{1/(a\sigma^2) + 1/(a^*\sigma^{*2})}{1-\bar{b}/(w+w^*)} \tag{11}$$

The condition for the positive risk premiums $(r < a^*)$ is as following:

$$(1-\gamma)(1-\frac{\bar{b}}{w+w^*}) > \frac{1}{a\sigma^2}(1-\frac{a^*}{a})$$

The condition can be interpreted as the exogenous supply of safe assets needs to be low enough or the agents should have a high enough risk averse coefficient.

$$\frac{\bar{b}}{w+w^*} < 1 - \frac{1}{a\sigma^2}\frac{1-a^*/a}{1-\gamma} \Leftrightarrow (1-\gamma) > \frac{(1/(a\sigma^2))(1-a^*/a)}{1-\bar{b}/(w+w^*)} \tag{12}$$

Combining (10), (11) with (12), we end up with two equivalent conditions:

$$\begin{aligned} 1 - \frac{1/(a\sigma^2) + 1/(a^*\sigma^{*2})}{1-\gamma} \quad &< \quad \frac{\bar{b}}{w+w^*} < 1 - \frac{1}{a\sigma^2}\frac{1-a^*/a}{1-\gamma} \\ \frac{(1/(a\sigma^2))(1-a^*/a)}{1-\bar{b}/(w+w^*)} \quad &< \quad (1-\gamma) < \frac{1/(a\sigma^2) + 1/(a^*\sigma^{*2})}{1-\bar{b}/(w+w^*)} \end{aligned}$$

Next, we find the condition for the feasible portfolio shares. In details,

$$\begin{aligned} n^d < 1 \quad &\Leftrightarrow \quad (1-\gamma)\sigma^2 a^2 - a + r > 0 \\ n^{d,*} < 1 \quad &\Leftrightarrow \quad (1-\gamma)\sigma^{*2} a^{*2} - a^* + r > 0 \\ n^b > 0 \quad &\Leftrightarrow \quad \frac{\bar{b}}{w+w^*} > 0 \end{aligned}$$

The first and second inequalities are satisfied because they are the quadratic function with the negative discriminant[1]. The last inequality is satisfied by assumption of the positive exogenous supply of safe assets.

Finally, we also assume that $(\sigma \geq \sigma^*)$. Combining with the assumption that $(a > a^*)$, this implies that the risk premium on Home risky capital is higher or at least equal to the risk premium on Foreign one: $(1-\gamma)a^2\sigma^2 > (1-\gamma)a^{*2}\sigma^{*2}$. Note that for σ is lower enough than σ^*, we can have $a^2\sigma^2 = a^{*2}\sigma^{*2}$, then the low domestic variance can lead to the Home bias on portfolio choice: $n^d > n^{d,*}$. But for $\sigma \geq \sigma^*$ and $a > a^*$, we can not compare between n^d and $n^{d,*}$.

Our result does not depend on the assumption that $(\sigma \geq \sigma^*)$. Indeed, the mean-variance framework implies that the Home's risky capital provides a higher mean and a higher variance than Foreign's. Therefore, the Home agent still has the motivation to buy the Foreign risky asset and Bonds for risk diversification . Moreover, the existence of safe assets makes the equilibrium portfolio share on the risky assets to be dependent the safe premium, not by the difference between Home and Foreign risky rate of return. In brief, an agent would buy both the risky and safe assets.

2.2.2 Endogenous Risk Premium.

The Home risk premium is the difference between the Home risky rate of return (a) and the safe interest rate (r).

$$a - r = \frac{(a - a*)/(a*^2\sigma*^2) + (1-\gamma)(1 - \bar{b}/(w + w*))}{1/(a^2\sigma^2) + 1/(a*^2\sigma*^2)}$$

As a result, the more scarcity the supply of safe assets (i.e, lower ratio $\bar{b}/(w + w^*)$) raises the risky premium. Indeed, the safe interest rate is increasing on the supply:

$$\frac{\partial r}{\partial \bar{b}} > 0$$

Our model provides an alternative explaination for raising risk premium after the 2008 financial crisis as documented by Caballero and Farhi (2017). The crisis has reduces substantially the world supply of safe assets: many assets fall out of AAA ranking group, some sovereign Debts become risky due to higher probability of default. Within our model, this decline on safe assets supply raises the risk premium by reducing the safe interest rate.

[1] $\Delta = 1 - 4(1-\gamma)\sigma^2 < 0$; $\Delta^* = 1 - 4(1-\gamma)\sigma^{*2} < 0$. And $(1-\gamma)\sigma^2 > 0; (1-\gamma)\sigma^{*2} > 0$. Then, the quadratic functions are always positive.

2.3 Safe Assets Mechanism.

2.3.1 International Risk-Sharing.

The demand for safe assets arises from the risk-sharing motivation. With safe assets, the agents can mitigate the output shocks by gaining the risk-free interest rate on any case. Therefore, the model solution attains the perfect risk sharing between Home and Foreign economy (cf. Obstfeld (1994)).

Within our mean-variance framework, a higher productivity level raises both mean and variance of output. Therefore, the household faces the trade-off between higher mean and lower variance of output. Around the equilibrium, we have:

$$\begin{aligned}\frac{\partial n^d}{\partial a} &= \frac{\frac{(a^2\sigma^2 + a^{*2}\sigma^{*2} - (a-a^*)2a\sigma^2}{(1-\gamma)} - (1 - \frac{\bar{b}}{w+w^*})2a\sigma^2 a^{*2}\sigma^{*2}}{[(a^2\sigma^2) + (a^{*2}\sigma^{*2})]^2} \\ \frac{\partial n^b}{\partial a} &= -\frac{\partial n^d}{\partial a}\end{aligned}$$

By setting $\frac{\partial n^d}{\partial a} > 0$, we find the condition on the relative risk averse coefficient such that an increase of productivity level raises the safe asset accumulation.

Proposition 2.3.1. *If the agent has a high enough coefficient of relative risk averse, i.e,* $(1-\gamma) > (1-\bar{\gamma})$*, then a higher productivity level raises the safe assets accumulation:* $\frac{\partial n^d}{\partial a} < 0; \frac{\partial n^b}{\partial a} > 0$*, whereby,* $(1-\bar{\gamma}) \equiv \frac{a^{*2}\sigma^{*2} + 2aa^*\sigma^2 - a^2\sigma^2}{2a\sigma a^{*2}\sigma^{*2}[1-\bar{b}/(w+w^*)]}$.

The existence of threshold $(1-\bar{\gamma})$ relies on the mean-variance output process. Since the productivity level enters both the mean and variance, its increase raises both the mean and variance of risky assets and wealth. This trade-off motivates an agent to accumulate the safe assets to insure against a higher variance on the growth rate of wealth accumulation.

In details, if the agent has a high enough relative risk averse coefficient, an increase of productivity reduces the demand for domestic risky investment because she evaluates the gain by the mean to be less than the lost by the variance. And she accumulate more safe assets. However, if the agent has a low relative risk averse coefficient, an increase of productivity raises the demand for domestic risky investment because she evaluates the gain from a higher mean to be more than the lost from a more variance. And she de-accumulates the safe assets to have more funds for the risky asset.

Moreover, the threshold is increasing on the supply of safe assets ($\bar{b}$). When the safe assets become more scare (i.e, $\bar{b}$ declines), $(1-\bar{\gamma})$ goes down. Therefore, the condition

that $(1-\gamma) > (1-\bar{\gamma})$ tends to be held easier. An increase of productivity will be more likely to raise the demand for safe assets. This might contribute on explaining the increase of the demand for safe asset for the last decades (for instance, panel B and C in Figure **??**) when the supply of world safe assets goes down.

Another interpretation of proposition (2.3.1) is that the negative impact of domestic productivity level on the domestic investment is a marginal effect at a high level of productivity and a high domestic investment-output ratio. The data sample from Eurostat shows that this ratio for 19 economies in Euro area is between 20% and 40%, which is quite high. This observation, in turn, might suggest a great motivation to accumulate the safe assets in Euro area.

Note that an increase of the variance of output unambiguously reduces the demand for domestic risky assets ($\frac{\partial n^d}{\partial \sigma^2} < 0$) and raises the demand for safe assets ($\frac{\partial n^b}{\partial \sigma^2} > 0$).

2.3.2 International Capital Flows.

We define the net total capital inflows as the negative value of changes on net foreign assets (NFA). In details, the Home country's net foreign assets are the difference between total foreign assets ($k^{d,*} + b$) and total foreign liabilities (k^f). Therefore, the Home's net total capital inflows are as following:

$$dNFA = d(k^{d,*} - k^f + b) \tag{13}$$

where the first two terms are the Home's investment in the Foreign capital stock minus Foreign's investment in the Home capital stock, and the last term is Home's balance on the Bonds account.

By using the definition of portfolio share on (1), we rewrite (13) as:

$$\begin{aligned} dNFA &= ((n^{d,*} + n^b)\psi w - n^f \psi^* w^*)dt + ((n^{d,*} + n^b)w d\bar{w} - n^f w^* d\bar{w}^*) \\ &\equiv \mu^{dNFA} dt + dw^{dNFA} \end{aligned}$$

whereby we denote the drift part as μ^{dNFA} and the diffusion part as dw^{dNFA}.
At the beginning of each instantaneous time period dt, the Home and Foreign agents take the wealth as given, (w, w^*). Then, the change in Net Foreign Asset depends on the portfolio shares, on the relative comparison of Home wealth over Foreigner's, and on the realization of production shocks. The unconditional expected value of net total capital inflows are: $E(dNFA) = \mu^{dNFA}$. Therefore, the impact of an increase on Home's productivity level is as following:

$$\frac{\partial \mu^{dNFA}}{\partial a} = ((n^{d,*} + n^b)w - n^f w^*)\frac{\partial \psi}{\partial a} + (\frac{\partial n^b}{\partial a}\psi w - \frac{\partial n^f}{\partial a}\psi w^*)$$

The effect of productivity level on the capital inflows depends on the initial position of net foreign assets (i.e, the term $(n^{d,*}+n^b)w - n^f w^*)$), the wealth's growth rate (i.e, the term $\frac{\partial \psi}{\partial a}$), and the portfolio share (i.e, the term $(\frac{\partial n^b}{\partial a}\psi w - \frac{\partial n^f}{\partial a}\psi w^*)$).

Given the positive value of other terms, for one creditor (i.e, $(n^{d,*}+n^b)w - n^f w^* > 0$), a higher domestic productivity level results in the greater changes on net foreign assets. Since the net total capital inflows are the negative value of changes on net foreign assets, a higher productivity level leads to lower net total capital inflows. However, for one debtor (i.e, $(n^{d,*}+n^b)w - n^f w^* < 0$), an increase of domestic productivity level raises the capital inflows. Therefore, the increase of productivity can lead to the reduction of capital inflows for one creditor but to the increase of capital inflows for one debtor.

Since $(\partial\psi/\partial a > 0)$, an increase of domestic productivity level would raises the net total capital inflows. Indeed, for a higher productivity level, the deterministic growth rate of wealth accumulation unambiguously goes up, which increases the Net Foreign Assets. We label this impact as the *income effect*. The impact of productivity improvement on portfolio shares, however, is ambiguous. With a low coefficient of relative risk averse (i.e, $(1-\gamma) > (1-\bar{\gamma})$), both Home and Foreign agents reduce their net claim on bond $(\partial n^b/\partial a < 0)$ and raise the investment on Home's capital stock $(\partial n^f/\partial a > 0)$. With a high coefficient of relative risk averse, they would increase the net claim on Bonds. We label this impact as the *portfolio effect*.

We summarize the results on the following proposition.

Proposition 2.3.2. *The impact of Home productivity level on the expected value of net total capital flows depends on its international investment position, on the relative magnitude of income effect and portfolio effect.*

3 Evidences.

The empirical analysis aims to investigate the evidences on the role of productivity level on the safe assets accumulations and its implication on the pattern of international capital flows.

Specification of Empirical Model.

For the choice of variables, we rely on the equilibrium portfolio share on Proposition 2.2.1. Indeed, since the risky rates of returns and safe interest rate jointly affect the equilibrium portfolio shares, we use them as the independent variables. Moreover,

other factors that can affect the portfolio shares are assumed to be uncorrelated to the explanation variables and be included into the error term.

For the functional form, we assume that both the portfolio shares and net total capital flows are the linear functions of productivity level and risk-free interest rate in the population sample. In fact, the linear functions are the direct implication by Proposition 2.2.1: since the shares are linear on the independent variables, the net total capital inflows which are determined by portfolio shares will also be linear on them. Note that, since the theoretical model is on the continuous-time, its implications can be tested over the quarterly or yearly data sample.

Finally, we perform the panel data analysis to capture the pattern of capital inflows over time on average across countries. The fixed-effect regression is employed to control for the unobserved heterogeneity, which is constant over time in each country.

3.1 Descriptive Statistics.

Portfolio Shares.

The portfolio shares on risky assets are measured by the concept of gross value. Indeed, for one economy, the share of domestic wealth on foreign risky assets ($n^{d,*}$) is measured by gross foreign assets on risky assets (FDI and Portfolio investment), scaled by domestic output. And the share of domestic wealth on domestic risky asset (n^d) is the ratio of domestic gross capital formation over GDP. However, the portfolio share on safe assets is measured by the concept of net value. Since one economy can buy foreign Bonds and the rest of world can also buy its domestic Bonds. Indeed, for one economy, the net position on Bonds = (gross foreign assets on Bonds - gross foreign liabilities on Bonds)/GDP. This measurement is consistent with our theoretical model in which the net position of Bonds enters the law of wealth accumulation.

For each country (called the Home country), we calculate the Home's portfolio shares by scaling its total foreign assets by domestic output, and scaling its total foreign liabilities by the sum of output over other economies. This calculation is consistent with the definition of portfolio shares in our model: the Home's investment on the Foreign risky capital and on Bonds are the ratios over the Home's wealth while the Foreign investments on the Home's risky capital are the ratio over the Foreign wealth.

Capital Flows.

The database from the statistical office of European Union (Eurostat) is the main data source, which includes Direct investment, Portfolio investment, Financial derivatives, Other investment and Official reserve assets. Each type of assets has total assets and total liabilities on million euros at current price, which are available on a quarterly base starting from 1990Q1 to 2014Q1. Therefore, the availability allows the analysis of portfolio shares and capital inflows for one economy, for each type of assets.

Since Eurostat does not have data from 1980 to 1990, we employ also the updated and extended version of dataset of net private and public capital flows (inflows and outflows) constructed by Alfaro, Kalemli-Ozcan and Volosovych (2014) for the robustness check. The main categories of capital flows include Foreign direct investment (FDI), Portfolio equity investment, and Debts. The data on Bonds from Eurostat is included into the Debts category in the database of Alfaro et all (2014). We use the data on Bond flows from Eurostat and on Debts flows from Alfaro et all as the proxy for the risk-free asset. This specification is consistent with the close substitutes between Debts and safe assets, which is emphasized by Gorton (2010) and Stein (2011).

We scale the net capital inflows (net inflows = inflows - outflows) by population. In details, we use the GDP deflator to convert the net capital inflows into the real value, before dividing over the population. For the sample from Eurostat, the capital flows data is converted into the market price at chain linked volume 2010, in million 2010 euro. For the sample from Alfaro et al (2014), the capital flows data is converted into the constant 2005 national price, in million US dollar.

The main advantage of scaling by population compared with scaling by GDP is that it focus on the impact of productivity level on net total capital flows. Indeed, scaling over output cannot differ the impact of productivity on net capital flows and on output. For instance, a higher productivity level can increase the output which, in turn, decreases the net capital flows per output ratio, even when the net capital flows is unchanged. Another advantage is that, as the scaling of net capital inflows by GDP, the scaling over population also rules out the country size effect. In brief, the measurement of capital inflows per capita can be more accurate than the one per GDP.

Productivity Level.

For database from Eurostat, we use the real productivity per hour worked, an index data with 2010 = 100. For database from Alfaro et al, we use the data on real productivity level at constant 2005 national price (in US dollars) from World Penn

Table 8.1 (2015). We also use the real output and capital stock at constant 2005 national price (in US dollar) to calculate the productivity level as implied by the AK production function, for robustness check.

Table 3.1.1: DESCRIPTIVE STATISTICS

Variable	Obs	Mean	Std. Dev.	Min	Max
Eurostat quaterly data 1990Q1 - 2014Q1: 19 countries in Eurozone					
Portfolio Shares by Home Economy					
Bonds Assets (net position=assets-liabilities) per Home GDP on % ($B2y$)	821	374.2693	1451.595	-255.9965	8145.377
Gross Capital Formation per Home GDP on % ($I2y$)	1530	23.46159	4.994745	6.055235	44.43372
Bonds Assets (gross position) per Home GDP on % ($B2yas$)	821	751.2202	2101.531	0	10720.08
Foreign Direct Investment (FDI) Assets per Home GDP on % ($FDI2yas$)	864	847.0259	2955.926	9.892064	20955.91
Portfolio Equities Assets per Home GDP on % ($PEqt2yas$)	874	504.2992	1759.32	.0743273	10788.44
Portfolio Money Market Instrument Assets per Home GDP on % ($M2yas$)	818	139.3595	452.0616	0	3158.503
Financial Derivatives Assets per Home GDP on % ($Fin2yas$)	873	58.81687	168.478	-.0141044	1456.699
Other Investment Assets per Home GDP on % ($O2yas$)	890	876.6667	2302.034	28.1329	14183.09
Portfolio Shares by Rest of World					
Bonds Liabilities per RoW's GDP on % ($B2ROWlia$)	952	10.03632	16.3232	0	73.84238
FDI Liabilities per RoW's GDP on % ($FDI2ROWlia$)	864	8.373001	13.28788	.0000506	84.04279
Portfolio Equities Liabilities per RoW's GDP on % ($PEqt2ROWlia$)	949	7.178518	13.17629	-.2450386	75.18885
Portfolio Money Market Instrument Liabilities per RoW's GDP on % ($M2ROWlia$)	950	1.033507	1.901109	0	9.985188
Financial Derivatives Liabilities per RoW's GDP on % ($Fin2ROWlia$)	872	2.142446	6.416336	-.1191715	49.00974
Other Investment Liabilities per RoW's GDP on % ($O2ROWlia$)	893	13.58581	16.90634	.0737451	69.77227
Net Total Capital Inflows					
Negative Changes of Net Foreign Assets per capita in Euro ($negDNFApc$)	732	-23.81369	4848.272	-55567.69	37601.01
Negative Current Account per capita in Euro ($negCApc$)	1389	-28.90942	519.8331	-3520.348	2473.101
Bonds Inflows per capita in Euro ($BInpc$)	952	42546.5	138588.8	0	1203854
Bonds Outflows per capita in Euro($BOutpc$)	821	115012.3	408771.1	0	2050501
FDI Inflows per capita in Euro ($FDIInpc$)	864	143824.4	619808.4	.5141096	4690185
FDI Outflows per capita in Euro ($FDIOutpc$)	864	138674.4	574004.6	346.5434	4010262
Porfolio Equities Inflows per capita in Euro ($PEqtInpc$)	949	175209.7	751734.3	-846.6924	4375975
Portfolio Equities Outflows per capita in Euro ($PEqtOutpc$)	874	85893.03	343974.7	1.028219	2236235
Other Investment Inflows per capita in Euro ($OInpc$)	893	108260.7	356121.3	875.5031	2315281
Other Investment Outflows per capita in Euro ($OOutpc$)	890	125971.2	450997.3	384.9873	2803216
Productivity and Interest Rate					
Real Labour Productivity per Hour Worked (2010=100) ($A2h$)	1478	90.29276	13.58468	41.5	123.3
Average Real Labour Productivity per Hour Worked (2010=100) by Rest of World ($A2hROW$)	1438	89.98632	10.79478	59.30001	108.8077
EMU Convergence Criterion Bond Yields on % ($RREU$)	1769	6.675534	3.758459	1.34	25.4
Alfaro, Kalemli-Ozcan and Volosovych (2014) annual data 1980-2013: 19 countries in Eurozone					
Negative Changes of Net Foreign Assets per capita in USD ($negDNFApc$)	429	262.052	4509.947	-35049.55	27694.3
Negative Current Account per capita in USD ($negCApc$)	545	-89.54089	1468.011	-9022.555	3652.21
Total Debts Inflows per capita in USD ($TDebtInpc$)	530	5470.542	23271.8	-33217.46	261843.2
Total Debts Outflows per capita in USD ($TDebtOutpc$)	530	8086.497	42419.39	-28993.15	464190.3
FDI Inflows per capita in USD ($FDIInpc$)	530	5755.889	34443.99	-7662.24	379362.8
FDI Outflows per capita in USD ($FDIOutpc$)	530	5812.427	35067.69	-2179.192	342987.8
Equities Inflows per capita in USD ($PEqtInpc$)	515	4699.685	31905.41	-128204.9	381459.8
Equities Outflows per capita in USD ($PEqtOutpc$)	513	1760.186	13247.95	-83219.61	171116.1
Productivity Level, based on AK Production Function in USD (A)	848	.2622039	.1469731	.0984078	1.283636
Productivity Level at Constant 2005 National Price in USD (TFP)	848	.9413703	.139847	.4723747	1.493684
EMU Convergence Criterion Bond Yields on % ($RREU$)	592	6.660203	3.527734	1.4	24.13
Chinn-Ito Index of Openness ($kaopen$)	531	1.360753	1.338268	-1.888895	2.389668

Risk-Free Interest Rate.

We use the Maastricht convergence criterion bond yields for the European Monetary Union as the risk-free interest rate. The data is the interest rates for long-term government Bonds denominated in national currencies, gross of tax, with a residual maturity of around 10 years. The Bonds are replaced regularly to avoid any maturity drift.

Table 3.1.1 shows descriptive statistics on 19 countries in Euro area. For the portfolio shares by Home economy, the Bonds net position have the mean of (374.26%) and standard deviation of (1451%), which are much higher than the domestic investment rate. Both FDI and Portfolio Equities assets exhibit higher mean and deviation than the Bonds net position. For the portfolio shares by Rest of World, the Bonds liabilities have the mean of (10%) and deviation of (16.3%), which are higher than the same statistics for the FDI and Portfolio Equities. For the net total capital inflows, the negative change of net foreign assets has a mean of (-23.81) with a standard deviation of (4848.27) in Eurostat sample; (-299.5) with (3997.7) on Alfaro et al. Moreover, the decomposition of net capital inflows by sub categories also shows a high variation on two samples. For other variables, the real productivity per hour worked and bond yields in Eurostat shows the variations of (13.58) and (3.75). On the sample from Alfaro et al, the productivity computed by AK function has lower mean (0.262) and variance (0.146) than the one from PWT 8.1: (0.94) and (0.13) respectively. Therefore, the data set offers rich variation for exploring the mechanism underlying the safe assets accumulation and the pattern of international capital flows.

3.2 International Risk-Sharing.

Table 3.2.1 shows the regression results of portfolio shares by the rest of world on the Home's productivity level. The main result is that the safe assets (Bonds) plays an important role on risk-sharing across countries: a higher domestic productivity level raises the demand for foreign bonds and reduces the domestic investment. Column 1 demonstrates that 1% of increase on the productivity per hour worked (index with 2011 as base year) raises the ratio of foreign bond over domestic output ($B2y$) by 2.8%. Column 2 shows that 1% of increase on the productivity level reduces the investment-output ratio ($I2y$) by 0.142%. These results are consistent with the theoretical implication that the safe assets are used to insure against the higher variance of domestic output, induced by a higher productivity level. Column 3 to 9 show that a higher productivity level attracts more investment from the Rest of World. Among various types of invest-

Table 3.2.1: Fixed-Effect Regressions of Portfolio Shares on Home's Productivity: 1990Q1-2014Q4

VARIABLES	(1) B2y	(2) I2y	(3) FDI2ROWlia	(4) PEqt2ROWlia	(5) B2ROWlia	(6) M2ROWlia	(7) Fin2ROWlia	(8) O2ROWlia
Productivity Level	2.811**	-0.142***	0.0672***	0.0788***	0.0640***	0.00580*	0.0487**	0.123***
($A2h$)	(1.373)	(0.0118)	(0.0236)	(0.0146)	(0.0223)	(0.00310)	(0.0208)	(0.0141)
Long-Term Interest Rate	10.43*	-0.552***	-0.234**	-0.00199	-0.180**	-0.0481***	-0.267***	0.334***
($RREU$)	(5.387)	(0.0485)	(0.0941)	(0.0587)	(0.0898)	(0.0125)	(0.0822)	(0.0563)
Constant	87.41	39.03***	3.749	0.204	5.564**	0.789**	-1.123	1.287
	(142.3)	(1.252)	(2.452)	(1.504)	(2.294)	(0.319)	(2.151)	(1.466)
Observations	753	1,300	796	878	881	881	806	825
R-squared	0.008	0.124	0.026	0.035	0.019	0.027	0.028	0.098
Number of Countries	17	18	18	18	18	18	18	18

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Samples: 19 countries in Eurozone. Data on quarterly from 1990Q1 to 2014Q4 from Eurostat. Categories of assets includes Direct investment (FDI), Portfolio equities (PEqt), Bonds and Notes (B), Money market instrument (M), Financial derivatives (Fin) and Other investment (O). Assets (as) are scaled by Home's GDP (on percent). Liabilities (lia) are scaled by sum of GDP over all foreign countries on the Rest of World (on percent). $I2y$ is ratio of Gross capital formation over GDP (on percent).

ment, the portfolio equities experience the highest increase (0.15%) while the financial derivatives the lowest (0.04%). In short, these evidences support the theoretical result that the domestic productivity level is a driven signal for the foreign investment.

Moreover, the regression results of long-term interest rate on the portfolio shares are also consistent with the theoretical model. An 1% increase of interest rate raises the net purchasing of the safe assets by (10.43%) while reduces the domestic investment by (0.56%). These evidences confirm the theory that an increase of safe interest rate reduces the portfolio shares on risky assets and raises the share on safe assets. Column 3 to 9 show that the portfolio investments from the rest of world are also decreasing on the safe interest rate. In brief, the empirical evidences reveal the positive effect of long-term interest rate on the safe assets accumulation and its negative effect on the risky investments.

Table 3.2.2 investigates the role of Rest of World's productivity on the Home decision on foreign investment. One prominent result is that a higher foreign productivity level motivates the domestic agents to raise the investment on abroad, for all types of assets. Among them, the direct investment increases most (17.28%) while money market instrument least (2.36%). Another interesting result is that the magnitude of increase on the demand for foreign Bonds induced by the foreign productivity (8.83% in column 1, table 3.2.2) is higher than the demand for the foreign Bonds induced

Table 3.2.2: Fixed-Effect Regressions of Portfolio Shares on ROW's Productivity: 1990Q1-2014Q4

VARIABLES	(1) B2yas	(2) FDI2yas	(3) PEqt2yas	(4) M2yas	(5) Fin2yas	(6) O2yas
ROW's Productivity Level	8.830***	17.28***	7.329***	2.364***	4.306***	10.64***
($A2hROW$)	(1.018)	(4.277)	(1.650)	(0.735)	(0.505)	(1.574)
Long-Term Interest Rate	-2.793	-18.14	0.988	3.270	-6.084***	15.42***
($RREU$)	(3.418)	(15.50)	(5.780)	(2.471)	(1.812)	(5.733)
Constant	-16.22	-656.3	-160.8	-92.95	-319.3***	-148.5
	(102.4)	(430.8)	(166.1)	(74.00)	(50.86)	(158.7)
Observations	753	796	806	752	807	822
R-squared	0.101	0.026	0.025	0.014	0.112	0.056
Number of Countries	17	18	18	17	18	18

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Samples: 19 countries in Eurozone. Categories of assets includes Direct investment (FDI), Portfolio equities (PEqt), Bonds and Notes (B), Money market instrument (M), Financial derivatives (Fin) and Other investment (O). Assets (as) are scaled by Home's GDP (on percent).

by the domestic productivity (5.6% in column 1, table 3.2.1). In sum, the regression results prove that the foreign productivity level affects positively the value of Home's investment on abroad.

In short, the empirical evidences suggest that the improvement of domestic productivity level raises the accumulation of foreign safe assets. Moreover, the productivity and the risk-free interest rate jointly determine the portfolio choice.

3.3 International Capital Flows.

Table (3.3.1) reports the fixed-effect regression of quarterly capital flows on the real productivity per hour worked, on controlling for the interest rate on long-term government's Bonds. The table reveals that the pattern of capital flows on the safe assets (Bonds) is reversal to that of risky assets (including the FDI and Portfolio equities). In details, a higher productivity level has an insignificant impact on the inflows of Bonds and FDI but a positive impact on the inflows of Portfolio equities (890 euro per capita, in column 5) and other type of investment (1140 euro per capita, in column 7). A higher level of productivity, however, significantly raises the outflows of Bonds (629 euro per capita in column 2), Portfolio Equities (849 euro per capita in column 6)

Table 3.3.1: Fixed-Effect Regressions of Capital Flows per Capita: 1990Q1-2014Q4

VARIABLES	(1) BInpc	(2) BOutpc	(3) FDIInpc	(4) FDIOutpc	(5) EqtInpc	(6) EqtOutpc	(7) OInpc	(8) OOutpc	(9) negDNFApc	(10) negCApc
Productivity Level	131.3	629.6***	-943.1	-669.7	890.0*	849.6**	1,140***	1,036***	-23.17	-6.439***
($A2h$)	(243.1)	(153.3)	(1,029)	(762.7)	(454.6)	(331.9)	(288.8)	(323.4)	(24.97)	(1.174)
Long-Term Interest Rate	-2,039**	-101.1	-8,647**	-6,080**	1,111	1,017	3,890***	2,991**	36.27	-17.46***
($RREU$)	(980.8)	(601.7)	(4,103)	(3,040)	(1,831)	(1,302)	(1,152)	(1,288)	(99.36)	(4.948)
Constant	43,120*	65,249***	288,105***	243,546***	98,594**	6,349	-11,420	22,293	2,036	641.0***
	(25,062)	(15,898)	(106,921)	(79,233)	(46,889)	(34,473)	(29,994)	(33,602)	(2,594)	(122.5)
Observations	881	753	796	796	878	806	825	822	676	1,208
R-squared	0.006	0.025	0.006	0.005	0.004	0.008	0.025	0.015	0.002	0.027
Number of Countries	18	17	18	18	18	18	18	18	17	18

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Samples: 19 countries in Eurozone, from Eurostat. Categories of assets includes Direct investment (FDI), Portfolio equities (E), Bonds and Notes (B), Money market instrument (M), Financial derivatives (Fin) and Other investment (O). Capital flows are expressed at chain linked volumes 2010, euro per capita. *In* denotes for the inflows, *Out* denotes for the outflows. Net flows = Inflows - Outflows. Regression with Money market instrument and Financial derivatives are insignificant, so they are dropped to save space.

and other types of investment (1036 euro per capita in column 8). While the portfolio equities and other type of investment experience the positive net capital inflows, the Bonds experience the positive net capital outflows. Moreover, a higher productivity level raises net total capital outflows, measured by the negative current account (about 6.4 euro per capita in column 10). In brief, the net total capital inflows are mainly driven by the accumulation of foreign safe assets.

Another finding is that an 1% increase of long-term interest rate reduces the net FDI inflows by about 2,567 per capita but only raises the net inflows of Other type of investment by 0,899 USD per capita on Column 7. Therefore, the interest rate exerts a negative effect on the net total capital inflows, with a reduction of 17.46 USD per capita recorded on Column (10). In short, the regression results show the negative impact of long-term interest rate on the net total capital inflows, by the greater negative effect on FDI than on other type of investment.

Table (3.3.2) repeats the same regressions on Table (3.3.1) but with the data on the annual capital flows from Alfaro, Kalemli-Ozcan and Volosovych (2014) and the data on productivity level from Penn World Table 8.1 (2015). The table reveals the same result as the previous regressions with the quarterly data sample from Eurostat: a higher productivity level raises the net total Debts outflows, increases the net FDI and Portfolio equities inflows and pushes up the net total capital outflows. Column 1 and 2 show that one percent of increase on productivity level index (2005 as base year) results in an increase of $37,314$ USD per capita of Debts outflows, which is higher than

Table 3.3.2: Fixed-Effect Regressions of Capital Flows per Capita: 1980-2013

VARIABLES	(1) TDebtsInpc	(2) TDebtsOutpc	(3) FDIInpc	(4) FDIOutpc	(5) PEqtInpc	(6) PEqtOutpc	(7) negDNFApc	(8) negCApc
Real Productivity Level (TFP)	24,386***	37,314***	5,590***	5,334***	19,624***	8,123***	-4,472	-2,559***
	(6,398)	(6,154)	(1,383)	(1,136)	(2,671)	(1,401)	(3,225)	(627.4)
Long-Term Interest Rate ($RREU$)	-57.29	182.0	45.00	-16.56	160.5**	7.558	-8.852	-10.41
	(184.4)	(177.4)	(39.87)	(32.74)	(76.93)	(40.34)	(89.61)	(18.09)
Chinn-Ito openness ($kaopen$)	800.3	1,266**	275.0*	201.4*	756.5***	256.3*	319.3	160.6**
	(657.6)	(632.5)	(142.1)	(116.7)	(274.5)	(143.9)	(328.4)	(64.49)
Constant	-21,585***	-36,500***	-5,263***	-4,473***	-20,496***	-7,751***	4,356	2,356***
	(7,051)	(6,782)	(1,524)	(1,252)	(2,943)	(1,543)	(3,633)	(691.5)
Observations	383	383	383	383	380	380	355	383
R-squared	0.070	0.121	0.062	0.111	0.158	0.125	0.010	0.067
Number of Countries	17	17	17	17	17	17	17	17

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Samples: 19 countries in Eurozone, based on data of International Financial Statistics (IFS) from Alfaro, Kalemli-Ozcan and Volosovych (2014). Categories of assets includes Direct investment (FDI), Portfolio equities (PEqt), Total Debts (TDebts). Capital flows are expressed in constant 2005 national price in USD, per capita. In denotes for the inflows, Out denotes for the outflows. Net flows = Inflows - Outflows.

an increase of $24,386$ USD per capita of Debts inflows. Column 3 to 6 demonstrates the reversal pattern for FDI and Portfolio net inflows when the total capital inflows is higher than the total capital outflows. Column 8 reports the net total capital outflows is 2559 USD per capita. In sum, the negative impact of productivity on the net total capital inflows is mostly driven by its negative effect on the net Debts inflows.

4 Conclusion.

We construct a two-country economy to analyze the role of productivity level on shaping the pattern of international capital flows. The theory implies that a higher productivity level raises the variance of output which motivates households to accumulate more foreign Bonds. The empirical analysis over one panel sample of 19 economies on Eurozone supports the theory. Moreover, the pattern of international capital flows on the productivity level is two-way in the sense that a higher productivity level raises net total FDI and Portfolio equities inflows but it induces more net total Bond's outflows.

Our results suggest that along with the policy of improving the domestic productivity level, one country also needs the policy which can reduce the variance of output. Moreover, providing more the safe assets for domestic households can prevent the outflows of domestic savings, which is important for the long-run capital accumulation

and economic growth of one country with an increasing path of productivity level.

On the future research agenda, the model can incorporate the price and exchange rate to capture the role of valuation effect on international financial adjustment (Gourinchas and Rey (2015)). Moreover, the model can also be modified to analyze the recent secular stagnation on the global economy (Baldwin and Teulings (2014)). Taking into account the impact of safe assets on the open-economy economic growth can be the next step to approach the issue.

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A Appendix: Proofs.

Proposition 2.2.1. The method to solve the stochastic optimization problem can be reached in Samuelson (1969), Merton (1969) or Turnovsky (1997). In our model, we are looking for only the interior solution.

Proof. The representative consumer's stochastic optimization problem is to choose consumption and portfolio shares to maximize

$$E\int_0^\infty \frac{1}{\gamma}c^\gamma e^{-\beta t}dt, -\infty < \gamma < 1$$

subject to the stochastic wealth accumudation equation.

$$\begin{aligned}
\frac{dw}{w} &= (\rho - \frac{c}{w})dt + d\bar{w} \\
1 &= n^d + n^{d,*} + n^b \\
\rho &= an^d + a^* n^{d,*} + rn^b \\
dw &= n^d a\sigma dz + n^{d,*}a^*\sigma^* dz^* \\
\sigma_{\bar{w}}^2 &= n_d^2 a^2\sigma^2 + n_d^{*2}a^{*2}\sigma^{*2}
\end{aligned}$$

We define the differential generator of the value function $V(w,t)$ by:

$$L_w[V(w,t)] := \frac{\partial V}{\partial t} + \left(\rho - \frac{c}{w}\right) w\frac{\partial V}{\partial w} + \frac{1}{2}\sigma_{\bar{w}}^2 w^2 \frac{\partial^2 V}{\partial w^2} \tag{14}$$

Given the exponential time discounting, V can be assumed to be of the time-separable form:

$$V(w,t) = e^{-\beta t}X(w)$$

The formal optimization problem is now to choose c, n_d, n_d^*, n_B to maximize the Lagrangean expression:

$$e^{-\beta t}\frac{1}{\gamma}c^\gamma + L_w[e^{\beta t}X(w)] + e^{-\beta t}\eta[1 - n_d - n_d^* - n_B]$$

Taking partial derivatives of this expression, and canceling $e^{-\beta t}$ yields:

$$\begin{aligned}
(c) &: c^{\gamma-1} = X_w \\
(n^d) &: (aX_w w - \eta)dt + cov(d\bar{w}, a\sigma dz)X_{ww}w^2 = 0 \\
(n^{d,*}) &: (\alpha^* X_w w - \eta)dt + cov(d\bar{w}, a^*\sigma^* dz^*)X_{ww}w^2 = 0 \\
(n^b) &: rX_w w - \eta = 0 \\
1 &= n^d + n^{d,*} + n^b
\end{aligned}$$

These equations determine the optimal values for $c/w, n^d, n^{d,*}, n^b, \eta$ as functions of X_w, X_{ww}. In addition, the value function must satisfy the Bellman equation:

$$max_{c,n^d,n^{d,*},n^b}\left\{\frac{1}{\gamma}c^\gamma e^{-\beta t} + L_w[e^{-\beta t}X(w)]\right\} = 0 \tag{15}$$

We postulate a solution of the form:

$$X(w) = \delta w^\gamma$$

Where δ is the coefficient to be determined. Then, $X_w = \delta\gamma w^{\gamma-1}; X_{ww} = \delta\gamma(\gamma-1)w^{\gamma-2}$. The F.O.Cs become:

$$\begin{aligned}
(c) &: \frac{c}{w} = (\delta\gamma)^{1/(\gamma-1)} \\
(n^d) &: (\alpha\delta\gamma w^\gamma - \eta)dt + cov(d\bar{w}, \alpha\sigma dz)\delta\gamma(\gamma-1)w^\gamma = 0 \\
(n^{d,*}) &: (\alpha^*\delta\gamma w^\gamma - \eta)dt + cov(d\bar{w}, \alpha^*\sigma^* dz^*)\delta\gamma(\gamma-1)w^\gamma = 0 \\
(n^b) &: r\delta\gamma w^\gamma - \eta = 0
\end{aligned}$$

Substituting for $(\frac{c}{w})$ into the Bellman equation (15) and the value function (14) leads to:

$$\frac{1}{\gamma}[(\delta\gamma)^{1/(\gamma-1)}w]^\gamma - \beta\delta w^\gamma + [\hat{\rho} - (\delta\gamma)^{1/(\gamma-1)}]w\delta\gamma w^{\gamma-1} + \frac{1}{2}\hat{\sigma}^2_{\bar{w}}w^2\delta\gamma(\gamma-1)w^{(\gamma-2)} = 0$$

$$\Rightarrow \left(\frac{\hat{c}}{w}\right) = (\delta\gamma)^{1/(\gamma-1)} = \frac{\beta - \hat{\rho}\gamma - \frac{1}{2}\gamma(\gamma-1)\hat{\sigma}^2_{\bar{w}}}{1-\gamma}$$

The F.O.Cs dividing by $(\delta\gamma w^\gamma)$:

$$\begin{aligned}
(n^b) &: r = \frac{\eta}{\delta\gamma w^\gamma} \\
(n^d) &: \left(a - \frac{\eta}{\delta\gamma w^\gamma}\right)dt = (1-\gamma)cov(d\bar{w}, a\sigma dz) \\
(n^{d,*}) &: \left(a^* - \frac{\eta}{\delta\gamma w^\gamma}\right)dt = (1-\gamma)cov(d\bar{w}, a^*\sigma^* dz^*)
\end{aligned}$$

By substitute the equilibrium value of $\left(\frac{\hat{c}}{w}\right)$ into the Bellman equation, we find:

$$\delta = \frac{1}{\gamma}\left(\frac{\hat{c}}{w}\right)^{\gamma-1}$$

From this system of F.O.Cs, and with the country-specific shocks ($cov(dz, dz^*) = 0$), we get the macroeconomic equilibrium in Home country:

$$\begin{aligned}
n^d &= \frac{1}{(1-\gamma)}\frac{(a-r)}{a^2\sigma^2} \\
n^{d,*} &= \frac{1}{(1-\gamma)}\frac{(a^*-r)}{a^{*2}\sigma^{*2}} \\
n^b &= 1 - n^d - n^{d,*} \\
\frac{c}{w} &= \frac{1}{1-\gamma}\left(\beta - \hat{\rho}\gamma + \frac{1}{2}\gamma(1-\gamma)\hat{\sigma}^2_{\bar{w}}\right) \\
\psi &= \frac{1}{(1-\gamma)}\left(\hat{\rho} - \beta - \frac{1}{2}\gamma(1-\gamma)\hat{\sigma}^2_{\bar{w}}\right) \\
\hat{\rho} &= an^d + a^*n^{d,*} + rn^b \\
\sigma^2_{\bar{w}} &= n^{d^2}a^2\sigma^2 + n^{d,*^2}a^{*2}\sigma^{*2}
\end{aligned}$$

Similar steps for the Foreign country.
Finally, the safe assets market clearing condition ($b + b* = n^b w + n^{b,*}w^* = \bar{b}$) implies the equilibrium safe interest rate as:

$$r = \frac{[1/(a\sigma^2) + 1/(a^*\sigma^{*2})] + (1-\gamma)[\bar{b}/(w+w^*) - 1)]}{1/(a^2\sigma^2) + 1/(a^{*2}\sigma^{*2})}$$

□