The U.S. Dollar and Global Imbalances

Liu, Kai and Zhou, Xuan

School of Economics, Renmin University of China

4 June 2015

The U.S. Dollar and Global Imbalances*

Kai Liu† and Xuan Zhou‡

June 4, 2015

Abstract: Global Imbalances are mainly featured by the massive and long-lasting U.S. trade deficit. Since the Breton Woods system collapsed and was replaced by the Jamaica Agreement, the U.S. trade deficit has been lasting for about 40 years. This paper proves that permanent global imbalances can be sustainable due to the special role of the U.S. dollar, by building a two-country cash-in-advance growth model with a dollar standard in the international trade. The permanent U.S. trade deficit is an increasing function of the strength of off-shore dollar demand, the long-run growth rate of global nominal GDP, the openness of the international trade, the elasticity of substitution between domestic and foreign goods, and the relative size of the U.S. economy to the rest of the world. The long-run non-neutrality of the U.S. dollar as the world currency exists. Structural global imbalances are accompanied by an unequal international trade with the terms of trade being beneficial to the U.S., and the welfare analysis indicates that: a weakened U.S. dollar in the international trade will reduce the welfare of the U.S. households, but increase the welfare of the whole world.

Key words: U.S. dollar, global imbalances, dollar standard, cash in advance

JEL codes: E42, F32, F41

---

*The authors thank the seminar participants at Renmin University of China. This research is supported by the Fundamental Research Funds for the Central Universities, and the Research Funds of Renmin University of China (No. 15XNF012).

†Corresponding author; Address: School of Economics, Renmin University of China, Beijing, China; Email: liukeynes@ruc.edu.cn

‡Address: School of Economics, Renmin University of China, Beijing, China; Email: xuanzhou@ruc.edu.cn

1 Introduction

Since 1976 the U.S. trade deficit has been lasting for about four decades. Global imbalances are mainly featured by the massive and long-lasting U.S. trade deficit with its major trade partners, such as Japan, China and Europe historically. Figure 1 depicts the evolving path of U.S. net export (as share of GDP), together with the U.S. GDP share in the world.[1] In the first half of 1980s, the deterioration of the U.S. trade deficit was attributed to the trade imbalance between the U.S. and Japan. In the period of 1996-2006, the trade imbalances from China and Europe were dominant. After the 2007-2008 global financial and economic crisis, the U.S. trade deficit shrank a lot. In 2013, it was 3% of U.S. GDP, which still is not a small number.

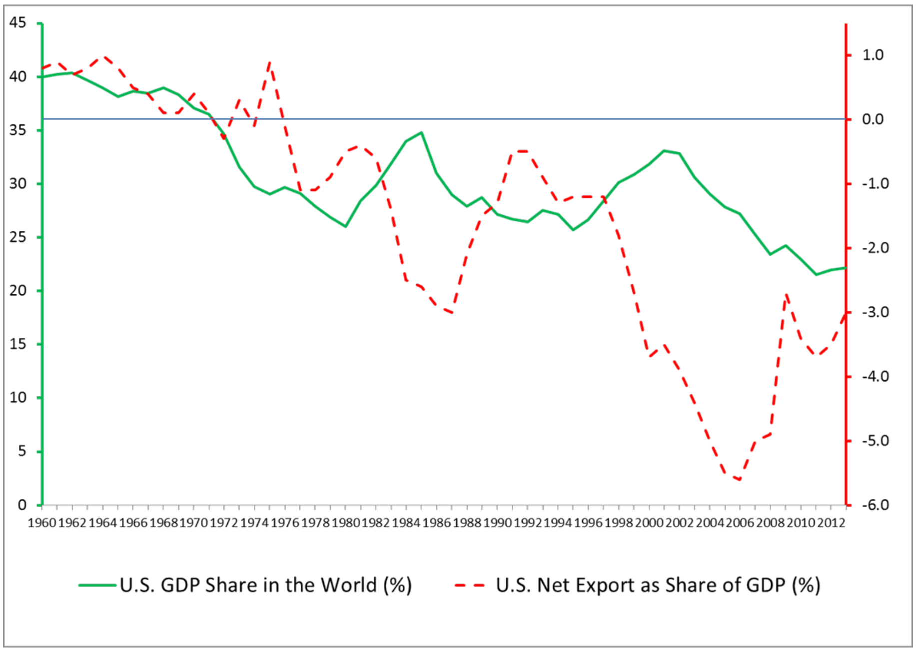

Figure 1: U.S. Net Export as Share of GDP and U.S. GDP Share in the World

There is a strong positive correlation between U.S. trade deficit and U.S. GDP share in the world in the business cycle frequency. This is intuitive since one country's export is positively correlated with the GDP of the rest of the world and its import is positively correlated with its GDP *ceteris paribus*. *Engel and Rogers (2006)* and others studied this kind of positive correlation. However, the most striking fact given by Figure 1 is that: the U.S. trade deficit is a long-run, rather than a short-run, phenomenon, and there is no

[1] The data of U.S. nominal net export and nominal GDP are from the Bureau of Economic Analysis at the U.S. Department of Commerce, and the data of world nominal GDP is from the World Bank database.

tendency for it to converge to zero even though it has already existed for about 40 years without any discontinuity. This indicates that global imbalances or the long-lasting U.S. trade deficit may be a long-run existence at the steady state of the global economy, rather than a temporary phenomenon (with some persistence) as believed by many researchers such as Obstfeld and Rogoff (2005) and Feldstein (2008).

What happened around 1976? The Breton Woods system collapsed in 1973, and it was replaced in 1976 by the Jamaica Agreement, under which the U.S. dollar was no longer pegged to gold and floating exchange rate regimes were allowed for other currencies. The demonetization of gold did not weaken the global roles of the U.S. dollar much. Along with oil and other major international commodities being denominated in the U.S. dollar and the change of global geopolitics, the roles of the U.S. dollar as a world currency have become quite stable. Goldberg and Tille (2008) show that: the dollar is overwhelmingly used for invoicing both export and import prices for the US economy and other economies. The U.S. dollar also plays a prominent role in the portfolios of foreign exchange reserve accounts. And the dollar is a leading transaction currency in the foreign exchange markets (Goldberg, 2010). Since 1976 the U.S. dollar has been playing a central and dominant role in the international trade and finance as both a store of value and a medium of exchange, and no other currencies rival it. The U.S. dollar is the only currency that can be viewed as a world currency in the global economy. The global roles of the U.S. dollar as a store of value and a medium of exchange in global markets induce global demands for it, which generate both the short-run non-neutrality of the U.S. dollar in the global economy, as illustrated by Liu (2014a), and the long-run non-neutrality of the U.S. dollar as the world currency, which is accompanied with global imbalances and will be further shown in this paper. According to a report to the US Congress by the Secretary of the Treasury Department, between 50 percent and 70 percent of the U.S. currency was held outside the U.S. in 2000.[2]

Since running a trade surplus is a major way to obtain U.S. dollar for other economies, global demands for the U.S. dollar make global imbalances a structural phenomenon: U.S. has run trade deficits with almost all its major trade partners for decades as depicted in

[2]This report is downloadable from http://www.treasury.gov/press-center/press-releases/Pages/report3084.aspx.

Figure 2.[3] As long as there is a nominal growth of dollar-denominated international trades due to either global economic growth or the deepening of globalization, the rest of the world excluding U.S. needs to run a trade surplus to obtain extra dollars needed if there is a cash-in-advance (CIA) constraint for these transactions.

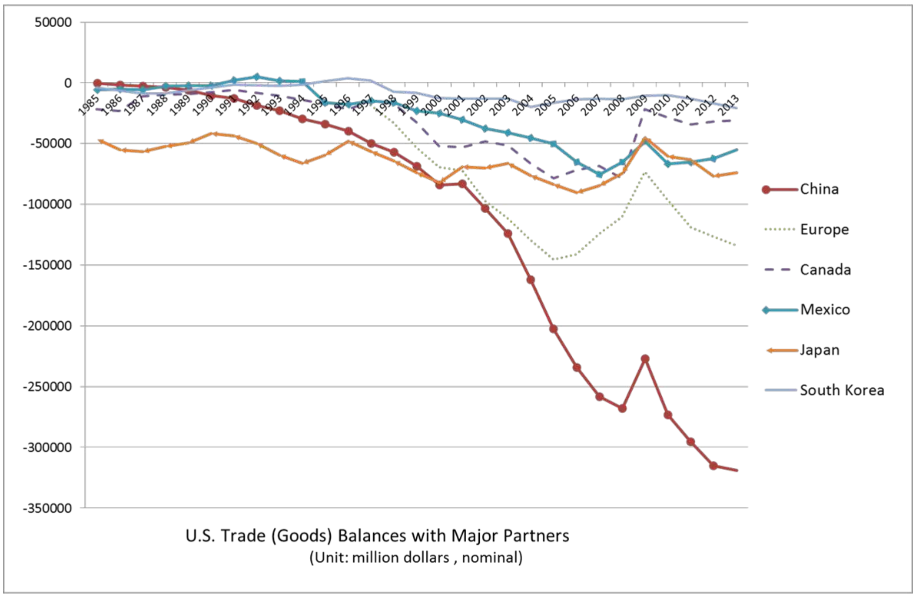

Figure 2: U.S. Trade (Goods) Balances with Major Partners

Obstfeld and Rogoff (2005) and Feldstein (2008) predicted that: a permanent trade imbalances between U.S. and the rest of the world is unsustainable, and thus a substantial depreciation of the dollar's real exchange rate will take place in the future. This viewpoint neglected that the special roles of the U.S. dollar as the only world currency will create more and more demands for it in a world with nominal economic and trade growth, and this force can prevent the U.S. dollar from depreciation, even in the long run. Figure 3[4] depicts the evolving path of the U.S. dollar (USD) index in the past four decades. Along with the four-decade trade deficits of the U.S., we can not see an evident trend of the U.S. dollar's nominal depreciation. In fact the USD index was about 90 on average in the first quarter of 2015, indicating a strong U.S. dollar. Considering the performance of the U.S. inflation rate compared to the inflation rates of major economies in the world during the past decades, we can not see a substantial depreciation of the dollar's real exchange rate.

[3]The relevant data is from the website of the U.S. Census Bureau: https://www.census.gov/foreign-trade/balance/. And the U.S. trade deficit mainly comes from the deficit in goods.

[4]The data is from the website of Federal Reserve Bank of St. Louis: http://research.stlouisfed.org/fred2/.

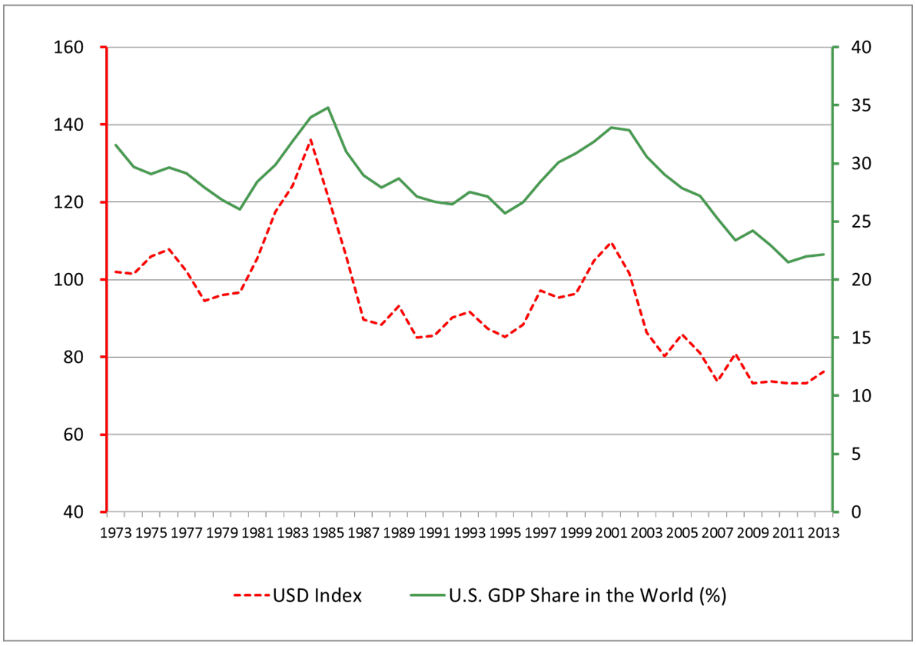

Figure 3: U.S. Dollar Index

To summarize, the long-lasting U.S. trade deficit, indicating global imbalances, is a long-run and structural phenomenon, and the special roles of the U.S. dollar as the world currency seem to be an important factor to explain this phenomenon. This paper proves that permanent global imbalances can be sustainable due to a special role of the U.S. dollar, by building a two-country cash-in-advance growth model with a dollar standard in the international trade. The permanent U.S. trade deficit is an increasing function of the strength of off-shore dollar demand to finance international transactions, the long-run growth rate of global nominal GDP, the openness of the international trade, the elasticity of substitution between domestic and foreign goods, and the relative size of the U.S. economy to the rest of the world. The long-run non-neutrality of the U.S. dollar as the world currency exists.

The internationalization of RMB has becomes a hot topic recently. Why does one country care so much about its currency's role in global markets? One economic reason is that: by becoming a world currency like the U.S. dollar, one currency can bring some permanent welfare to its country. This paper shows that: structural global imbalances are accompanied by an unequal international trade with the terms of trade being beneficial to the U.S., and the welfare analysis indicates: a weakened U.S. dollar in the international trade, represented by a weaker strength of off-shore dollar demand, will reduce the welfare of the U.S. households, but increase the welfare of the rest of the world; and the welfare of the whole world will be improved according to the utilitarian standard.

To simplify the analysis, in this paper we focus on the U.S. dollar's dominant role in the international trade, but ignore its role in global financial markets as a global reserve currency. So financial autarky is assumed for our following benchmark model. We believe that the role of the U.S. dollar as a global reserve currency is also very important to explain the long-run global imbalances. Secondly, we focus on the long-run steady state analysis of the global economy, but ignore the business-cycle movement of the U.S. and world economy, which has partly captured in Figure 1 and 3. We leave these issues for future studies.

The rest of this paper is organized as follows: Section 2 reviews the related literature; Section 3 constructs the benchmark model; in Section 4 the relationship between structural global imbalances and deep parameters of the global economy is discussed in detail, and welfare analysis is provided as well; in Section 5 we conclude.

2 Literature review

Literature on global imbalances and massive and long-lasting U.S. trade deficit is rich. According to different reasons provided to explain global imbalances, the literature falls into the following categories.

Bernanke (2005), Backus et al. (2005) and many others believe in the "global savings glut" story, and take the viewpoint that a lack of investment opportunities and high savings in the rest of the world caused an excessive supply of funds to the U.S. and thus resulted in global imbalances.

Caballero et al. (2008) and Mendoza et al. (2009) use the asymmetry of financial deepness and the integration of global financial markets to explain the "global savings glut". They argue that the superior quality and depth of the U.S. financial system and capital market imperfections in the emerging markets have led global investors to supply funds cheaply to the U.S.

Engel and Rogers (2006), McGrattan and Prescott (2010) and Hoffmann et al. (2011) consider that real factors such as differentials in growth prospects or productivity, rather than financial factors, are the key reasons leading to global imbalances.

Policies are important as well. Blanchard et al. (2005) and Obstfeld and Rogoff (2009) attribute the long-lasting U.S. trade deficit partially to the economic policies of U.S. and other economies. It is thought that a loose monetary policy along with credit market distortions in the U.S. and the misalignment of nominal exchange rates of other economies will lead to excessively cheap import prices for the U.S. in the short run, which will cause the U.S. trade imbalance.

Demographic factors in different economies are also employed to account for global imbalances, such as in Domeij and Floden (2006) and Ferrero (2010). Ferrero (2010) investigates the contribution of productivity growth, demographics and fiscal policy in explaining the evolution of the U.S. external imbalances against industrialized countries. He points out that while productivity growth plays a dominant role, demographics explain a non-negligible and nearly permanent component of the U.S. trade deficit. Besides the above explanations, the large public-sector budget deficits of the U.S. and some other reasons are sometimes mentioned as well to explain global imbalances.

To summarize, most of the literature views the U.S. trade deficit and global imbalances as a persistent transitory phenomenon at the business-cycle frequency, rather than a long-run steady state existence. They, such as Obstfeld and Rogoff (2005), Feldstein (2008) and Hoffmann et al. (2011), do not think that a permanent trade imbalance between the U.S. and the rest of the world is sustainable forever. Secondly, most of the literature ignores the special roles of the U.S. dollar as the world currency and their contribution in accounting for global imbalances. This paper proves that permanent global imbalances can be sustainable due to a special role of the U.S. dollar as the world currency, by building a two-country cash-in-advance growth model with a dollar standard in the international trade. This paper also proves the long-run non-neutrality of the U.S. dollar as the world currency, and renews the thoughts about money neutrality in an open-economy setting with a world currency.

3 The Model

There are two countries in the world: the U.S. (denoted by H) and the ROW (rest of the world, denoted by F). The world is populated with a continuum of agents of $1+n$ mass, where the population in the segment $[0, n)$ belongs to the U.S. and the population in the segment $(n, 1+n]$ belongs to the ROW. The U.S. dollar serves as the invoicing currency in the international trade. Each country specializes in one semi-final good (produced in a number of intermediate goods with measure equal to population size): home good $Y_{H,t}$ produced by the U.S. and foreign good $Y_{F,t}$ by the ROW. The final good for each country (Y_t orY_t^*) is a composite of the home good and the foreign good, which can be used for households' consumption and capital investment; and the composition CES technologies are as follows:

$$Y_t = \left[(1-\rho^H)^{\frac{1}{\omega}} \cdot \left(Y_{H,t}^H\right)^{\frac{\omega-1}{\omega}} + (\rho^H)^{\frac{1}{\omega}} \cdot \left(Y_{F,t}^H\right)^{\frac{\omega-1}{\omega}}\right]^{\frac{\omega}{\omega-1}}$$

$$Y_t^* = \left[(1-\rho^F)^{\frac{1}{\omega}} \cdot \left(Y_{F,t}^F\right)^{\frac{\omega-1}{\omega}} + (\rho^F)^{\frac{1}{\omega}} \cdot \left(Y_{H,t}^F\right)^{\frac{\omega-1}{\omega}}\right]^{\frac{\omega}{\omega-1}}$$

where ω represents the elasticity of substitution between domestic and foreign goods, ρ^j ($j = H$ or F) refers to the share of domestic aggregate demand allocated to foreign goods and is thus a natural index of openness for country j, and $Y_{i,t}^j (i = H$ or F, and $j = H$ or F) is the demand of country j for the intermediate good produced by country i.

3.1 The U.S. economy

3.1.1 Households

The representative household seeks to maximize the life time utility of each family member:

$$U_0 = E_0 \sum_{t=0}^{\infty} \beta^t \cdot \left(ln\left(\frac{C_t}{n}\right) - \phi_L \cdot \frac{(L_t/n)^{1+\eta}}{1+\eta} \right)$$

where E is the expectation operator, β is the utility discount factor, L_t is aggregate labor supply, and C_t is aggregate real consumption.

The representative household can invest in the real U.S. capital K_t with a capital rental rate r_t. Due to the monopolistic power of the intermediate-good firm, nominal profit D_t

is generated and then distributed to households. The household receives a nominal lump-sum transfer T_t from the monetary authority. Therefore, the budget constraint for the representative household is:

$$P_tC_t + P_tI_t + M_{t+1}^H \leqq r_tP_tK_t + W_tL_t + D_t + T_t + M_t^H \tag{1}$$

where P_t is the aggregate price level, $I_t(= K_{t+1} - (1-\delta)K_t)$ is the investment on the real U.S. asset, δ is the depreciation rate of the real asset, M_t^H is the money (the U.S. dollar) demand of the U.S. households, and W_t is the nominal wage rate.

Money is introduced by a cash-in-advance (CIA) constraint as follows:

$$\xi \cdot (P_tC_t + P_tI_t) \leq M_t^H \tag{2}$$

where $\xi > 0$ describes the strength of the CIA constraint on private consumption and investment. When $\xi = 1$, it is the usual CIA constraint. Although there should be a CIA constraint for import as well, this import CIA constraint for the U.S. households holds naturally as long as inequality (2) is satisfied, because the international trade adopts the dollar standard and the U.S. dollar is both a national currency and a world currency. However, as we will show, it is not the same for the ROW households, because they need to hold enough U.S. dollars in advance to finance imports from the U.S. and also its internal transactions denominated in the U.S. dollar.

The first order conditions (FOCs) of the utility maximization problem are given by

$$\begin{cases} \phi_L \cdot L_t^\eta \cdot \frac{1}{n^{1+\eta}} - \lambda_t^1 W_t = 0 \\ \frac{1}{C_t} - \left(\lambda_t^1 + \xi \cdot \lambda_t^2\right) P_t = 0 \\ \left(\lambda_t^1 + \xi \cdot \lambda_t^2\right) P_t - \beta \cdot E_t\left[\lambda_{t+1}^1 P_{t+1}\left(1-\delta+r_{t+1}\right)\right] \\ -\xi \cdot \beta \cdot E_t\left[\lambda_{t+1}^2 P_{t+1}\left(1-\delta\right)\right] = 0 \\ \lambda_t^1 - \beta \cdot E_t\left(\lambda_{t+1}^1 + \lambda_{t+1}^2\right) = 0 \end{cases} \tag{3}$$

where λ_t^1 and λ_t^2 are respectively the Lagrangian multipliers corresponding to inequality (1) and (2). Given that there is a positive inflation rate and a positive profit of investment on the U.S. asset, it is easy to prove that both λ_t^1 and λ_t^2 are positive, so inequality (1) and (2) are both binding.

Because the U.S. dollar serves as the global currency and the ROW households need to have enough U.S. dollar in advance to finance imports, there is a foreign demand of the U.S. dollar, M_t^F, which is normally called "offshore dollar". Therefore, the total demand of the U.S. dollar, M_t, consists of two components:

$$M_t = M_t^H + M_t^F$$

3.1.2 Semi-final goods production and Price indices

In this paper we assume that the representative household produces the final good by himself. Equivalently, one can also assume there are perfectly competitive final-good producers with the same CES technologies given above and there is zero profit for them. Since there is dollar standard in international trade, the export goods from either the U.S. or the ROW are priced in the U.S. dollar. Consequently, it is PCP (producer currency pricing) for the U.S. and LCP (local currency pricing) for the ROW. Given the price levels of goods, the cost minimization problem of the final good producers yields the following demand functions:

$$Y_{H,t}^H = \left(1 - \rho^H\right) \cdot \left[\frac{P_{H,t}}{P_t}\right]^{-\omega} Y_t \tag{4}$$

$$Y_{F,t}^H = \rho^H \cdot \left[\frac{P_{F,t}^E}{P_t}\right]^{-\omega} Y_t \tag{5}$$

where $P_{H,t}$ is the price level of home good, and $P_{F,t}^E$ is the price level (denominated in the U.S. dollar) of imported foreign good.

Similarly, semi-final goods markets of each country are also perfectly competitive. Semi-final goods are produced by combining a continuum of domestic intermediate goods, $Y_{H,t}(i)$ or $Y_{F,t}(i)$. The relevant technologies are also CES as follows:

$$Y_{H,t} = \left[\left(\frac{1}{n}\right)^{\frac{1}{\varepsilon}} \int_0^n Y_{H,t}(i)^{\frac{\varepsilon-1}{\varepsilon}} di\right]^{\frac{\varepsilon}{\varepsilon-1}}$$

$$Y_{F,t} = \left[\int_0^1 Y_{F,t}(i)^{\frac{\varepsilon-1}{\varepsilon}} di\right]^{\frac{\varepsilon}{\varepsilon-1}}$$

where i represents the brand of intermediate goods, and ε denotes the elasticity of substitution between the differentiated intermediate goods within one single country. Then the following demand functions can be obtained:

$$Y_{H,t}^{H}(i) = \frac{1}{n}\left(\frac{P_{H,t}(i)}{P_{H,t}}\right)^{-\varepsilon} \cdot Y_{H,t}^{H}$$

$$Y_{H,t}^{F}(i) = \frac{1}{n}\left(\frac{P_{H,t}^{E}(i)}{P_{H,t}^{E}}\right)^{-\varepsilon} \cdot Y_{H,t}^{F}$$

$$Y_{F,t}^{F}(i) = \left(\frac{P_{F,t}(i)}{P_{F,t}}\right)^{-\varepsilon} \cdot Y_{F,t}^{F}$$

$$Y_{F,t}^{H}(i) = \left(\frac{P_{F,t}^{E}(i)}{P_{F,t}^{E}}\right)^{-\varepsilon} \cdot Y_{F,t}^{H}$$

where $Y_{k,t}^{j}(i)$, $P_{j,t}(i)$ and $P_{j,t}^{E}(i)$ ($j = H$ or F, and $k = H$ or F) have similar meanings to $Y_{k,t}^{j}$, $P_{j,t}$ and $P_{j,t}^{E}$ except that they are for intermediate goods rather than the semi-final goods.

3.1.3 Intermediate goods firms and price setting

The intermediate goods market is monopolistically competitive. Firm i produces a differentiated intermediate good $Y_{H,t}(i)$ with the following Cobb-Douglas production function:

$$Y_{H,t}(i) = a_t \cdot [K_t(i)]^{1-\alpha} [A_t \cdot L_t(i)]^{\alpha}$$

where total factor productivity is decomposed into a temporary shock a_t and a permanent trend A_t which is growing at a rate γ_1:

$$ln\left(A_t\right) = ln\left(A_{t-1}\right) + \gamma_1$$

The FOCs of the cost minimization problem are given by:

$$\begin{cases} \frac{W_t}{P_t r_t} = \frac{\alpha}{1-\alpha} \cdot \frac{K_t(i)}{L_t(i)} \\ mc_t = \frac{1}{a_t}\frac{(1-\alpha)^{\alpha-1}}{\alpha^{\alpha}}\left(\frac{W_t}{P_t A_t}\right)^{\alpha}(r_t)^{1-\alpha} \end{cases} \tag{6}$$

where mc_t is the real marginal cost.

The firms need to set prices for both domestically sold and export goods, both denominated in the U.S. dollar. In this paper we assume there is no price stickiness and firms can freely set prices in any given period[5], so the law of one price (LOOP) holds. Since the market is monopolistic competition, the intermediate goods firms will set the same prices, which are a markup over the nominal marginal cost. Therefore, the following holds:

$$P_{H,t} = P^E_{H,t} = \kappa \cdot P_t \cdot mc_t \tag{7}$$

where $\kappa = \varepsilon/(\varepsilon - 1)$ is the markup.

3.1.4 Equilibrium and aggregation

The following is the aggregate demand equation of the U.S. economy:

$$Y_t = C_t + I_t$$

Real GDP of the U.S. is in fact $Y_{H,t}$, and the following identity holds:

$$Y_{H,t} = Y^H_{H,t} + Y^F_{H,t}$$

According to equation (4) and (5) and their counterparts for the ROW, the above equation is equivalent to the following:

$$Y_{H,t} = \left(1 - \rho^H\right) \cdot \left[\frac{P_{H,t}}{P_t}\right]^{-\omega} Y_t + \rho^F \cdot \left[\frac{P^E_{H,t} \cdot EX_t}{P^*_t}\right]^{-\omega} Y^*_t \tag{8}$$

where P^*_t is the aggregate price level of the ROW, and EX_t is the exchange rate of the ROW currency (named as *Ro*).

Suppose the money supply rule of the U.S. is:

$$lnM_{t+1} = ln\overline{M_{t+1}} + \varepsilon_t, \quad ln\overline{M_{t+1}} = ln\overline{M_t} + \gamma_2$$

where $\overline{M_t}$ is the balanced-growth level of the money supply, γ_2 is the balanced growth rate at the steady state, and ε_t is a temporary money supply shock. The increase money supply of the U.S. dollar is distributed as a lump-sum transfer to the U.S. households only rather than to the world households, so we have:

[5]Since we will focus on the long-run steady state of the model, it is indifferent to assume price stickiness or not.

$$M_{t+1} - M_t = T_t$$

3.1.5 The external sector

Nominal net export of the U.S., NNX_t, is denominated in the U.S. dollar and defined as:

$$NNX_t = P^E_{H,t} \cdot Y^F_{H,t} - P^E_{F,t} \cdot Y^H_{F,t}$$

Combining the above equation with the identities among price indices, we can easily obtain the following national income identity:

$$P_{H,t} Y_{H,t} = P_t \cdot Y_t + NNX_t \tag{9}$$

Since the nominal profit of the economy comes from the monopolistic power of intermediate goods firms, then the following identity holds:

$$D_t = P_{H,t} Y_{H,t} - r_t P_t K_t - W_t L_t$$

Given the above identities and the binding household's budget constraint, inequality (1), we can get the following identity linking the net export and off-shore money demand :

$$M^F_{t+1} - M^F_t + NNX_t = 0 \tag{10}$$

This means that if the households of ROW would like to hold more U.S. dollar ($M^F_{t+1} - M^F_t > 0$), the ROW must run a trade surplus ($NNX_t < 0$), which is intuitive.

3.2 The economy of the ROW

Many components of the model economy of the ROW are similar to the U.S. For example, as the counterpart of equation (8), GDP of the ROW can be expressed as follows:

$$Y_{F,t} = \rho^H \cdot \left(\frac{P^E_{F,t}}{P_t} \right)^{-\omega} Y_t + \left(1 - \rho^F\right) \cdot \left[\frac{P_{F,t}}{P^*_t} \right]^{-\omega} Y^*_t$$

The intermediate goods market is also monopolistically competitive. Firm i produces a differentiated intermediate good $Y_{F,t}(i)$ with the following production function:

$$Y_{F,t}(i) = a^*_t \cdot \left[K^*_t(i)\right]^{1-\alpha} \left[A^*_t \cdot L^*_t(i)\right]^{\alpha}$$

where total factor productivity is decomposed into a temporary shock a_t^* and a permanent trend A_t^*, whose growth rate is also γ_1. LOOP holds as well and the price setting is given as:

$$\begin{cases} P_{F,t} = \kappa \cdot P_t^* \cdot mc_t^* \\ P_{F,t}^E = P_{F,t}/EX_t \end{cases}$$

The ROW money supply rule is similarly described by:

$$lnM_{t+1}^* = ln\overline{M_{t+1}^*} + \varepsilon_t^*, \quad ln\overline{M_{t+1}^*} = ln\overline{M_t^*} + \gamma_2$$

$$M_{t+1}^* - M_t^* = T_t^*$$

where M_t^* is the money supply of *Ro* and T_t^* is the lump-sum transfer from the ROW central bank to the ROW households. We assume the steady-state money growth rate of *Ro* is the same as that of the U.S. dollar, to simplify the model and the analysis.

3.2.1 ROW households' problem and CIA constraint for international trade

Structural differences between the U.S. and the ROW exist because of the special role of the U.S. dollar as the world currency. As explained above, there is a CIA constraint for transactions using the U.S. dollar as the invoicing currency, and the ROW households need to hold enough U.S. dollars to finance imports from the U.S. and also its internal dollar-denominated transactions. Therefore, for the representative ROW household, the following CIA constraint related to the U.S. dollar holdings must be satisfied:

$$\xi^D \cdot \left[\left(P_{H,t}^E Y_{H,t}^F\right) + \varphi \cdot \left(P_{F,t} Y_{F,t}^F / EX_t\right)\right] \leq M_t^F$$

where ξ^D is the strength of the CIA constraint for dollar-denominated transactions outside the U.S, and φ is the fraction of the ROW internal transactions denominated in the U.S. dollar.

The representative ROW household can also invest in the domestic real capital $K_t^*$with a capital rental rate r_t^*. Then the budget constraint is:

$$P_t^* C_t^* + P_t^* I_t^* + M_{t+1}^* + EX_t \cdot M_{t+1}^F$$

$$\leqq r_t^* P_t^* K_t^* + W_t^* L_t^* + D_t^* + T_t^* + M_t^* + EX_t \cdot M_t^F \tag{11}$$

where variables with asterisk have similar definitions as their counterparts of the U.S.

economy.

The ROW internal CIA constraint for its national currency using is then given by:

$$\xi^* \cdot (1-\varphi) \cdot P_{F,t} Y_{F,t}^F \leq M_t^*$$

Because the final good $Y_t^* (= C_t^* + I_t^*)$ is a CES composite of domestic and foreign semi-final goods, $Y_{F,t}^F$ and $Y_{H,t}^F$, the above two CIA constraints can be written as:

$$\xi^* \cdot (1-\varphi) \cdot P_{F,t} \cdot \left(1-\rho^F\right) \cdot \left[\frac{P_{F,t}}{P_t^*}\right]^{-\omega} (C_t^* + I_t^*) \leq M_t^* \tag{12}$$

$$\xi^D \cdot \left\{ P_{H,t}^E \cdot \rho^F \cdot \left[\frac{P_{H,t}^E \cdot EX_t}{P_t^*}\right]^{-\omega} + \varphi \cdot \frac{1}{EX_t} \cdot P_{F,t} \cdot \left(1-\rho^F\right) \cdot \left[\frac{P_{F,t}}{P_t^*}\right]^{-\omega} \right\} (C_t^* + I_t^*) \leq M_t^F \tag{13}$$

Thus the representative ROW household chooses $\left(L_t^*, C_t^*, K_{t+1}^*, M_{t+1}^*, M_{t+1}^F\right)$ to maximize his life time utility:

$$U_0^* = E_0 \sum_{t=0}^{\infty} \beta^t \cdot \left(lnC_t^* - \phi_L \cdot \frac{(L_t^*)^{1+\eta}}{1+\eta} \right)$$

subject to the budget constraint (11) and two CIA constraints, (12) and (13). Then FOCs are given by:

$$\begin{cases} \phi_L \cdot (L_t^*)^{\eta} - \lambda_t^3 W_t^* = 0 \\ \frac{1}{C_t^*} - \lambda_t^3 \cdot P_t^* - \lambda_t^4 \cdot (1-\varphi) \cdot \xi^* \cdot RF_t - \lambda_t^5 \cdot \xi^D \cdot \left(RH_t + \varphi \cdot \frac{1}{EX_t} \cdot RF_t \right) = 0 \\ \lambda_t^3 \cdot P_t^* + \lambda_t^4 \cdot (1-\varphi) \cdot \xi^* \cdot RF_t + \lambda_t^5 \cdot \xi^D \cdot \left(RH_t + \varphi \cdot \frac{1}{EX_t} \cdot RF_t \right) \\ -\beta \cdot E_t \left\{ \lambda_{t+1}^3 \cdot P_{t+1}^* \left(1 - \delta + r_{t+1}^*\right) \right\} \\ -\beta \cdot E_t \left\{ \lambda_{t+1}^4 \cdot (1-\varphi) \cdot \xi^* \cdot RF_{t+1} \cdot (1-\delta) \right\} \\ -\beta \cdot E_t \left\{ \lambda_{t+1}^5 \cdot \xi^D \cdot \left(RH_{t+1} + \varphi \cdot \frac{1}{EX_{t+1}} \cdot RF_{t+1} \right) \cdot (1-\delta) \right\} = 0 \\ \lambda_t^3 - \beta \cdot E_t \left(\lambda_{t+1}^3 + \lambda_{t+1}^4 \right) = 0 \\ \lambda_t^3 \cdot EX_t - \beta \cdot E_t \left(\lambda_{t+1}^3 \cdot EX_{t+1} + \lambda_{t+1}^5 \right) = 0 \end{cases} \tag{14}$$

where λ_t^3, λ_t^4 and λ_t^5 are respectively the Lagrangian multipliers corresponding to inequality (11), (12) and (13), and RF_t and RH_t are defined as follows:

$$RF_t \triangleq P_{F,t} \cdot \left(1-\rho^F\right) \cdot \left[\frac{P_{F,t}}{P_t^*}\right]^{-\omega}$$

$$RH_t \triangleq P_{H,t}^E \cdot \rho^F \cdot \left[\frac{P_{H,t}^E \cdot EX_t}{P_t^*}\right]^{-\omega}$$

It is also easy to prove that λ_t^3, λ_t^4 and λ_t^5 are all positive, so inequality (11), (12) and (13) are all binding.

3.2.2 Off-shore dollar

The off-shore dollar holdings, M_t^F, evolve as follows:

$$M_{t+1}^F = M_t^F + NNX_t^* \tag{15}$$

where NNX_t^* is the nominal net export of the ROW, denominated in the U.S. dollar. The above identity together with equation (10) can yield the following:

$$NNX_t + NNX_t^* = 0$$

which is obviously true in a two-country model.

3.3 Steady state

Since at the long-run steady state, the growth rates of trend technology in both U.S. and ROW are the same and so are the growth rates of money supply, a balanced growth of the world economy will be achieved at the steady state: real aggregate variables of the two economies will grow at the same rate as that of permanent technology growth (which is γ_1), nominal variables (money and nominal wages) will grow at the same rate as that of permanent money growth (which is γ_2), and price levels of the two economies will grow at the same rate of $(\gamma_2 - \gamma_1)$.

Therefore, after detrending real aggregate variables by A_t, nominal variables by $\overline{M_t}$, price levels by $\overline{M_t}/A_t$, and Lagrangian multipliers by $1/\overline{M_t}$, we can obtain a stationary system, and then the steady state can be solved numerically, using the steady-state equilibrium conditions given in the Appendix.[6]

[6]Since this paper focuses on the long-run steady state analysis, it will not discuss whether the global economic system in the neighborhood of the balanced-growth steady state is saddle-path stable or not. The saddle-path stability is a holistic phenomenon, depending on the interaction of all agents' behaviors. In a closed economy, the Taylor principle usually makes the model satisfy the Blanchard-Kahn conditions, which guarantee the stability and determinacy of the dynamic system. In this paper the simple money supply rules given by us may possibly result in indeterminacy, and the money supply policy may need to properly respond to output gap or inflation gap to guarantee saddle-path stability. Alternatively, a method proposed by Farmer and Khramov (2013) can also help to solve the indeterminacy problem. These issues theoretically will not change our results of steady-state analysis in this paper, and we leave them for our future studies about cyclical global imbalances.

3.4 Calibration

Table 1 below gives the calibrated values of the benchmark model parameters. The labor share α in the production function is set to be a standard value, 0.33. The utility discount rate β and the capital depreciation rate δ are chosen respectively as 0.96 and 0.10 since our model is an annual model. The values of η and ω are consistent with the literature such as Alves et al. (2007). The openness parameter ρ^H is set to be 0.2 for the U.S., and the price markup κ is 1.1 as in the literature. Two CIA coefficients, ξ and ξ^*, are both specified to be 1, indicating a normal CIA constraint for domestic transactions. ξ^D is simply set to be equal to ξ.

Table 1: Parameters of Benchmark Model

	Main parameters									
parameter	α	β	δ	η	ω	ρ^H	ϕ_L	κ	ξ	ξ^*
value	0.33	0.96	0.10	2.0	1.5	0.2	1.0	1.1	1.0	1.0
	Inferred parameters									
parameter	γ_1	γ_2	n	ρ^F	EX	m	φ			
value	2.88%	6.18%	0.37	0.074	0.9357	1.430	8.6%			

The second panel of Table 1 provides inferred parameters which are calibrated to match the U.S. and global macroeconomic data. γ_1 and γ_2 are respectively specified as the average growth rates of the U.S. real GDP and the U.S. nominal GDP over the period 1976-2013. The parameter n indicating the relative effective-labor population of the U.S. to the ROW is set to be 0.37, in order to match the U.S. GDP share in the world on average over the period 1976-2013 (which is 28.06%). Thus ρ^F is calibrated to be $n \cdot \rho^H$, as explained in Liu (2014b). EX is the steady-state exchange rate of Ro, which is set to be 0.9357 to match the average USD index over the period 1976-2013. And then the parameter m, which is defined as the steady-state ratio of the two economies' money supplies ($m \triangleq \overline{M_t^*}/\overline{M_t}$), is calibrated to match the value of EX. Finally, we choose the value for φ, which is the fraction of the ROW internal transactions denominated in the U.S. dollar and represents the strength of the off-shore dollar demand in some sense. As we will explain later, a non-negative value for φ will always generate a permanent positive trade deficit of the U.S.

at the steady state, even when it is zero. In this paper, we assume that φ can be larger than zero. This is reasonable because in the reality international transactions take place not only between the U.S and the ROW (which consists of many separate economies in the real world) but also within the ROW, and the U.S. dollar is the major invoicing currency of all these international transactions. For the benchmark model, φ is set to be 8.6% so as to yield a permanent 2.4% trade deficit-GDP ratio of the U.S., which is an average number over the period 1976-2013.

4 Structural global imbalances

In this section we will discuss the structural global imbalances, represented by a permanent steady-state trade deficit of the U.S. with the ROW, and analyze its relationship with deep parameters of the model, such as the parameter φ which describes to what extent the rest of the world demands the U.S. dollar, global long-run technology growth rate, the openness degree of global economies, and so on.

4.1 Structural global imbalances

Equation (10) indicates that there must be a trade deficit for the U.S. as long as the off-shore dollar, M_t^F, is increasing. Since at the balanced-growth steady state of the world economy M_t^F will grow at the rate of γ_2, equation (10) can yield the following:

$$nx = -\gamma_2 \cdot \theta \tag{16}$$

where nx is the net export-GDP ratio of the U.S. at the steady state and θ is the steady-state ratio of off-shore dollar to the U.S. nominal GDP. Therefore, as long as γ_2 is positive (i.e. there is a positive long-run growth of global nominal GDP), the world economy will run into a structural global trade imbalance. Because the ROW has to run a trade surplus to obtain enough U.S. dollar, in order to finance the next period international transactions. The bigger the long-run growth rate of world nominal GDP is and the more the rest of the world demands off-shore dollar, the larger the global imbalances will be.

Given equation (16), equation (13), equation (7) and other equilibrium conditions, the U.S net export-GDP ratio can be expressed more clearly as follows:

$$nx = -\gamma_2 \cdot \xi^D \cdot \left[1 - abs \cdot (1-\rho^H) \cdot (\kappa \cdot mc)^{-\omega} + \frac{\varphi}{\bar{n}} \cdot abs^* \cdot (1-\rho^F) \cdot (\kappa \cdot mc^*)^{-\omega}\right] \quad (17)$$

where $abs \triangleq \overline{Y_t}/\overline{Y_{H,t}}$ and $abs^* \triangleq \overline{Y_t^*}/\overline{Y_{F,t}}$ are the steady-state absorption-GDP ratios for U.S. and ROW, $\bar{n}$ is the relative size of U.S. nominal GDP to ROW at the steady state (which is mainly determined by n and is 0.39 for the benchmark setting), and mc and mc^* are the steady-state real marginal costs for U.S. and ROW. Although abs, abs^*, mc, and mc^* are not exogenous and still depend on deep parameters of the model, equation (17) provides a good way to analyze the relationship between structural global imbalances and deep parameters.

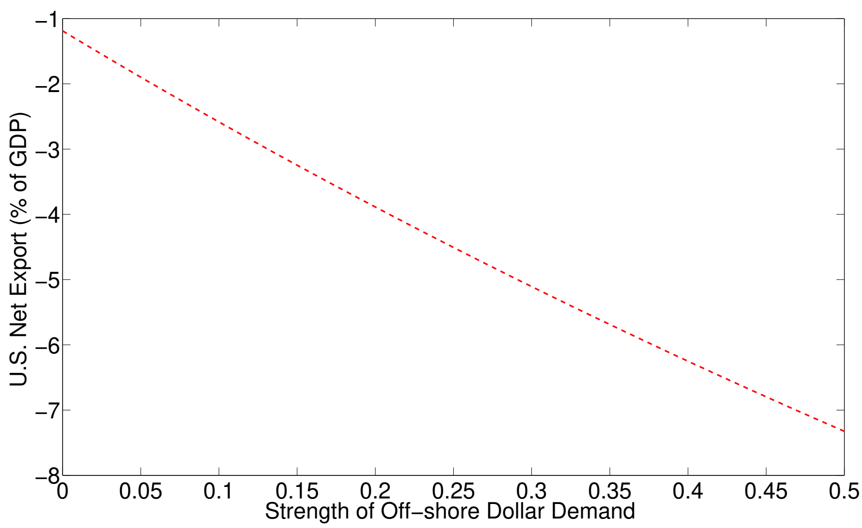

Figure 4: Strength of Off-shore Dollar Demand and Global Imbalances

A key parameter of the model is the fraction of the ROW internal transactions denominated in the U.S. dollar, φ, which indicates the strength of the off-shore dollar demand from the rest of the world. Structural global imbalances can exist permanently in our model because of two key issues: one is the CIA constraint of international transactions using the U.S. dollar as the invoicing currency, and the other is a positive long-run growth of global nominal GDP. So one can predict that: other things being equal, the larger φ is, the more U.S. dollars the ROW needs to finance its import from the U.S and its internal dollar-denominated transactions, so the larger the U.S trade deficit (or global imbalances) will be, because running a trade surplus is the only way for the ROW to obtain more U.S. dollars. Equation 17 together with Figure 4, showing the steady-state relationship between φ and the U.S net export-GDP ratio, proves this story. As explained before, for the benchmark calibration φ is set to be 8.6%, larger than zero, to reflect the heavy use of the U.S. dollar within the ROW economy as in the reality and then to match the global imbalance data. When $\varphi = 0$, then the U.S. will run a permanent 1.2% trade deficit. When there is no CIA constraint for international trade, i.e. $\xi^D = 0$, long-run global imbalances will disappear.

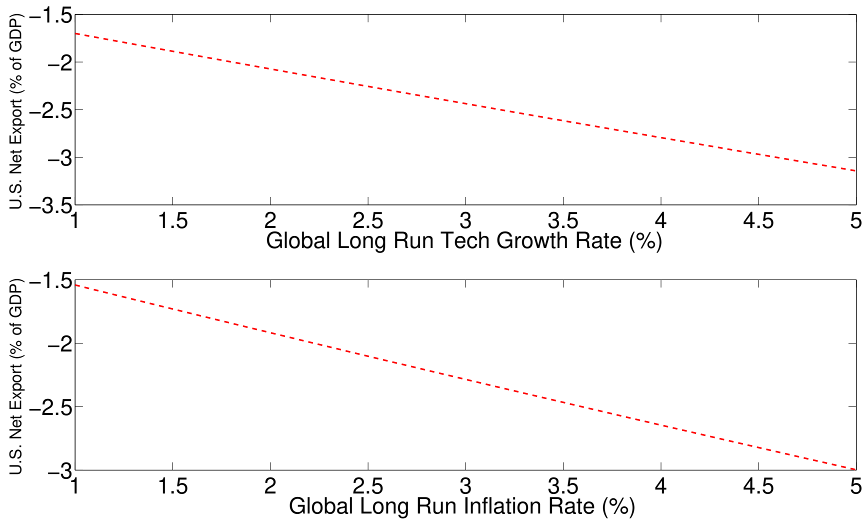

Figure 5: Global Tech Growth, Global Inflation and Global Imbalances

As shown in equation 17, another determinant factor for structural global imbalances is the long-run growth rate of global nominal GDP, γ_2. Since at the balanced-growth steady state export is a fixed proportion of GDP and the fraction of the ROW internal transactions denominated in the U.S. dollar is also fixed, we have that: the bigger γ_2 is, the faster the ROW GDP and its import grow, and the more extra U.S. dollars the ROW needs to finance its next period import and internal dollar-denominated transactions, so the larger the trade surplus of the ROW and then global trade imbalances will be. Since the long-run growth rate of global nominal GDP (γ_2) is decided by the global long-run technology grow rate (γ_1) and the global long-run inflation rate ($\gamma_2 - \gamma_1$) , structural global imbalances will be an increasing function of either global long-run technology grow rate or global long-run inflation rate, *ceteris paribus*. Figure 5 depicts these positive relationships. In fact, when $\gamma_2 = 0$, i.e. there is neither global long-run technology growth nor global long-run inflation rate, structural global imbalances will also disappear. In this circumstance without nominal growth, the nominal volume of international trade will keep unchanged at the steady state, and the ROW demand for the U.S. dollar will not increase, and thus the ROW does not need to run a structural trade surplus, although the off-shore dollar holdings of the ROW is still positive.

After the 2007-2008 global financial and economic crises, the economic growth slowed down worldwide, and also many large economies encountered deflation pressure. If we take the viewpoint that the potential economic growth and potential inflation rate of the world economy have a structural decline, we can judge that the global imbalances will shrink structurally rather than cyclically.

Figure 5 confirms the long-run non-neutrality of the U.S. dollar as the world currency. Because the long-run growth rate of global nominal GDP is in fact equal to the long-run growth rate of U.S. money supply in our model, a change to the long-run growth rate of U.S. money supply (accompanied by the same change to long-run growth rate of ROW money supply) will alter the world production, international trade and then structural global imbalances. So in our model money does affect the real economy even in the long run.

Figure 6 shows the relationships between structural global imbalances and some other deep parameters, including ρ^H representing the openness of international trade, ω which is the elasticity of substitution between domestic and foreign goods, and n which is the relative size of the U.S. economy to the ROW. ρ^H has a significant impact on the structural global imbalances. Other things being equal, equation 17 indicates that: when ρ^H increases (i.e. the global international trading system becomes more open and more of the aggregate consumption is from import), the structural global imbalances will be enlarged by the increasing trade volume between U.S. and ROW but will be reduced by the decreasing trade volume of ROW internal dollar-denominated transactions, and the net effect on structural global imbalances is positive given that φ is less than 100%. The first panel of Figure 6 is consistent with this result. When the world economy is close to autarky, structural global imbalances approach to disappearing. Along with the ratio of international trade to the world GDP becoming larger and larger (due to such as globalization), the off-shore dollar demand will increase and structural global imbalances will expand.

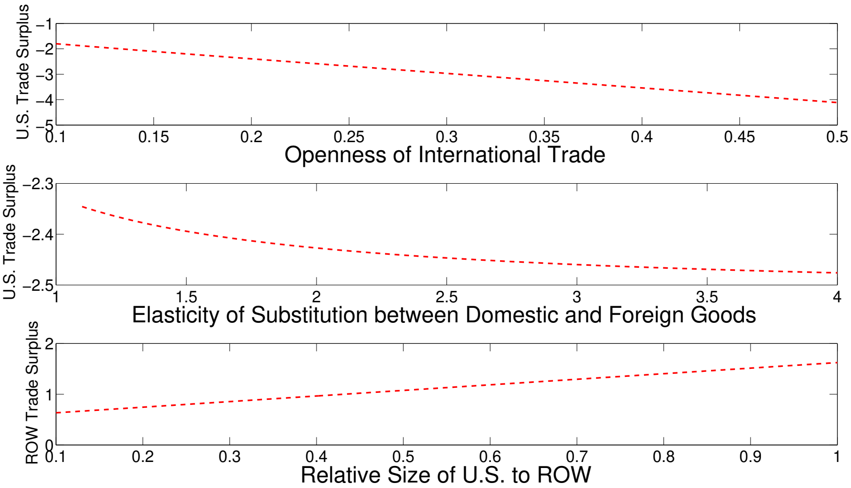

Figure 6: Openness, Elasticity of Substitution, Relative Size of the U.S. economy and Global Imbalances

The elasticity of substitution has a positive effect on structural global imbalances, as shown in the second panel of Figure 6. Although equation 17 tells that a bigger elasticity of substitution means a larger structural global trade imbalance as long as $\kappa \cdot mc > 1$,[7] it is not straightforward to understand this result. As we will see in Figure 9, the special role of the U.S. dollar generates not only structural global imbalances, but also an "unequal" trading system: the terms of trade for the U.S. is greater than one at the steady state (i.e. the U.S. export price is higher than the ROW export price and the ROW export goods are relatively cheaper) even after adjusting the terms of trade to the two economies' real marginal costs. In fact, it is this kind of "unequal" relative price that makes the U.S. import more and the ROW import less than the normal situation with "equal" terms of trade, and then makes structural global imbalances. When the elasticity of substitution becomes larger, this kind of relative price effect will become stronger and then lead to more severe global imbalances.

The last panel of Figure 6 shows that the relative size of the U.S. economy to the ROW has a positive effect on structural global imbalances as well. This is not hard to

[7] As our above analysis about the openness of international trade, here there are also two opposite effects on structural global trade imbalances: the positive one related to the international trade between U.S. and ROW, and the negative one related to ROW internal dollar-denominated transactions. Still the net effect is positive.

understand. Given the degree of openness and the absolute size of the ROW economy unchanged, when the U.S. economy becomes larger, its import from the ROW and also the ROW import from the U.S. will both increase. Therefore, the ROW will need more U.S. dollars to finance its import, and then its trade surplus should be larger than before. Equation 17 tells the same story: because $\rho^F = n \cdot \rho^H$ and $\bar{n} \simeq n$, nx will remain nearly unaffected when n increases; but be noted that nx is the U.S. net export-GDP ratio, so the absolute value of U.S. trade deficit will increase proportionally with the U.S. GDP size. Consequently, the exchange rate of U.S. dollar will appreciate due to the increasing dollar demand in the global market. Figure 7 shows this positive relationship between the USD index and the relative size of the U.S. economy in the long run. If we view some co-movements of the USD index and the U.S. GDP share in the world in Figure 3 as a long run transition rather than a business cycle fluctuation, our model here provides a reasonable explanation for these co-movements.

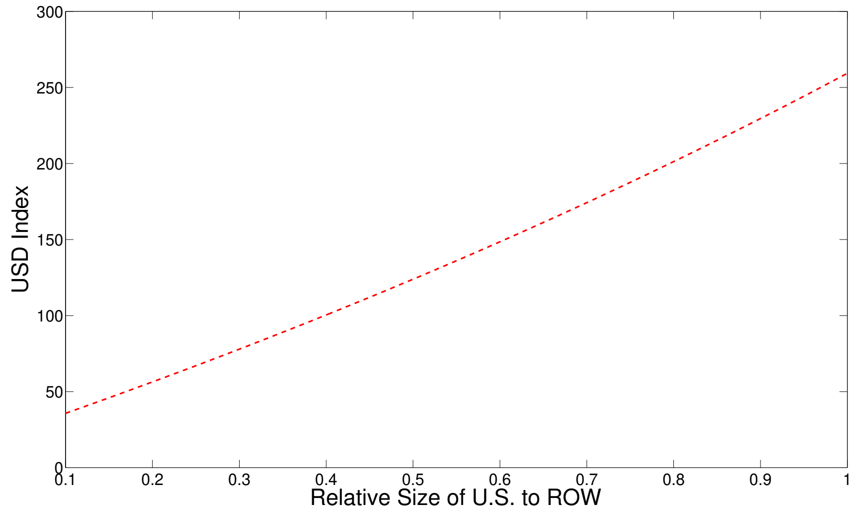

Figure 7: Relative Size of the U.S. economy and USD Index

4.2 Welfare result

Permanent global imbalances intuitively constitute a permanent gift to the U.S. households and seem to increase the welfare of U.S. households. The larger the structural global imbalances are, the more the welfare of U.S. households is likely to be improved. This is true in our model. Given the long-run growth rate of technology keeps constant, we define the welfares of the U.S. and ROW households using their corresponding detrended period utility as follows:

$$Welfare_{US} \triangleq n \cdot \left[ln\left(\frac{C}{n}\right) - \phi_L \cdot \frac{(L/n)^{1+\eta}}{1+\eta}\right]$$

$$Welfare_{ROW} \triangleq lnC^{*} - \phi_L \cdot \frac{(L^{*})^{1+\eta}}{1+\eta}$$

$$Welfare_{World} \triangleq Welfare_{US} + Welfare_{ROW}$$

where variables without time subscript denote detrended steady state values as given in the Appendix, and the world welfare is calculated as the sum of the U.S. and ROW welfares, according to the utilitarian standard.

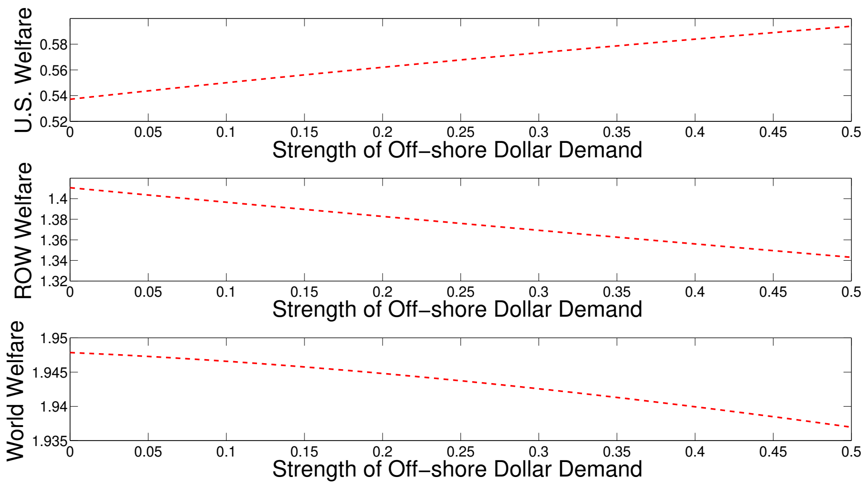

Figure 8: Strength of Off-shore Dollar Demand and Global Welfares

We focus on the welfare changes when there is a change to the parameter φ, which represents the strength of the off-shore dollar demand and thus the importance of the U.S. dollar in the international trade. Figure 8 depicts the relationship between the welfares of U.S., ROW and the whole world and the parameter φ. When the strength of off-shore dollar demand increases, the welfare of U.S. households increases, the welfare of ROW households decreases, and the welfare of the whole world decreases as the net effect. Figure 4 tells us that when the strength of off-shore dollar demand increases, the structural global imbalances will be enlarged, which means that ROW needs to increase its net export to obtain enough U.S. dollars to finance its dollar-denominated internal and external transactions. Intuitively, since its aggregate absorption (consumption plus investment) as a fraction of its GDP becomes smaller, ROW's welfare will naturally decrease. On the contrary, U.S. welfare will naturally increase because structural global imbalances constitute a permanent gift to the U.S. households (they permanently consume more than what they produce at the steady state) and this kind of gift becomes bigger when the strength of off-shore dollar demand increases.

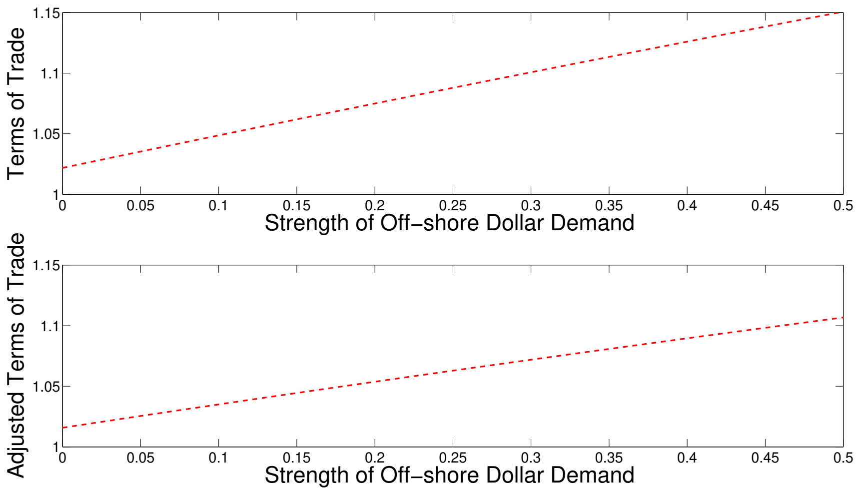

Figure 9: Strength of Off-shore Dollar Demand and Terms of Trade

The above welfare result can also be explained by the unequal international trade accompanying the structural global imbalances. The first panel of Figure 9 shows how the terms of trade for the U.S. (defined as U.S. export price over its import price) evolves with the strength of off-shore dollar demand. The second panel of Figure 8 gives the result for adjusted terms of trade, which adjust U.S. export price and import price by U.S. real marginal cost and ROW real marginal cost respectively; and it is consistent with the result of the first panel. Overall, the terms of trade is always beneficial to the U.S. (export price is relatively higher than import price), even when the parameter φ is equally to zero. As explained before, when $\varphi = 0$, structural global imbalances still exists because the international trade between U.S. and ROW is denominated in the U.S. dollar and the CIA constraint, equation 13, still must be satisfied for the ROW households. To obtain enough U.S. dollars, ROW needs to export more, and consequently the ROW goods become relatively cheaper in the international market, which results in the terms of trade being beneficial to the U.S. but unfavorable for ROW. Along with the increase of the strength of off-shore dollar demand, this kind of unequal trade will become more and more unequal, and thus the welfare distribution between the U.S. and ROW will become more and more unequal as well. Weakening the role of the U.S. dollar in the international trade is not a Pareto improvement, but is a Kaldor improvement for the whole world.

5 Concluding remarks

The data indicates that the long-lasting U.S. trade deficit during the past four decades is a long-run and structural phenomenon. This paper has proposed a simple framework to investigate the role of the U.S. dollar as the world currency in accounting for structural global imbalances in the long-run steady state. The framework highlights the special role of the U.S. dollar in the international trade. By building a two-country cash-in-advance growth model with a dollar standard in the international trade, this paper proves that permanent global imbalances can be sustainable.

Structural global imbalances can exist permanently in our framework because of two key issues: one is the CIA constraint of international transactions using the U.S. dollar as the invoicing currency, and the other is a positive long-run growth of global nominal GDP. Along with the nominal growth of the global economy, the rest of the world needs more and more U.S. dollars to finance dollar-denominated transactions, which will lead to a permanent trade surplus for the ROW and also prevent the U.S. dollar from a substantial depreciation in the long tun. The permanent U.S. trade deficit is an increasing function of the strength of off-shore dollar demand. If there is no dollar standard in the international trade, structural global imbalances will disappear.

The benchmark model is calibrated to match the world economic data of the period 1976-2013, and the framework of this paper is flexible enough to examine the relationship between structural global imbalances and other deep parameters. It is found that: the permanent U.S. trade deficit is an increasing function of the long-run growth rate of global nominal GDP, the openness of the international trade, the elasticity of substitution between domestic and foreign goods, and the relative size of the U.S. economy to the rest of the world. Along with a relatively bigger size of the U.S. economy, the U.S. dollar will appreciate.

The long-run non-neutrality of the U.S. dollar as the world currency exists. A change to the long-run growth rate of U.S. money supply (accompanied by the same change to long-run growth rate of ROW money supply) will influence the world real production, international trade and then structural global imbalances.

This paper also shows that: structural global imbalances co-exist with an unequal international trade, and the terms of trade are beneficial to the U.S.. The welfare analysis indicates: a weakened U.S. dollar in the international trade, represented by a weaker strength of off-shore dollar demand, will reduce the welfare of the U.S. households, but increase the welfare of the rest of the world; and the welfare of the whole world will be improved.

Our framework can be extended in several ways. First of all, the role of the U.S. dollar as a global reserve currency is also believed to be very important to account for long-run global imbalances. In general, any kind of increasing demand for the U.S. dollar can generate structural global imbalances. In global financial markets, dollar assets including currency, U.S. government bonds and U.S. equities have advantages in both liquidity and security. Excessive demands for the U.S. dollar as global reserve currency may result in not only cyclical but also structural global imbalances. Secondly, this paper focuses on the long-run steady state analysis of the global economy, but the business-cycle movement of the U.S. and world economy is equally important. Based on the benchmark model of this paper, a two-country New Keynesian DSGE model with both long-run economic growth and short-run price stickiness and other frictions can be constructed, in which global imbalances can be divided into structural and cyclical ones, and cyclical global imbalances can be explained by various monetary and real shocks.

References

Alves, N., Gomes, S., Sousa, J., 2007. An open economy model of the euro area and the us. Banco de Portugal, Economics and Research Department Working Papers, No.

W200718. 3.4

Backus, D., Henriksen, E., Lambert, F., Telmer, C., 2005. Current account fact and fiction. Society for Economic Dynamics Meeting Papers 115, 115. 2

Bernanke, B., 2005. The global saving glut and the u.s. current account deficit. Board of Governors of the Federal Reserve System Speech Series, No. 77. 2

Blanchard, O., Giavazzi, F., Sa, F., 2005. International investors, the u.s. current account, and the dollar. Brookings Papers on Economic Activity 36 (1), 1–66. 2

Caballero, R., Farhi, E., Gourinchas, P., 2008. An equilibrium model of gi and low interest rates. American Economic Review 98 (1), 358–393. 2

Domeij, D., Floden, M., 2006. Population ageing and international capital flows. International Economic Review 47, 1013–1032. 2

Engel, C., Rogers, J. H., 2006. The u.s. current account deficit and the expected share of world output. Journal of Monetary Economics 53 (5), 1063–1093. 1, 2

Farmer, R., Khramov, V., 2013. Solving and estimating indeterminate dsge models. IMF Working Papers, No. WP/13/200. 6

Feldstein, M., 2008. Resolving the global imbalance: The dollar and the u.s. saving rate. Journal of Economic Perspectives 22 (3), 113–125. 1, 2

Ferrero, A., 2010. A structural decomposition of the u.s. trade balance: Productivity, demographics and fiscal policy. Journal of Monetary Economy 57, 478–490. 2

Goldberg, L., 2010. Is the international role of the dollar changing? Current Issues in Economics and Finance 16 (1), 1–7. 1

Goldberg, L., Tille, C., 2008. Vehicle currency use in international trade. Journal of International Economics 76 (2), 177–192. 1

Hoffmann, M., Krause, M., Laubach, T., 2011. Long-run growth expectations and "global imbalances". CFS Working Paper Series, 2011/01. 2

Liu, K., 2014a. Dollar hegemony and china's economy. Cambridge Working Papers in Economics, No. 1410. 1

Liu, K., 2014b. Public finances, business cycles and structural fiscal balances. Cambridge Working Papers in Economics, No. 1411. 3.4

McGrattan, E., Prescott, E., 2010. Technology capital and the us current account. American Economic Review 100 (4), 1493–1522. 2

Mendoza, E., Quadrini, V., Rios-Rull, J., 2009. Financial integration, financial development and global imbalances. Journal of Political Economy 117 (3), 371–416. 2

Obstfeld, M., Rogoff, K., 2005. The unsustainable u.s. current account position revisited. Federal Reserve Bank of San Francisco Proceedings Feb. 1, 2

Obstfeld, M., Rogoff, K., 2009. Global imbalances and the financial crisis: Products of common causes. Federal Reserve Bank of San Francisco Proceedings Oct, 131–172. 2

Appendix: detrended steady-state equilibrium conditions

Variables without time subscript in the following equations denote detrended steady state values for the corresponding variables.

The U.S. economy

$$M \equiv 1$$

$$M^* \equiv m$$

$$P_H = \kappa \cdot P \cdot mc$$

$$\xi \cdot (PC + P \cdot I) = M^H$$

$$\begin{cases} \phi_L \cdot L^\eta \cdot \frac{1}{n^{1+\eta}} = \lambda^1 W \\ \left(\lambda^1 + \xi \cdot \lambda^2\right) PC = 1 \\ (1+\gamma_1)\left(\lambda^1 + \xi \cdot \lambda^2\right) = \beta \cdot \left[\lambda^1 (1-\delta+r)\right] \\ +\xi \cdot \beta \cdot \left[\lambda^2 (1-\delta)\right] \\ \lambda^1 (1+\gamma_2) = \beta \cdot \left(\lambda^1 + \lambda^2\right) \end{cases}$$

$$M = M^H + M^F$$

$$(1+\gamma_1)K = (1-\delta)K + I$$

$$Y_H^H = \left(1-\rho^H\right) \cdot \left[\frac{P_H}{P}\right]^{-\omega} Y_t$$

$$Y_F^H = \rho^H \cdot \left[\frac{P_F}{EX \cdot P}\right]^{-\omega} Y$$

$$P = \left[\left(1-\rho^H\right) \cdot (P_H)^{1-\omega} + \rho^H \cdot (P_F/EX)^{1-\omega}\right]^{\frac{1}{1-\omega}}$$

$$Y_H = [K]^{1-\alpha} [L]^{\alpha}$$

$$\begin{cases} \frac{W}{Pr} = \frac{\alpha}{1-\alpha} \cdot \frac{K}{L} \\ mc = \frac{(1-\alpha)^{\alpha-1}}{\alpha^{\alpha}} \left(\frac{W}{P}\right)^{\alpha} (r)^{1-\alpha} \end{cases}$$

$$Y = C + I$$

$$Y_H = Y_H^H + Y_H^F$$

$$\gamma_2 M^F + (P_H Y_H - P \cdot Y) = 0$$

The ROW economy

$$P_F = \kappa \cdot P^* \cdot mc^*$$

$$Y_F = Y_F^H + Y_F^F$$

$$Y_F^F = \left(1-\rho^F\right) \cdot \left[\frac{P_F}{P^*}\right]^{-\omega} Y^*$$

$$Y_H^F = \rho^F \cdot \left[\frac{P_H \cdot EX}{P^*}\right]^{-\omega} Y^*$$

$$P^* = \left[\left(1-\rho^F\right) \cdot (P_F)^{1-\omega} + \rho^F \cdot (P_H \cdot EX)^{1-\omega}\right]^{\frac{1}{1-\omega}}$$

$$\xi^D \cdot \left[\left(P_H Y_H^F\right) + \varphi \cdot \left(P_F Y_F^F / EX\right)\right] = M^F$$

$$I^* = (1+\gamma_1)K^* - (1-\delta) \cdot K^*$$

$$\xi^* \cdot (1-\varphi) \cdot P_F Y_F^F = M^*$$

$$Y^* = C^* + I^*$$

$$\begin{cases} \phi_L \cdot (L^*)^\eta = \lambda^3 W^* \\ \lambda^3 \cdot P^* C^* + \lambda^4 \cdot (1-\varphi) \cdot \xi^* \cdot RF \cdot C^* + \lambda^5 \cdot \xi^D \cdot \left(RH + \varphi \cdot \frac{1}{EX} \cdot RF\right) \cdot C^* = 1 \\ (1+\gamma_1)\lambda^3 \cdot P^* + (1+\gamma_1)\lambda^4 \cdot (1-\varphi) \cdot \xi^* \cdot RF + (1+\gamma_1)\lambda^5 \cdot \xi^D \cdot \left(RH + \varphi \cdot \frac{1}{EX} \cdot RF\right) \\ = \beta \cdot \left\{\lambda^3 \cdot P^* \left(1-\delta+r^*\right)\right\} \\ +\beta \cdot \left\{\lambda^4 \cdot (1-\varphi) \cdot \xi^* \cdot RF \cdot (1-\delta)\right\} \\ +\beta \cdot \left\{\lambda^5 \cdot \xi^D \cdot \left(RH + \varphi \cdot \frac{1}{EX} \cdot RF\right) \cdot (1-\delta)\right\} \\ \lambda^3(1+\gamma_2) = \beta \cdot \left(\lambda^3 + \lambda^4\right) \\ \lambda_t^3 \cdot EX \cdot (1+\gamma_2) = \beta \cdot \left(\lambda^3 \cdot EX + \lambda^5\right) \end{cases}$$

$$RF \triangleq P^F \cdot \left(1-\rho^F\right) \cdot \left[\frac{P_F}{P^*}\right]^{-\omega}$$

$$RH \triangleq P_H \cdot \rho^F \cdot \left[\frac{P_F}{P^*}\right]^{-\omega}$$

$$Y_F = \left[K^*\right]^{1-\alpha} \left[L^*\right]^\alpha$$

$$\begin{cases} \frac{W^*}{P^* r^*} = \frac{\alpha}{1-\alpha} \cdot \frac{K^*}{L^*} \\ mc^* = \frac{(1-\alpha)^{\alpha-1}}{\alpha^\alpha} \left(\frac{W^*}{P^*}\right)^\alpha \left(r^*\right)^{1-\alpha} \end{cases}$$