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YiLi Chien
Federal Reserve Bank of St. Louis

Kanda Naknoi
University of Connecticut

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365 Fairfield Way, Unit 1063
Storrs, CT 06269-1063
Phone: (860) 486-3022
Fax: (860) 486-4463
http://www.econ.uconn.edu/

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The Risk Premium and Long-Run Global Imbalances *

YiLi Chien† Federal Reserve Bank of St. Louis

Kanda Naknoi‡ University of Connecticut

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Abstract

This study proposes that heterogeneous household portfolio choices within a country and across countries offer an explanation for global imbalances. We construct a stochastic growth multi-country model in which heterogeneous agents face the following restrictions on asset trade. First, the degree of US equity market participation is higher than that of the rest of the world. Second, a fraction of households in every country maintains a fixed share of equity in their portfolios. In our calibrated model, which matches the US net foreign asset position and the equity premium, the average US household loads up more aggregate risk than the average foreign household by investing in a risky asset abroad and issuing a risk-free asset. As a result, the US is compensated by a high risk premium and runs trade deficits even as a debtor country. The long-run average trade deficit in our model accounts for more than 50% of the observed US trade deficit.

Keywords: Global Imbalances; Current Account; Risk Premium; Asset Pricing; Limited Participation (JEL code: E21, F32, F41, G12)

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†Research Division, Federal Reserve Bank of St. Louis, P.O. Box 442, St. Louis, MO 63166-0442; Email: yilichien@gmail.com

‡Department of Economics, University of Connecticut, 365 Fairfield Way, Unit 1063, Storrs, CT 06269-1063; Email: kanda.naknoi@uconn.edu.

1 Introduction

The debate on sustainability of global imbalances is divided into three strands in the literature. First, Obstfeld and Rogoff (2000) argue, based on the intertemporal approach to the current account, that a reversal of the US trade deficit and a large dollar depreciation are inevitable. Second, Engel and Rogers (2006) propose that a future higher US GDP growth rate than the rest of the world (ROW) can justify global imbalances. Finally, the last and growing strand of the literature is motivated by the positive net investment income flows to the US, suggesting that US foreign assets perform better than US foreign liabilities at least in terms of dividends. Hausmann and Sturzenegger (2006), Gourinchas and Rey (2007a,b) and Pavlova and Rigobon (2010) argue that the valuation of US net foreign assets (NFA) has a stabilizing effect on the current account. The proposed causes of international differences in portfolio choices are asymmetry of supply of assets (Caballero, Farhi, and Gourinchas (2008)), asymmetry of enforcement of financial contracts (Mendoza, Quadrini, and Rios-Rull (2009)), asymmetry of idiosyncratic income shocks (Mendoza, Quadrini, and Rios-Rull (2009), Pavlova and Rigobon (2010), Angeletos and Panousi (2011)), and asymmetry of credit constraint for the financial intermediary (Maggiori (2011)).

We contribute to the last strand of the literature by quantifying the valuation effect in a stochastic multi-country growth model of international portfolio choices. We differentiate our model from those by Caballero, Farhi, and Gourinchas (2008) and Pavlova and Rigobon (2010) by focusing on the demand side in asset markets. Our work complements Mendoza, Quadrini, and Rios-Rull (2009), Pavlova and Rigobon (2010) and Angeletos and Panousi (2011) by incorporating aggregate risk sharing, which is absent in their studies. In this regard, our work is closely related to Maggiori (2011), who incorporates aggregate risk sharing into a model of financial intermediation. However, we are interested in the role of household finance because the empirical evidence suggests wide heterogeneity in portfolio choices across households not only within a country but also across countries. To emphasize the demand-side heterogeneity, we assume that assets issued in every country are identical but households face restrictions on asset trade as follows. First, the degree of US equity market participation is higher than the ROW. Second, a fraction of households in every country maintains a fixed share of equity in their portfolios.

Our idea is motivated by the literature on financial literacy and evidence from international household finance data. Portfolio choices among US households have been found to be very het-

erogeneous. To be precise, only 50% of US households in the 2010 Survey of Consumer Finance data participate in the equity market. Even for those who do participate in the equity market, their investment styles are quite different. Most market participants do not change their portfolios often (Ameriks and Zeldes (2004), Brunnermeier and Nagel (2008), Calvet, Campbell, and Sodini (2009) and Alvarez, Guiso, and Lippi (2012)), while a small fraction of households trades more aggressively and earns a higher return by taking more risk. The heterogeneity of portfolio choices is even more striking in cross-country comparisons. In a sample of 12 European countries, Christelis, Georgarakos, and Haliassos (2010) found an average 26% participation rate among the senior population.[1] Given that the participation rate tends to be higher among seniors, the average participation rate for European households could be even lower than 26%. In addition, Rooij, Lusardi and Aleesie (2011) found that only 23.8% of Dutch households in the 2005 De Nederlandsche Bank's Household Survey data own stock or mutual funds. For households in Asia, Iwaisako (2009) examined Japanese household portfolios and found that their equity market participation rate declined from 30% in 1990 to 25% in 1999. Furthermore, among households participating in the equity market, their exposure to aggregate risk also varied greatly across countries. Christelis, Georgarakos, and Haliassos (2010) show that US participants hold larger equity positions than European participants even when characteristics of households are controlled for. Curcuru, Dvorak, and Warnock (2010) and Curcuru, Thomas, Warnock, and Wongswan (2011) found that US investors are better than foreign investors at choosing country composition in their equity portfolios; thus, their work provides indirect evidence that US investors are less restrictive than their foreign counterparts.

Given this empirical evidence, we incorporate the cross-country asymmetry of limited participation into our model by assuming a higher rate of equity market participation in the US than the ROW. In addition, some households in all countries are assumed to hold a fixed share of equity in their portfolios. These restrictions on households' portfolios have real consequences on consumption and welfare. Intuitively, households facing no restrictions take greater aggregate risk by holding a large fraction of equities in their portfolios, while those facing restrictions take a more cautious approach. Thanks to the compensation for risk holding, households facing no restrictions hold a large equity position, earn a high rate of return on their portfolios, accumulate a large amount of

[1]The sample countries are Austria, Belgium, Denmark, France, Germany, Greece, Italy, the Netherlands, Spain, Sweden, Switzerland and the United Kingdom.

wealth, and enjoy a high level of consumption. Conversely, households facing restrictions earn a low return on their portfolio, acquire a small amount of wealth, and keep their consumption low. Hence, heterogeneity in households' portfolios induces consumption and wealth dispersion. When we aggregate all households in each country, a country holding more aggregate risk than the ROW earns higher average returns, consumes more than its output, and runs trade deficits even in the long run. Consequently, the size of structural trade imbalances depends on the amount of risk held in the NFA position and the scale of the risk premium.

In the quantitative part of our study, we calibrate our model to match the US NFA position and the equity premium, using the equity share in household portfolios from the international household finance data. In addition, we rely on another type of asymmetry —namely, incomplete markets with asymmetric idiosyncratic labor income risk across countries —to match the US NFA position. The reason is that when the ROW faces higher idiosyncratic risk than the US, their residents tend to have a stronger precautionary saving motive than US residents, as illustrated by Mendoza, Quadrini, and Rios-Rull (2009) and Angeletos and Panousi (2011).

Our benchmark model generates a 6.31% equity premium and a 2.32% risk-free return; these values are quite close to the estimates in Guvenen (2009).[2] Our benchmark calibration predicts that the US accumulates a positive net foreign equity (NFE) position despite its negative NFA position. The positive NFE position, combined with a high risk premium, allows the US to run trade deficits in the long run. The long-run average US trade deficit is predicted to be 2.65% of output, which is more than half the average US trade deficit in 2000-2011. The predicted trade deficit is highly countercyclical, as documented in the data. Furthermore, our finding is consistent with the empirical literature that documents positive returns differential between US foreign assets and liabilities over the past few decades (Obstfeld and Rogoff (2005), Meissner and Taylor (2006), Lane and Milesi-Ferretti (2007), Gourinchas and Rey (2007a) and Gourinchas, Rey, and Govillot (2010)). We consider the documented return differential as evidence suggesting that US investors have loaded up more aggregate risk in foreign assets than foreign liabilities. In addition, Gourinchas and Rey (2007a) found that the US has financed risky investment abroad by issuing low-risk, short-

[2]In the asset-pricing literature, the equity premium is generally considered at least higher than 6% and the risk-free rate is lower than 2%. For examples, Guvenen (2009) shows that the US equity premium is 6.17% and the risk-free rate is 1.94%. Chien, Cole, and Lustig (2011) find that the equity premium is 7.53% and the risk-free rate is 1.05%. According to Campbell and Cochrane (1999), the US equity premium and the US risk-free rate are 6.69% and 0.1% respectively. In Table 2 of Alvarez and Jermann (2001), the equity premium is 6.18% and the risk-free rate is 0.8%.

run liabilities to the ROW over the past two decades.[3]

To highlight the role of cross-country asymmetry of limited participation, we compare our benchmark model with an alternative simulation in which the degree of limited participation is symmetric. In the alternative simulation, the risk premium remains high but the US NFE position turns negative as does its net foreign bond (NFB) position. The reason is that the strong precautionary saving motive in the ROW causes average foreign residents to save more and invest more in both bond and equity than average US residents. Consequently, in this case the US finances payments of investment income to the ROW by running trade surpluses in the long run. This exercise demonstrates that without cross-country asymmetry of limited participation the trade balance will not turn deficits in the long run despite a high risk premium.

Our main contribution to the literature is the integration of the microfoundation of household finance into an explanation for global imbalances. In addition to our prediction that the debtor country has a positive net foreign position of risky assets, as in Mendoza, Quadrini, and Rios-Rull (2009) and Angeletos and Panousi (2011), our combination of demand-side restrictions and aggregate shocks makes the compensation of risk so large that the debtor country can sustain trade deficits in the long run. Hence, our model successfully matches both stock and flow characteristics of global imbalances. Furthermore, our demand-side explanation for a low risk-free rate complements the supply-side theory of Caballero, Farhi, and Gourinchas (2008). Similarly, Gourinchas, Rey, and Govillot (2010) offer a rare disaster model to account for global imbalances. However, their predicted scale of imbalances is small. To be precise, they predict that the trade balance is -0.72% of output in normal times, 1.53% of output during disaster periods, and overall -0.18% unconditionally.

Our work is closely related to Maggiori (2011), who also views global imbalances as a result of asymmetric risk sharing in response to aggregate shocks. However, his argument is that the US financial intermediaries are more advanced than those in the ROW, and thus the US financial intermediaries —not the households —are loading up more aggregate risk than those in the ROW. Our mechanism differs from Maggiori's in that we do not think the equity market participation rate is driven solely by the advancement of financial intermediaries. Even in the US, which is

[3]Curcuru, Dvorak, and Warnock (2008) found that the US foreign assets do not necessarily yield higher returns than foreign liabilities. However, their dataset covers 40% of US foreign assets and 50% of US foreign liabilities because of the exclusion of foreign direct investment, assets reported by nonbanking concerns, and assets reported by US banks and securities brokers.

the most financially advanced economy, the equity market participation rate is only 50%, which partially accounts for dispersion of US household asset holdings. In addition, although Maggiori (2011) offers a plausible explanation for asymmetric portfolio choices, it is difficult to predict the scale of risk premium and global balances in his qualitative study.

In addition to the literature on global imbalances, we contribute to the theoretical literature on international portfolio choices. Specifically, we demonstrate the importance of household heterogeneity in open economies, while the majority of open-economy macroeconomic models rely on a representative agent framework. Although representative agent models of international portfolio choices can generate qualitative predictions in line with the data, their major drawback is the inability to generate a large risk premium. Our model combines both household heterogeneity and cross-country asymmetry; therefore, it can answer questions related to income and consumption dispersion. We can also extend our model to study the impact of monetary policy on consumption dispersion in open economies.

The rest of the paper is organized as follows. The next section describes our model. The quantitative results and the sensitivity analysis are in Section 3. Section 4 concludes our study.

2 The Model

This section offers a detailed description of the model.

2.1 Environment

Consider a multi-country world in which there are a large number of agents in each country. There is one endowment good, which is also the consumption good. The endowment good is homogeneous and freely traded across borders; hence the international relative price of the good, or the real exchange rate, is always 1. Time is discrete, infinite, and indexed by $t \in [0, 1, 2, ...)$. The initial period, $t = 0$, is a planning period in which financial contracting takes place. There is aggregate uncertainty in the world and we do not assume country-specific productivity shocks to simplify our analysis. We use $z_t \in Z$ to denote the aggregate shock in period t, and let z^t denote the history of

aggregate shocks up to period t. The aggregate endowment of the entire world is given by

$$Y_t(z^t) = Y_{t-1}(z^{t-1})g_t(z_t),$$

where $g_t(z_t)$ is the stochastic growth rate of the endowment and is equivalent to the growth rate of world output. The share of each country in world output is exogenously given and denoted by δ_i. Hence, output of country i is denoted by $Y_t^i(z^t) = \delta_i Y_t(z^t)$ and $\sum_{i=1}^{I} \delta_i = 1$. Output of each country is divided into two parts: diversifiable output and nondiversifiable output. The nondiversifiable portion is subject to idiosyncratic stochastic shocks in addition to aggregate shocks. Let η_t^i denote the idiosyncratic shock in period t of country i. Similarly, $\eta^{i,t}$ denotes the history of idiosyncratic shocks for a household at country i. The nondiversifiable portion of output is therefore given by $\gamma Y_t^i(z^t)\eta_t^i$, where γ denotes the share of nondiversifiable output.[4] The idiosyncratic events η_t^i are i.i.d. across households within country i. Their mean is normalized to 1. We use $\pi(z^t, \eta^{i,t})$ to denote the unconditional probability of state $(z^t, \eta^{i,t})$ being realized. The events are first-order Markov and their probabilities are assumed to be independent:

$$\pi(z^{t+1}, \eta^{i,t+1}|z^t, \eta^{i,t}) = \pi(z_{t+1}|z_t)\pi(\eta_{t+1}^i|\eta_t^i).$$

2.2 Leverage and Assets Supply

There are two type of assets available in this economy: risky equity and risk-free bond. Both assets are claims to the diversifiable output. The international financial market is assumed to be fully integrated. We simply consider the equity of country i as a leveraged claim on its aggregate diversifiable output $((1-\gamma)Y_t^i(z^t))$. The leverage ratio is constant over time and denoted by ϕ. Let $\overline{B}_t^i(z^t)$ denote the supply of a one-period risk-free bond in period t in country i and $W_t^i(z^t)$ denote the price of a claim to country i's aggregate diversifiable output in period t. With a constant leverage ratio, the total supply of $\overline{B}_t^i(z^t)$ must be adjusted such that

$$\overline{B}_t^i(z^t) = \phi\left[W_t^i(z^t) - \overline{B}_t^i(z^t)\right].$$

[4]The share of nondiversifiable output is assumed to be identical across countries to simplify our analysis. The quantitative results might be enhanced if we relaxed this assumption.

By the equation above, the aggregate diversifiable output can be decomposed into the interest payment to bondholders and payouts to shareholders; the total payouts, $\overline{D}_t^i(z^t)$, are

$$\overline{D}_t^i(z^t) = (1-\gamma)Y_t^i(z^t) - R_{t,t-1}^f(z^{t-1})\overline{B}_{t-1}^i(z^{t-1}) + \overline{B}_t^i(z^t), \tag{1}$$

where $R_{t,t-1}^f(z^{t-1})$ denotes the risk-free rate at period $t-1$. For simplicity, our model assumes a constant supply of equity shares. As a result, if a firm reissues or repurchases shares of equity, it must be reflected by $\overline{D}_t^i(z^t)$ in our model. Simply stated, $\overline{D}_t^i(z^t)$ includes both the cash dividends and net repurchases.

The assumption of a constant leverage ratio over time and countries serves three purposes. First, our paper focuses on the demand-side heterogeneity in the asset market rather than the supply side. There is no heterogeneity of the asset supply across countries while the supply of assets might change in the time dimension since the value of wealth changed. This feature distinguishes our paper from the work by Caballero, Farhi, and Gourinchas (2008), which emphasizes the supply side of financial markets. Second, together with no country-specific shock on output, this assumption implies that all bonds or equities issued by different countries are identical, which makes the model very parsimonious. There are only one type of equity and one type of bond in our model; hence this saves notation. Moreover, it is easy to determine who bears the aggregate risk. A portfolio with a $1/(1+\phi)$ equity share defines the market portfolio, which is identical to holding a claim to aggregate output. Therefore, if households hold equity shares, ω, higher than the equity share in market portfolio, then they are more exposed to aggregate risk compared with the average. Otherwise, households take less than average aggregate risk if their ω is lower than $1/(1+\phi)$. In short, risk-taking behaviors across populations are directly linked to the distribution of the equity share in portfolios.

Finally, we denote the value of total equity (a claim to total payouts $\overline{D}_t(z^t) = \sum_i \overline{D}_t^i(z^t)$) by $V_t(z^t)$. The gross return of equity, $R_{t,t-1}^d(z^t)$, is therefore given by

$$R_{t,t-1}^d(z^t) = \frac{\overline{D}_t(z^t) + V_t(z^t)}{V_{t-1}(z^{t-1})}. \tag{2}$$

2.3 Heterogeneity in Portfolios

Strong empirical evidence has shown that significant portfolio heterogeneity exists across populations not only within a country but also across countries. This paper exogenously imposes different restrictions on portfolio choices of households to capture this empirical fact. These restrictions apply both in terms of the menu as well as the composition of assets that a household can implement in any given period. Our model assumes two types of restrictions that define three types of households. The first type of households faces no restrictions on its portfolio choices. These households can optimally adjust their portfolio choices in response to changes in the investment opportunity set. We call the first type of households Mertonian traders. The second type of households also faces no restrictions on the menu of assets but the composition of assets is restricted to be constant in equity share. For these households, ω is exogenously given and is constant over time. They are called non-Mertonian equity traders. Finally, the portfolio choice of the last type of households is restricted by the menu of assets. These households can trade only bonds and do not participate in the equity market. We call them non-participants.

Non-Mertonian equity traders deviate from the optimal portfolio choices in the following dimension: They cannot change the share of equity in their portfolios in response to changes in the market price of risk. Simply stated, they miss market timing. As a result, they choose their level of saving only while their portfolio return is given by the fixed portfolio choice. Depending on their equity share, they might overtake or undertake aggregate risk compared with the optimal portfolio. Non-participants simply cannot hold equity, are not exposed to any aggregate risk, and hence earn a lower average return on their portfolios. In other words, they forgo the risk premium. These two different portfolio restrictions create a suboptimal consumption-savings choice along with distorted asset allocations. Therefore, the consumption variation caused by the suboptimal portfolio choice is closely related to the level of the risk premium and the variation of the risk premium.

We denote the fraction of different types of households in each country i by μ_i^j, where $j \in \{me, et, np\}$ represents Mertonian traders, non-Mertonian equity traders, and non-participants, respectively.

2.4 The Household's Problem

Preferences All households have identical preferences. A household in country i ranks the consumption plan, $\{c^i\}$, by the following equation

$$U\left(\{c^i\}\right) = \sum_{t=1}^{\infty} \beta^t \sum_{(z^t,\eta^{i,t})} \frac{c_t^i(z^t,\eta^{i,t})^{1-\alpha}}{1-\alpha} \pi(z^t,\eta^{i,t}), \tag{3}$$

where α denotes the coefficient of relative risk aversion, β is the time discount factor, and $c_t^i(z^t,\eta^{i,t})$ denotes the household's consumption in state $(z^t,\eta^{i,t})$. All households are ex-ante identical except for their portfolio restrictions, which are reflected in their budget constraints.

Budget Constraints of Mertonian Traders Consider a Mertonian trader in country i entering the period with a net financial wealth $a_t^i(z^t,\eta^{i,t-1})$ given the history $(z^t,\eta^{i,t-1})$. Note that the net financial wealth is not spanned by the realization of idiosyncratic shocks, η_t^i, since there are no contingent claims on idiosyncratic shocks. At the end of the period, Mertonian traders buy shares of equities $s_t^i(z^t,\eta^{i,t})$ and bonds $b_t^i(z^t,\eta^{i,t})$ in financial markets and consumption $c_t^i(z^t,\eta^{i,t})$ in the goods markets subject to this one-period budget constraint:

$$s_t^i(z^t,\eta^{i,t})V_t(z^t) + b_t^i(z^t,\eta^{i,t}) + c_t^i(z^t,\eta^{i,t}) \leq a_t^i(z^t,\eta^{i,t-1}) + \gamma Y_t^i(z^t)\eta_t^i, \text{ for all } z^t,\eta^{i,t}. \tag{4}$$

The agent's net financial wealth, $a_t^i(z^t,\eta^{i,t-1})$, in state $(z^t,\eta^{i,t})$, is given by the payoffs from her equity and bond position:

$$a_t^i(z^t,\eta^{i,t-1}) = s_{t-1}^i(z^{t-1},\eta^{i,t-1})\left[D_t(z^t) + V_t(z^t)\right] + R_{t,t-1}^f(z^{t-1})b_{t-1}^i(z^{t-1},\eta^{i,t-1}). \tag{5}$$

Budget Constraints of Non-Mertonian Equity Traders Consider a non-Mertonian equity trader in country i starting with a net financial wealth $a_t^i(z^t,\eta^{i,t-1})$ in the beginning of period t. During the period, this household receives nondiversifiable income, $\gamma Y_t^i(z^t)\eta_t^i$, and consumes $c_t^i(z^t,\eta^{i,t})$ in the goods markets. At the end of period t, the household buys equity shares, $s_t^i(z^t,\eta^{i,t})$, and risk-free bonds, $b_t^i(z^t,\eta^{i,t})$, subject to a fixed target portfolio equity share, denoted by ω^*. In

addition to equations (4) and (5), their constraints also include a portfolio restriction:

$$\omega^* = \frac{s_t^i(z^t, \eta^{i,t})V_t(z^t)}{s_t^i(z^t, \eta^{i,t})V_t(z^t) + b_t^i(z^t, \eta^{i,t})}.$$

Budget Constraints of Non-Participants Since non-participants can hold only risk-free bonds, their total asset holding in the beginning of period t, $a_t^i(z^t, \eta^{i,t-1})$, is their bond position. The budget constraint of non-participants in country i is written as follows:

$$b_t^i(z^t, \eta^{i,t}) + c_t^i(z^t, \eta^{i,t}) \leq R_{t,t-1}^f(z^{t-1}) b_{t-1}^i(z^{t-1}, \eta^{i,t-1}) + \gamma Y_t^i(z^t)\eta_t^i, \text{ for all } z^t, \eta^{i,t}. \tag{6}$$

Finally, all households are subject to solvency constraints, which are $a_t^i(z^t, \eta^{i,t-1}) \geq 0$ for all households. The details of the household problem and its associated Euler equations are detailed in Appendix A.

2.5 Law of Motion of Net Foreign Assets

To obtain the dynamics of NFA, first we derive the aggregate budget constraint of country i by summing the flow budget constraints (equations (4) and (6)) across all types of households in country i. The idiosyncratic risks across households offset each other by applying the law of large numbers to the continuum population. Let the aggregate variables of country i be denoted by uppercase letters, where $X_t^i(z^t) = \sum_{j=me,et,np} \sum_{\eta^{i,t}} \mu_i^j x_t^i(z^t, \eta^{i,t})\pi(\eta^{i,t})$. The aggregate budget constraint of country i is therefore given by

$$S_t^i(z^t)V_t(z^t) + B_t^i(z^t) \leq A_t^i(z^t) + \gamma Y_t^i(z^t) - C_t^i(z^t), \text{for all } z^t, \tag{7}$$

where $A_t^i(z^t)$ denotes the aggregate asset holdings of country i in period t and

$$A_t^i(z^t) \;=\; S_{t-1}^i(z^{t-1})V_{t-1}(z^t)R_{t,t-1}^d(z^t) + R_{t,t-1}^f(z^{t-1})B_{t-1}^i(z^{t-1}).$$

Our simplified assumptions that make all equities issued by different countries identical comes with a small cost: the indetermination of the domestic equity share of total equity holdings for one country. As a result, the model cannot determine the gross foreign asset and gross foreign liability

positions. However, the model does reveal the total asset holdings and the portfolio composition of one country; therefore, we can compute the net external equity position and the net external bond position of a country. We define the NFE position as the total equity holdings of country i minus the total equities issued by country i:

$$NFE_t^i(z^t) = S_t^i(z^t)V_t(z^t) - \overline{V}_t^i(z^t)$$

Similarly, we define the NFB position as the total bond holdings of country i minus the total bonds issued by country i:

$$NFB_t^i(z^t) = B_t^i(z^t) - \overline{B}_t^i(z^t)$$

Consequently, the NFA position of country i in period t is the sum of the NFE and NFB positions:

$$NFA_t^i(z^t) = NFE_t^i(z^t) + NFB_t^i(z^t). \tag{8}$$

We impose equality on the budget constraint and use the NFA in equation (8) to rewrite the aggregate budget constraint in (7) as follows:

$$\begin{aligned} NFA_t^i(z^t) &= R_{t,t-1}^d(z^t)NFE_{t-1}^i(z^{t-1}) + R_{t,t-1}^f(z^{t-1})NFB_{t-1}^i(z^{t-1}) + R_{t,t-1}^d(z^t)\overline{V}_{t-1}^i(z^{t-1}) \\ &\quad + R_{t,t-1}^f(z^{t-1})\overline{B}_{t-1}^i(z^{t-1}) - \overline{V}_t^i(z^t) - \overline{B}_t^i(z^t) + \gamma Y_t^i(z^t) - C_t^i(z^t). \end{aligned} \tag{9}$$

Finally, we use the value of equity in equation (2) and the asset supply in equation (1) to find $R_{t,t-1}^d(z^t)\overline{V}_{t-1}^i(z^{t-1})$, and substitute it into equation (9) to obtain the following law of motion of NFA of country i:

$$NFA_t^i(z^t) = R_{t,t-1}^d(z^t)NFE_{t-1}^i(z^{t-1}) + R_{t,t-1}^f(z^{t-1})NFB_{t-1}^i(z^{t-1}) + TB_t^i(z^t), \tag{10}$$

where $TB_t^i(z^t) = Y_t^i(z^t) - C_t^i(z^t)$. Intuitively, NFA is the sum of gross returns on the NFE and NFB positions in the previous period and the trade balance.

To highlight the role of risk premium, we define the excess return $\rho_{t,t-1}(z^t)$ as

$$\rho_{t,t-1}(z^t) = R_{t,t-1}^d(z^t) - R_{t,t-1}^f(z^{t-1}).$$

Then we rewrite the NFA in equation (10) using the following definition of excess return:

$$NFA_t^i(z^t) = R_{t,t-1}^f(z^{t-1})NFA_{t-1}^i(z^t) + \rho_{t,t-1}(z^t)NFE_{t-1}^i(z^t) + TB_t^i(z^t). \quad (11)$$

Clearly, positive excess return has a positive effect on the NFA.

Next, we deflate equation (10) by the output and obtain the change in the NFA-to-GDP ratio:

$$\Delta\frac{NFA_t^i(z^t)}{Y_t^i(z^t)} = \left(\frac{R_{t,t-1}^f(z^{t-1})}{g_t(z_t)} - 1\right)\frac{NFA_{t-1}^i(z^{t-1})}{Y_{t-1}^i(z^{t-1})} + \frac{\rho_{t,t-1}(z^t)}{g_t(z_t)}\frac{NFE_{t-1}^i(z^t)}{Y_{t-1}^i(z^{t-1})} + \frac{TB_t^i(z^t)}{Y_t^i(z^t)} \quad (12)$$

In a stationary equilibrium, the average change in the NFA-to-GDP ratio in the left-hand side of equation (12) is zero. The time subscript is dropped from all variables to denote their long-run average. The long-run average of equation (12) is approximated by the following:

$$-\frac{TB^i}{Y^i} \approx \left(\frac{R^f}{g} - 1\right)\frac{NFA^i}{Y^i} + \left(\frac{\rho}{g}\right)\frac{NFE^i}{Y^i}, \quad (13)$$

where g is the average (gross) growth rate of output and we assume NFA^i/Y^i and NFE^i/Y^i are invariant in a stationary equilibrium. In addition, R^f denotes the average risk-free return, and ρ denotes the average risk premium. Evidently, a debtor country ($NFA^i/Y^i < 0$) can run long-run trade deficits ($TB^i < 0$) if (i) the risk-free rate is lower than the average growth rate of world output ($R^f < g$), or (ii) this country has a positive NFE position paying positive risk premium ($\rho > 0$ and $NFE^i > 0$), or both.

2.6 Competitive Equilibrium

A competitive equilibrium for this economy is defined in the standard way. It consists of a consumption allocation, allocations of bond and equity choices, and a list of prices such that (i) given these prices, a trader's asset and consumption choices maximize her expected utility subject to the budget constraints, the solvency constraints, and the constraints on portfolio choices, and (ii) all asset markets clear.

3 Quantitative Results

This section begins with a summary of key statistics of the US external account. In the following subsections, we calibrate and evaluate our model to examine the extent to which our model can account for the US external balances, especially the trade balance. We use several steps to achieve this goal. To illustrate the intuition of our model, we first consider a symmetric two-country model, in which both countries have identical portfolio restrictions and an identical idiosyncratic shock process. Second, we consider a benchmark model calibrated to match several key features of data in asset pricing and household portfolio behaviors. Then in subsection 3.5, we demonstrate the importance of the risk premium to our results by considering a counterfactual example, in which the equity premium is zero by construction. Finally, in subsection 3.6 we consider an identical rate of equity market participation across countries to highlight the role of asymmetry of equity market participation. The last subsection displays the results of another counterfactual exercise in which the composition of Mertonian traders and non-participants varies.

3.1 US External Account Statistics

Table I provides the average of the US NFA position, its breakdown, and the balance of payments relative to output in 2000-2011. We disaggregate the US NFA position into three components. First, we define the NFE position as the sum of foreign equities and foreign direct investment (FDI) abroad net of domestic equities held by foreigners and inward FDI. Second, we define the NFB position as the sum of foreign bonds and foreign currencies net of foreign-owned US government securities and corporate bonds. Finally, the remainder is called the net other foreign asset position and we do not know its composition. The average of the US NFE and NFB positions during 2000-2011 are -40.42% of output and 15.34% output, respectively. The net other foreign assets position is -2.82%. Their sum, which is the US NFA position, is -27.90% of output.

The last three rows in Table I report the balance of payments. We exclude unilateral transfers from our measure of the current account to capture only market transactions. On average, the US current account deficit in 2000-2011 is 4.50% of output. More than 100% of this sizable deficit is trade deficit, which amounts to 5.30% of output. The net factor income account is in surplus of 0.80% of output.

[Table 1 about here.]

3.2 Calibration

We consider a two-country version of our model. Country 1, or the home country, is the US and Country 2, or the foreign country, is the ROW. The size of each country is measured by its share of world GDP. Table II displays country size and other parameter values used in all cases.

The US share of world GDP is 33%, although the actual US GDP share from the US Department of Agriculture's Economic Research Service Database in 1980-2009 is 27% on average because our hypothetical world does not include all countries. To be precise, our hypothetical world consists of 48 countries: OECD countries, large developing countries such as China and India, and medium-size developing countries. These 48 countries account for 83% of the actual world GDP in 1980-2009. Thus, the US GDP share in our hypothetical world adjusts to 33%.

Our calibration strategy of aggregate shocks and idiosyncratic shocks is based on Alvarez and Jermann (2001). Aggregate shocks are calibrated into a two-state first-order Markov chain with the first aggregate state as a recession and the second aggregate state as an expansion. The stochastic aggregate output growth process is calibrated by four statistics: (i) the relative frequency between expansion and recession; (ii) the average growth rate of consumption per capita; (iii) the standard deviation of the growth rate of consumption per capita; and (iv) the first-order autocorrelation of the growth rate of consumption per capita.

Expansions occur more often than recessions; the frequency of recessions is set to 27.4% as in Alvarez and Jermann (2001). The aggregate shocks are assumed to be i.i.d. given that the growth rate of consumption is hard to predict (see the empirical support by Neely, Roy, and Whiteman (2001)). We also verify this assumption in our data by checking that the first-order autocorrelation of the growth rate of real consumption per capita is not statistically different from zero for most countries. Specifically, we obtain the first-order autocorrelation of country-specific growth rates of real consumption per capita by regressing the growth rates of real consumption per capita on its one-period lag and a constant. We find that the coefficient of the lag term is statistically not different from zero at the 1% significance level for 42 of the 48 countries.

The average output growth rate and its standard deviation are 2.54% and 3.02%, respectively, in our data set (See Appendix B for details). As a result, the transition probability of aggregate

shocks is calibrated to

$$\pi(z'|\,z) = \begin{bmatrix} 0.2740 & 0.7260 \\ 0.2740 & 0.7260 \end{bmatrix},$$

and the average growth rate of output in the recession state and the expansion state is $z_L = 0.9762, z_H = 1.0440$.

We also consider a two-state first-order Markov chain for idiosyncratic shocks. The first state is low and the second state is high. Following Alvarez and Jermann (2001) and Storesletten, Telmer, and Yaron (2004), we calibrate this shock process by two moments: the standard deviation of idiosyncratic shocks and the first-order autocorrelation of the shocks, except we eliminate the countercyclical variation in idiosyncratic risk. The Markov process for the log of the nondiversified income share, $\log \eta$, has a standard deviation of 0.71, and its autocorrelation is 0.89. The transition probability is denoted by

$$\pi(\eta'|\,\eta) = \begin{bmatrix} 0.9450 & 0.0550 \\ 0.0550 & 0.9450 \end{bmatrix}.$$

The two states of idiosyncratic shocks, the mean of which is normalized to 1, are $\eta_L = 0.3894$ and $\eta_H = 1.6106$.

Note that we do not have good sources for the idiosyncratic shock process for the ROW. As we show later, we calibrate the ROW idiosyncratic shock process to approximate the US NFA position. Our calibration, in fact, indicates that the volatility of the ROW idiosyncratic process is slightly larger than that of the US, which is consistent with the finding of Mendoza, Quadrini, and Rios-Rull (2009).

All households in the world have the same CRRA preference. Since this is a growth economy with a 2.54% average growth rate, we set the time discount factor $\beta = 0.995$ to match the low risk-free rate. The risk-aversion rate γ is set to 6 to produce a high risk premium in our benchmark calibration. Following Mendoza, Quadrini, and Rios-Rull (2009), the fraction of nondiversifiable output is set to 88.75%. As shown in Section 2, equity in our model is simply a leveraged claim to diversifiable income. In the US Flow of Funds Accounts, the ratio of corporate debt to net worth is roughly 0.65, suggesting a leverage parameter of 2. Nevertheless, the study by Cecchetti, Lam, and Mark (1990) reports that the standard deviation of the growth rate of dividends is at least 3.6 times that of aggregate consumption, suggesting that the appropriate leverage level is over 3.

Following Abel (1999) and Bansal and Yaron (2004), the leverage ratio parameter is set to 3.

[Table 2 about here.]

3.3 Symmetric Cases

To illustrate the mechanism of our model, we start with a symmetric version in which the composition of traders and the idiosyncratic shock process are identical in the home country and the foreign country. In this symmetric version of the model, we consider three quantitative experiments, which differ according to the traders' pool.

1. Experiment 1: The pool of traders consists of 100% Mertonian traders in both countries.

2. Experiment 2: The pool of traders consists of 5% Mertonian traders and 95% non-Mertonian equity traders in both countries. The equity target share of non-Mertonian traders, ω^*, is assumed to be 25%, which is the equity share of market portfolio.

3. Experiment 3: The pool of traders consists of 5% Mertonian traders, 25% non-Mertonian traders and 70% of non-participants in both countries. The non-Mertonian equity traders are still assumed to hold the market portfolio ($\omega^* = 25\%$).

Symmetric Cases: Quantitative Results The first panel of Table III reports the asset pricing results of all experiments. We report the equity premium $E(R^d - R^f)$, the standard deviation of excess return $\sigma(R^d - R^f)$, the Sharpe ratio on equity, the average risk-free rate $E(R^f)$, and the standard deviation of the risk-free rate $\sigma(R^f)$. The second panel reports the wealth return and the portfolio choice for each type of traders. Specifically, it reports the following: the average excess wealth return for Mertonian equity traders and non-Mertonian equity traders, denoted by $E(R^w - R^f)_{me}$ and $E(R^w - R^f)_{et}$, respectively; the average equity share of portfolios for Mertonian traders and non-Mertonian equity traders, $E(\omega)_{me}$ and $E(\omega)_{et}$, respectively; and the same statistics at the country level. $E(R^w - R^f)_{US}$ and $E(R^w - R^f)_{ROW}$ denote the average total wealth return in the US and the ROW. Similarly, $E(\omega)_{US}$ and $E(\omega)_{ROW}$ stand for the average equity portfolio share of the US and the ROW.

The last panel reports the US external balances statistics as a percentage of US output. It is important to note that the current account in our model differs from the official current account

statistics: our theoretical current account includes capital gains or capital losses as well as payments of dividends and interest earnings, but the official current account statistics include only payments of dividends and interest earnings. To illustrate the quantitative impact of capital gains or the valuation effect on the current account, we compute the official version of the current account, denoted by CA^o, by adding net dividend payments and net interest income payments to the trade balance. A dividend process is necessary to compute the net factor income account (NFIA). For this model economy, the dividend process is assumed to be a version of leveraged aggregate consumption, with dividend growth determined by the following equation:

$$\Delta \ln Div - E(\Delta \ln Div) = \lambda[\Delta \ln C - E(\Delta \ln C)],$$

where the leverage parameter λ is assumed to be 3. We report the following statistics in the last panel: the average trade balance, $E(\frac{TB}{Y})_{US}$, the average current account, $E(\frac{CA}{Y})_{US}$, the average official current account, $E(\frac{CA^o}{Y})_{US}$, the average NFIA, $E(\frac{NFIA}{Y})_{US}$, the average NFE position, $E(\frac{NFE}{Y})_{US}$, the average NFB position, $E(\frac{NFB}{Y})_{US}$, and the average NFA position, $E(\frac{NFA}{Y})_{US}$. All are reported as a percentage of output.

In the first experiment, all households face no trading restriction and hence have an identical portfolio choice. In order to clear the market, the equilibrium prices must adjust such that holding the market portfolio is the optimal portfolio choice. This experiment is similar to the one by Krusell and Smith (1998) except that ours is an endowment economy. Since all households face idiosyncratic risk, the precautionary saving motive leads to a low risk-free rate of 3.47% as reported in panel A of Table III.[5] The risk-free rate is constant due to the unpredictable consumption growth rate. In addition, the risk premium is only 2.11%, reflecting the equity premium puzzle shown by Mehra and Prescott (1985). To summarize, with identical no restriction on portfolio choices across the population, the asset-pricing result of our economy coincides with that of standard macroeconomic models.

In the second experiment, we replace 95% of traders with non-Mertonian equity traders, who are assumed to hold the market portfolio. The second column of Table III reports the results, which suggest that the equilibrium allocations and prices of the second experiment are identical to those of

[5]The risk-free rate in the version of the representative agent economy under our calibration is 16.83% because the average output growth is 2.54% and the intertemporal rate of substitution, $1/\alpha$, is low.

the first experiment. The intuition is straightforward. Given the equilibrium prices of Experiment 1, the portfolio choice of non-Mertonian equity traders is an optimal one (market portfolio) and Mertonian traders behave exactly the same as in Experiment 1. No agents change their decision rules regarding consumption and investment. Consequently, the equilibrium allocations and prices are unchanged. In fact, this result is proven analytically by Krueger and Lustig (2010). From this experiment, we learn that even though Mertonian traders adjust their portfolio optimally, they take no advantage if the two other types of traders do not make investment mistakes. As a result, there is no difference between Mertonian and non-Mertonian equity traders. However, this will not be the case if we replace a fraction of non-Mertonian equity traders with non-participants, who deviate from the optimal portfolio choice. The third experiment demonstrates this scenario.

In the third experiment, we decrease the fraction of non-Mertonian equity traders to 25% and add 70% of non-participants, while keeping 5% of Mertonian traders. The third column of Table III reports the results. The risk-free rate becomes even lower, 2.33%, and still remains almost constant with only 0.08% standard deviation. At the same time, the equity premium increases to 6.67%, which is close to that in the data. Panel B shows that Mertonian traders realize a much higher wealth return, 5.48%, by taking a large fraction of equity in their portfolio, 80%. The intuitions for these results can be understood as follows. First, non-participants deviate from the market portfolio by holding no equity and hence they do not bear any aggregate risk. In contrast to Experiments 1 and 2, replacing 70% of the population of non-Mertonian equity traders with non-participants creates some residual aggregate risk. The residual risk must be taken by other traders in equilibrium. Non-Mertonian equity traders are still assumed to hold the market portfolio and hence they are unable to absorb any extra risk. Eventually, all residual risk created by the non-participants must be absorbed by Mertonian traders. There is a large amount of residual risk due to the high fraction of non-participants. Hence, the risk premium must be high in order to make a small fraction of Mertonian traders willing to take a great amount of extra risk. Eventually, Mertonian traders earn a higher average return by taking more aggregate risk and enjoy a higher level of consumption, while non-participants only earn the low risk-free return and consume less.

The last two rows of Panel B show that the wealth return and portfolio choice are identical in both countries in all experiments. In addition, Panel C reports that the US trade balance, current account, official current account, NFIA position, and NFA position are all zero. These zero balances

clearly result from the symmetric assumption of these experiments. Most importantly, these results suggest that each country holds the market portfolio; therefore, both countries bear an amount of aggregate risk exactly proportional to their country size. Since both bonds and equities are identical across countries, without loss of generality, we assume each country holds its own assets, consumes its own endowments, and carries no international trade. Hence, all external balances become zero in all experiments. However, the results of balanced external accounts are no longer true if we assume asymmetry across countries in portfolio restrictions and in the idiosyncratic process. In the next section, our benchmark economy considers the asymmetric case.

[Table 3 about here.]

3.4 The Benchmark Case

Now consider the benchmark case in which the composition of the traders' pool and the idiosyncratic shock process in the US differ from those in the ROW.

Benchmark Calibration In order to match a high equity premium —more than 6% as measured in the post-war US data —a small fraction of Mertonian traders must absorb a large amount of residual risk. We therefore set the fraction of Mertonian traders to 5% for both countries. Since 50% of US households do not hold stocks according to the 2010 Survey of Consumer Finance data, we set 50% of US investors as non-participants. As for the ROW, the equity market participation rate is significantly lower than that in the US even among many high-income countries. The rate is between only 20% to 30% in Europe and Japan (Christelis, Georgarakos, and Haliassos (2010), Van Rooij, Lusardi, and Alessie (2011) and Iwaisako (2009)). For this reason, we set the fraction of non-participants in the ROW to 70%, which is modest given that the ROW consists of a large fraction of developing countries with very low market participation. In fact, 70% is roughly the share of US non-participants in 1985, reflecting that the US leads other countries in terms of financial development. The remaining investors are non-Mertonian equity traders, and their fractions are 45% and 25% in the US and the ROW, respectively.

In addition to the market participant rate, the equity share of market participants is also an important parameter. We rely on the 2010 Survey of Consumer Finance data to calibrate the equity share of non-Mertonian equity traders in the US, which accounts for 45% of the population.

Among those 50% of households that hold equities in the data, we first sort them by their equity position and compute the average equity share excluding the top 5% of equity holders. The averaged computed equity share is 34.7%, which we use as the equity share of US equity traders in the benchmark case. This calibration reflects the observations from both the data and our model that more sophisticated households tend to hold larger amount of equities. Unfortunately, we do not have information about the equity share of non-Mertonian equity traders in the ROW. For this reason, we simply assume that the ROW non-Mertonian equity traders hold the market portfolio, which has a 25% equity share. This equity share is conservative, according to Christelis, Georgarakos, and Haliassos (2010), who document that the equity shares among market participants are significantly higher in the US than in Europe.

Quantitative Results of Benchmark Case Similar to the symmetric economy in the previous subsection, we report the statistics for asset pricing, portfolio returns, and US external balances. The benchmark asset-pricing results are shown in Panel A of Table IV. Our benchmark economy produces a high equity premium as well as a low and stable risk-free rate. The equity premium is 6.31% and the Sharpe ratio on equity is 47.66%. The average risk-free rate is 2.32% and its volatility is only 0.08%. Hence, our calibrated model is capable of producing reasonable asset-pricing results. Note that the return on bonds is less than the growth rate of output, implying that a country can in fact run a long-run trade deficit by selling risk-free bonds abroad, as indicated by the trade balance equation in (13).

The success of matching high risk premiums and low risk-free rates relies on two key frictions in our model. The first friction is the incomplete market with respect to idiosyncratic risk. It is well known that incomplete market models can produce reasonable risk-free rates implications in a growing economy. The second friction, which is limited participation combined with a relatively small fraction of Mertonian traders, produces a high equity premium by concentrating the aggregate risk among Mertonian traders. This is in line with Chien, Cole, and Lustig (2011), who use a similar setup in a closed economy to explain the average level and volatility of risk premium.

Panel B in Table IV reports the wealth returns and the portfolio choices across traders and across countries. The US Mertonian traders earn an average excess return of 5.31% by holding about 82% of equity in their portfolio. Because of higher idiosyncratic risks faced by foreign investors, the ROW Mertonian traders take a slightly more cautious approach: Their equity share

is roughly 80% and the average excess return on wealth drops to 5.14%. The US non-Mertonian equity traders realize a higher excess wealth return, 2.20%, compared with the ROW non-Mertonian equity traders earning 1.58% because of the difference in the equity target share, 34.7% and 25%, respectively. Given that the US not only has a larger fraction of equity investors but also a higher equity target share among these investors, in aggregate, US investors have a 30.64% equity share in their overall portfolio, which is higher than the 21.55% share among foreign investors. Since the market portfolio is 25% in equity, the average portfolio of US investors is riskier than that of average foreign investors. As a result, US investors are compensated by the higher overall portfolio excess return, 1.93%, compared with 1.36%, the overall average return of foreign investors. The higher average return earned by US investors has a significant impact on US external accounts as discussed below.

The external account statistics are reported in Panel C in Table IV. The long-run average US trade balance is -2.65% of output, suggesting the valuation effect through asset returns alone accounts for 50% of trade deficit in the data, -5.30% of GDP. In addition, the US trade deficit is also highly volatile and countercyclical. To demonstrate this effect, the top panel of Figure 1 plots a sample path of the US trade balance as a fraction of GDP. The shaded areas represent recessions. The US trade deficit can vary from close to zero to more than 4% of GDP, which is quite volatile. Also, the US trade balance drops significantly after a long expansion, indicating that US investors consume more during good aggregate states. When a recession hits, the trade balance improves greatly, indicating that US investors reduce their consumption more compared with ROW households. The countercyclical behavior of the trade deficit is consistent with the recent reduction of the US trade deficit after the 2007-2009 financial crisis. In the long run, the theoretical current account must be zero, otherwise there is no stationary equilibrium. The bottom panel of Figure 1 plots the US current account as a fraction of GDP in our model. It varies greatly, from 10% to almost -20% of GDP, and is highly procyclical. However, the official US current account, which considers only the interest and dividend payments, is -2.17% and the NFIA is 0.48% of output. Clearly, ignoring capital gains creates a downward bias in the current account statistics. Finally, the model produces 46.55% of the US NFE-to-output ratio and -74.72% of output in the NFB position, reflecting significant risk-taking behavior by US investors.

Compared to the data, our benchmark case predicts a larger NFE position than the US statistics

in Table I. The reason for the difference is that our model is abstract from differences in risks within the same asset class, while in practice there are many types of assets with different risk loading within asset classes. It is possible that bonds or equities held by US investors are riskier than those held by foreign investors. Thus, the simple decomposition of the US NFA statistics into bonds and equities cannot truly reflect the total risk exposure by US investors. As a measure of aggregate risk exposure, we can calculate the average return on the US NFA position from the portfolio composition and asset returns. To be precise, the average return on the US NFA position predicted by our benchmark model is 2.28%. We can compare our average return with that in the literature that documents return differentials between US foreign assets and liabilities. For instance, Gourinchas and Rey (2007a) estimate that the average return on US foreign assets and the average return on US foreign liabilities in the post-Bretton Woods era are 6.8% and 3.5%, respectively. Note that the US foreign assets and liabilities positions in 2000-2011 are on average 110.69% and 138.59% of output, respectively. Therefore, based on the returns in Gourinchas and Rey (2007a), the return on the US NFA is 2.67%, which is quite close to our 2.28%.

The main message of our exercise is that the asymmetry between portfolios in the US and those in the ROW plays an important role in explaining large US trade deficits. The combination of long-run trade deficits and a negative NFA position predicted by our model differentiates our work from other studies on global imbalances except for Maggiori (2011). However, we cannot compare our benchmark results with Maggiori (2011) because he does not provide *quantitative* predictions. We view our calibrated trade deficits as conservative because we use conservative parameters to capture the asymmetric risk-taking behavior of the households across countries as documented by empirical studies. In our model, the allocation of aggregate risk is the key determinant of the sustainability of the trade deficit. The country bearing more aggregate risk can enjoy the long-run trade deficit financed by the risk premium, despite its negative NFA position, as indicated by equation (13). As a result, the US can run a large negative NFA position and enjoy the trade deficit in the long run, while the ROW runs the trade surplus.

[Table 4 about here.]

[Figure 1 about here.]

3.5 The Importance of Risk Premium

The combination of the US long-run trade deficit and negative NFA position in our model comes from the compensation for excess aggregate risk borne by US investors. If the market price of risk is low, taking the excess risk could have a significantly small impact on the trade balance and current account. We now explore the importance of the risk premium on the trade balance.

Consider an economy without the aggregate risk. If there is no aggregate risk, then the return on equity is identical to the return on bonds, implying zero equity premium. The asymmetric trading restrictions no longer matter, since portfolio returns are independent of portfolio choices between equities and bonds. In this environment, a country with a negative NFA position in the long run must run trade surpluses unless the return on foreign liabilities is lower than the output growth rate. The only factor that matters to external balances here is the level of saving in each country. In this case, the precautionary saving motivated by the idiosyncratic risk plays an essential role in global imbalances. Table V clearly reflects the discussion above.

Panel A in Table V confirms that there is no returns differential between equities and bonds, and thus the risk premium is zero. The risk-free rate is now 4.09%, which is higher than the growth rate of output in this case. Since the composition of equities and bonds in portfolios no longer affect the return, the wealth return statistics are identical across households and countries regardless of their trading restrictions. Note that neither the portfolio choice of Mertonian traders nor the portfolio choice for each country can be determined because now equities and bonds are the same asset. Finally, Panel C in Table V indicates that the US NFA position is negative, -75.72% of GDP, due to cross-country asymmetry in the volatility of idiosyncratic risk. The foreign households have a stronger precautionary saving motive because of a higher level of uncertainty in their nondiversifiable income process. They accumulate a higher level of risk-free assets compared with US households. This channel operates in the same way as the studies of Mendoza, Quadrini, and Rios-Rull (2009) and Angeletos and Panousi (2011), but they did not consider the implication of the risk premium for trade balance. More importantly, this exercise demonstrates that a model that relies solely on idiosyncratic shocks to explain global imbalance cannot generate large trade deficits for debtor countries such as the US. Quantitatively, if there were no aggregate risk, the US would run 1.13% of GDP of trade surplus in each period.

To summarize, both the aggregate uncertainty and the level of the risk premium are crucial to

our results. In the case without a risk premium, the model still correctly predicts the US as a debtor country because of asymmetric idiosyncratic shocks, but it delivers a counterfactual prediction of the US trade balance.

[Table 5 about here.]

3.6 The Importance of Asymmetric Equity Market Participation

The asymmetric equity market participation in both the intensive and extensive margins is important to our results. If both countries have a similar degree of equity market participation, then extra risk borne by US investors will be relatively small and hence the impact on the trade balance and current account will be significantly reduced. We now explore the importance of asymmetric equity market participation on the trade balance.

Consider the following two cases. Case 1 assumes households in the ROW are equipped with the same degree of equity market participation both in terms of the fraction of traders (extensive margin) as well as the equity share of non-Mertonian traders (intensive margin). The second case is a reverse of case 1, in which the US is endowed with the same degree of participation as in the ROW. The results of the two cases are reported in columns 1 and 2 in Table VI, respectively.

Panel A in Table VI indicates the negative relationship between market participation and risk premium. Compared with the benchmark economy in Table IV, case 1 (2) has a higher (lower) rate of market participation, so the equity premium is lower (higher) than in the benchmark model. As the last two rows in Panel B show, the overall US portfolio equity holdings are only sightly higher than those in the ROW. The higher idiosyncratic risk faced by the ROW Mertonian traders induces them to hold less equity in their portfolios. Most importantly, the US becomes a trade surplus country since both NFE and NFB positions turn to negative in both cases, as shown in Panel C. The overall aggregate risk-taking by US traders is less than the benchmark, which results from the fixed portfolio choice of non-Mertonian traders and less incentive to save among US households. The lower standard deviation of the idiosyncratic shock for the US households has two opposite effects on overall equity holdings. First, it reduces the need for precautionary savings for all US households and results in a negative net NFA position for the US. Given that the portfolio choices of non-Mertonian traders are the same for both cases, lower overall asset holding simply implies a smaller equity position. Second, lower idiosyncratic risk encourages US Mertonian traders to hold

riskier equities while also discourages them from attaining higher wealth. Since the fraction of Mertonian traders is small in our exercise, the first effect dominates the second and consequently the US demands less risky assets than its supply. Cases 1 and 2 both project a trade surplus of 1.01% and 0.65%, respectively. In short, this exercise demonstrates that (i) the asymmetric equity market participation rate is essential for replicating both trade deficits and a negative NFA position and (ii) the asymmetry in idiosyncratic risk plays a minimal role.

[Table 6 about here.]

3.7 Counterfactual Examples

We can use our model as a laboratory to examine the impact of financial deepening with respect to changing the fraction of traders in each country. We consider two counterfactual examples. One varies the fraction of Mertonian traders and the other considers the increasing trend of stock market participation in the ROW.

Varying the Fraction of Mertonian Traders Mertonian traders respond to the change in investment opportunities in every period by optimally adjusting their portfolios and make no investment mistakes. Increasing the fraction of Mertonian traders of a country indicates an overall reduction in portfolio restrictions.

Table VII varies the fraction of Mertonian traders in the US and/or the ROW. The first column reports the benchmark case. The second column shows the results when we increase the fraction of US Mertonian traders to 10%, the third column shows the case of 10% Mertonian traders in the ROW, and finally, the last column reports the case of 10% Mertonian trader in both the US and the ROW.

Panel A in Table VII reports the lower risk premium as we increase the fraction of Mertonian traders for all cases. Given that Mertonian traders take residual risk, a larger fraction of Mertonian traders reduces the equity premium since the aggregate risk is spread out over the larger population. The risk-free rate is slightly higher and its volatility remains almost unchanged.

As reported in Panel C in Table VII, the optimal equity share of Mertonian traders decreases in all three cases because of the lower equity premium. Similar to our benchmark case, the US Mertonian traders earn a slightly higher wealth return and take more risks compared with the

ROW because of asymmetric idiosyncratic risks. Although the equity premium is lower compared with our benchmark case, the optimal portfolio still has a significantly higher fraction of equity than that of the market portfolio. Therefore, the equity share of the portfolio of a country is positively correlated with the fraction of Mertonian traders. In the first case, the equity share of the US increases to 35.09% while the equity share of the ROW drops to 18.97% simply because of the higher fraction of Mertonian traders. On the other hand, the second case reports an increase of the equity share in the ROW to 23.55% and a decrease of the equity share in the US to 26.57%. Finally, the equity shares are relatively unchanged in the third case because of the equal percentage increment of Mertonian traders.

Panel C in Table VII demonstrates the effects on the US external account. The trade balance responds to the change in the fraction of Mertonian traders significantly. A 5% increase in Mertonian traders pushes the net equity position into a positive number and increases the US trade deficit to 5.49% of US output, which is a 107% increase from the benchmark. This occurs because the additional Mertonian traders hold mostly equity in their portfolios. On the other hand, if the change occurs in the ROW as shown in the third column, the US trade deficit improves to a surplus: 0.12% of GDP. Another key point is noteworthy in the second case. Both the NFE and NFB positions in the US are negative, while the trade balance is only slightly positive because the return on bonds is slightly lower than the average growth rate of output. Therefore, it is still possible for the US to maintain a balanced trade despite holding negative positions in all asset classes. Finally, the equal increment of Mertonian traders has a small impact on the trade balance. The US trade balance changes to -1.92% compared with -2.65% of GDP in the benchmark calibration. In sum, the trade balance critically depends on the overall portfolio restrictions of a country, especially the fraction of Mertonian traders.

[Table 7 about here.]

Varying the Fraction of Non-Participants in the Equity Market This subsection studies the impact of increasing stock market participation among non-Mertonian traders in the ROW. Specifically, we reduce the fraction of non-participants from 70% in our benchmark case to 60% and 50%, respectively. A decrease in the fraction of non-partipants implies an increase in the fraction of non-Mertonian equity traders, given that other parameters remain unchanged. Table VIII shows

the results with the benchmark result in the first column for comparison. The second column reports the results of increasing the fraction of non-Mertonian equity traders to 35% and decreasing non-participants to 60%. The third column further changes the fraction of non-Mertonian equity traders and non-participants to 45% and 50%, respectively.

Panel A in Table VIII shows that, as we decrease the fraction of non-participants from 70% to 50%, the equity premium and the Sharpe ratio decrease while the risk-free rate increases. The reason for these changes is that fewer non-participants imply less residual risk and hence the aggregate risk has been spread out over a larger pool of equity market participants. The equity premium drops slightly from 6.35% to 5.95% as the fraction of non-participants abroad changes from 70% to 50%. Increasing the fraction of equity market participants affects the overall portfolio choice in the ROW as follows. The equity share in the ROW portfolio increases from 21.95% in the benchmark case to 23.35%. Evidently, increasing the fraction of equity market participants in the ROW shifts the load of risk from the US to the ROW.

Panel C indicates that unloading the aggregate risk of US investors affects both the trade balance and the NFA position. The US trade deficit falls from 2.65% of GDP in our benchmark to 1.74% of GDP in response to a 10% increase in the fraction of equity market participants in the ROW; it falls further to 0.84% of GDP when the distribution of traders is identical across countries. However, the equity target shares of the US and the ROW are still different: 34.7% and 25%, respectively. Hence the US is still more exposed to aggregate risk than the ROW. The US NFA position deteriorates from -28.16% in the benchmark case to -53.79% with 50% non-participants in the ROW.

[Table 8 about here.]

4 Conclusion

We use a general equilibrium model with asset trading restrictions to demonstrate that global imbalances are related to the asymmetric portfolio choices across households within a country as well as across countries. The trading restrictions imposed in our model are in line with the empirical evidence in the household finance literature. With a realistic assumption that US residents are willing to take more aggregate risk than the ROW, the US is predicted to have trade deficits in

the long run despite its negative NFA position.

Our study makes both qualitative and quantitative contributions to the literature on global imbalances. On the qualitative side, the combination of long-run trade deficits and a negative NFA position differentiates our work from the existing studies on global imbalances except for Maggiori (2011). Other studies on global imbalance focus on explaining the composition of the negative NFA position of the US, and the US long-run trade balance predicted by these models is in surplus. We reach an opposite prediction about the trade balance because we incorporate aggregate shocks into our model with a different channel from Maggiori (2011). Instead of emphasizing asymmetry in financial intermediaries as in Maggiori (2011), we highlight the importance of asymmetry in household participation in the equity market and their willingness to hold equities.

On the quantitative side, we explicitly predict the scale of long-run trade deficits of the US, which Maggiori (2011) does not calculate. The predicted US trade deficits account for more than half of the US trade deficit in 2000-2011, or roughly 2.65% of GDP. The qualitative prediction that the US can sustain the long-run trade deficit or the current account deficit (excluding capital gains or losses as in the official statistics) is based on two simple conditions: (i) a positive risk premium and (ii) the willingness of average US investors to take a relatively larger amount of aggregate risk than average foreign investors. Therefore, we expect that any model that produces these two conditions will yield the same qualitative results. In addition, these two conditions are supported by a large body of empirical literature. Empirical studies have shown that US investors continue to bear more risk by issuing short-term debts and investing in foreign equities. The large equity premium, as well as the low and stable risk-free rate observed in the data, have been a long-standing phenomenon that many studies aim to explain.

Nevertheless, we do not claim that asymmetric trading restrictions are the only cause of positive returns on the US NFA position. For instance, it is possible that foreign equities are different from domestic equities because of country-specific nondiversifiable risks, but we do not consider this case to emphasize the demand-side asymmetry in the asset market. Another possible reason is provided by McGrattan and Prescott (2010), who offer intangible capital as an explanation for cross-country return differentials in FDI.

In addition to contributing to the literature on global imbalances, we add to the theoretical literature on international portfolio choices. Specifically, we demonstrate the importance of house-

hold heterogeneity in open economies, while the majority of open-economy macroeconomic models rely on a representative agent framework.[6] The recent study by Alvarez, Atkeson, and Kehoe (2002) demonstrates that household heterogeneity can help explain, among other things, persistence of the real exchange rate. Although representative agent models of international portfolio choices generate qualitative predictions in line with the data, their major drawback is the inability to generate a large risk premium. On the other hand, our model combines both household heterogeneity and cross-country asymmetry; therefore, it has the potential to shed light on questions related to income and consumption dispersion. For instance, what are the effects of equity market liberalization on the consumption dispersion within a country and across countries? How large is the welfare gain from equity market liberalization? We can also extend our model to study the impact of monetary policy on consumption dispersion in open economies.

[6]For example, see Bacchetta and Benhima (2010), Devereux and Sutherland (2010), Tille and van Wincoop (2010), and Hnatkovska (2010)

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Table I: Average US External Balances Relative to Output (2000-2011)

Description	Average (%)
A. International investment position	
Net foreign bond/output	-40.42
Net foreign equity/output	15.34
Net other assets/output	-2.82
Net foreign asset/output	-27.90
B. Balance of payments	
Current account/output	-4.50
Trade balance/output	-5.30
Net factor income account/output	0.80

Source: US Bureau of Economic Analysis.

Table II: Common Parameter Values for All Cases

Parameter	Description	Value
	A. Structural parameter	
δ^{US}	US share of world GDP	0.33
δ^{ROW}	ROW share of world GDP	0.67
β	Annual discount factor	0.995
γ	Degree of risk aversion	6.00
$\phi^i, i = US, ROW$	Leverage ratio	3.00
$\gamma^i, i = US, ROW$	Share of nondiversifiable output	0.8875
	B. Aggregate shock process	
$\pi(z'\|z)$	Transition probability	$\begin{bmatrix} 0.2740 & 0.7260 \\ 0.2740 & 0.7260 \end{bmatrix}$
z_L	Consumption growth in a recession	0.9762
z_H	Consumption growth in an expansion	1.0440
$\sigma(z_t)$	Standard deviation of consumption growth	0.0302
$\rho(z_t, z_{t-1})$	First-order autocorrelation of consumption growth	0
	C. US idiosyncratic shock process	
$\pi(\eta'\|\eta)$	Transition probability	$\begin{bmatrix} 0.9450 & 0.0550 \\ 0.0550 & 0.9450 \end{bmatrix}$
η_L	Labor income shock in a recession	0.3894
η_H	Labor income shock in an expansion	1.6106
$\sigma(\eta_t)$	Standard deviation of labor income	0.71
$\rho(\eta_t, \eta_{t-1})$	First-order autocorrelation of labor income	0.89

Table III: Three Experiments in the Symmetric Case

	Experiment 1	Experiment 2	Experiment 3
Mertonian	100%	5%	5%
Non-Mertonian equity	0%	95%	25%
Non-Participant	0%	0%	70%
	A. Asset-pricing result (%)		
$E(R^d - R^f)$	2.11	2.11	6.67
$\sigma(R^d - R^f)$	12.42	12.42	13.53
$\frac{E(R^d - R^f)}{\sigma(R^d - R^f)}$	17.01	17.01	49.26
$E(R^f)$	3.47	3.47	2.33
$\sigma(R^f)$	0.00	0.00	0.08
	B. Portfolio and return (%)		
$E(R^w - R^f)_{me}$	0.53	0.53	5.48
$E(R^w - R^f)_{et}$	NA	0.53	1.67
$E(R^w - R^f)_{US}$	0.53	0.53	1.67
$E(R^w - R^f)_{ROW}$	0.53	0.53	1.67
$E(\omega)_{me}$	25.00	25.00	80.63
$E(\omega)_{et}$	NA	25.00	25.00
$E(\omega)_{US}$	25.00	25.00	25.00
$E(\omega)_{ROW}$	25.00	25.00	25.00
	C. External balance (%)		
$E(\frac{TB}{Y})_{US}$	0	0	0
$E(\frac{CA}{Y})_{US}$	0	0	0
$E(\frac{CA^o}{Y})_{US}$	0	0	0
$E(\frac{NFIA}{Y})_{US}$	0	0	0
$E(\frac{NFE}{Y})_{US}$	0	0	0
$E(\frac{NFB}{Y})_{US}$	0	0	0
$E(\frac{NFA}{Y})_{US}$	0	0	0

Notes:
Abbreviations for external balance: TB = trade balance, CA = current account, CA^o = official current account, $NFIA$ = net factor income account, NFE = net foreign equities, NFB = net foreign bonds, NFA = net foreign assets.
Parameter settings: $\gamma = 6$, $\beta = 0.995$, diversified share of income is 11.25%. The simulation results are generated by an economy with $18,000$ agents and $10,000$ periods.

Table IV: The Results of Benchmark Calibration

	Share of traders (%)
	Benchmark
US Mertonian	5.00
US Non-Mertonian equity	45.00
US Non-Participant	50.00
ROW Mertonian	5.00
ROW Non-Mertonian equity	25.00
ROW Non-Participant	70.00
	A. Asset-pricing result (%)
$E(R^d - R^f)$	6.31
$\sigma(R^d - R^f)$	13.24
$\frac{E(R^d - R^f)}{\sigma(R^d - R^f)}$	47.66
$E(R^f)$	2.32
$\sigma(R^f)$	0.08
	B. Portfolio and return (%)
$E(R^w - R^f)_{me,US}$	5.31
$E(R^w - R^f)_{me,ROW}$	5.14
$E(R^w - R^f)_{et,US}$	2.20
$E(R^w - R^f)_{et,ROW}$	1.58
$E(R^w - R^f)_{US}$	1.93
$E(R^w - R^f)_{ROW}$	1.36
$E(\omega)_{me,US}$	82.37
$E(\omega)_{me,ROW}$	79.83
$E(\omega)_{et,US}$	34.70
$E(\omega)_{et,ROW}$	25.00
$E(\omega)_{US}$	30.64
$E(\omega)_{ROW}$	21.55
	C. US external balance (%)
$E(\frac{TB}{Y})_{US}$	-2.65
$E(\frac{CA}{Y})_{US}$	0
$E(\frac{CA^o}{Y})_{US}$	-2.17
$E(\frac{NFIA}{Y})_{US}$	0.48
$E(\frac{NFE}{Y})_{US}$	46.55
$E(\frac{NFB}{Y})_{US}$	-74.72
$E(\frac{NFA}{Y})_{US}$	-28.17

Notes:
Abbreviations for external balance: TB = trade balance, CA = current account, CA^o = official current account, $NFIA$ = net factor income account, NFE = net foreign equities, NFB = net foreign bonds, NFA = net foreign assets.
The simulation results are generated by an economy with $18,000$ agents for each type and $10,000$ periods.

Table V: Results without Aggregate Shocks

	Share of traders (%)	
	Benchmark	No aggregate shock
US Mertonian	5.00	5.00
US Non-Mertonian equity	45.00	45.00
US Non-Participant	50.00	50.00
ROW Mertonian	5.00	5.00
ROW Non-Mertonian equity	25.00	25.00
ROW Non-Participant	70.00	70.00
	A. Asset-pricing result (%)	
$E(R^d - R^f)$	6.31	0
$\sigma(R^d - R^f)$	13.24	0
$\frac{E(R^d - R^f)}{\sigma(R^d - R^f)}$	47.66	NA
$E(R^f)$	2.32	4.09
$\sigma(R^f)$	0.08	0
	B. Portfolio and return (%)	
$E(R^w - R^f)_{me,US}$	5.31	0
$E(R^w - R^f)_{me,ROW}$	5.14	0
$E(R^w - R^f)_{et,US}$	2.20	0
$E(R^w - R^f)_{et,ROW}$	1.58	0
$E(R^w - R^f)_{US}$	1.93	0
$E(R^w - R^f)_{ROW}$	1.36	0
$E(\omega)_{et,US}$	34.70	34.70
$E(\omega)_{et,ROW}$	25.00	25.00
	C. External balance (%)	
$E(\frac{TB}{Y})_{US}$	-2.65	1.13
$E(\frac{CA}{Y})_{US}$	0	0
$E(\frac{NFA}{Y})_{US}$	-28.17	-75.72

Notes:
Abbreviations for external balance: TB = trade balance, CA = current account, CA^o = official current account, $NFIA$ = net factor income account, NFE = net foreign equities, NFB = net foreign bonds, NFA = net foreign assets.
The simulation results are generated by an economy with $18,000$ agents for each type and $10,000$ periods.

Table VI: Results without Asymmetric Participation in Equity Market

	Share of traders (%)		
	Benchmark	Case 1	Case 2
US Mertonian	5.00	5.00	5.00
US Non-Mertonian equity	45.00	45.00	20.00
US Non-Participant	50.00	50.00	70.00
ROW Mertonian	5.00	5.00	5.00
ROW Non-Mertonian equity	25.00	45.00	20.00
ROW Non-Participant	70.00	50.00	70.00
	A. Asset-pricing result (%)		
$E(R^d - R^f)$	6.31	5.07	6.68
$\sigma(R^d - R^f)$	13.24	12.79	13.48
$\frac{E(R^d - R^f)}{\sigma(R^d - R^f)}$	47.66	0.40	0.50
$E(R^f)$	2.32	2.63	2.22
$\sigma(R^f)$	0.08	0.09	0.09
	B. Portfolio and return (%)		
$E(R^w - R^f)_{me,US}$	5.31	4.06	5.55
$E(R^w - R^f)_{me,ROW}$	5.14	3.88	5.40
$E(R^w - R^f)_{et,US}$	2.20	1.77	1.67
$E(R^w - R^f)_{et,ROW}$	1.58	1.77	1.67
$E(R^w - R^f)_{US}$	1.93	1.27	1.68
$E(R^w - R^f)_{ROW}$	1.36	1.25	1.61
$E(\omega)_{me,US}$	82.37	77.58	81.55
$E(\omega)_{me,ROW}$	79.83	74.37	79.34
$E(\omega)_{et,US}$	34.70	34.70	25.00
$E(\omega)_{et,ROW}$	25.00	34.70	25.00
$E(\omega)_{US}$	30.64	25.33	25.24
$E(\omega)_{ROW}$	21.55	24.36	24.74
	C. External balance (%)		
$E(\frac{TB}{Y})_{US}$	-2.65	1.01	0.65
$E(\frac{CA}{Y})_{US}$	0.00	0.00	0.00
$E(\frac{CA^o}{Y})_{US}$	-2.17	−1.44	−1.43
$E(\frac{NFIA}{Y})_{US}$	0.48	−2.44	−2.08
$E(\frac{NFE}{Y})_{US}$	46.55	−18.01	−12.82
$E(\frac{NFB}{Y})_{US}$	-74.72	−64.24	−65.74
$E(\frac{NFA}{Y})_{US}$	-28.17	−82.26	−78.56

Notes:
Abbreviations for external balance: TB = trade balance, CA = current account, CA^o = official current account, $NFIA$ = net factor income account, NFE = net foreign equities, NFB = net foreign bonds, NFA = net foreign assets.
The simulation results are generated by an economy with $18,000$ agents for each type and $10,000$ periods.

Table VII: Effects of Size of Mertonian Traders

	Share of traders (%)			
	Benchmark	Case 1	Case 2	Case 3
US Mertonian	5.00	10.00	5.00	10.00
US Non-Mertonian equity	45.00	40.00	45.00	40.00
US Non-Participant	50.00	50.00	50.00	50.00
ROW Mertonian	5.00	5.00	10.00	10.00
ROW Non-Mertonian equity	25.00	25.00	20.00	20.00
ROW Non-Participant	70.00	70.00	70.00	70.00
	A. Asset-pricing result (%)			
$E(R^d - R^f)$	6.31	6.00	5.62	5.38
$\sigma(R^d - R^f)$	13.24	13.21	13.10	13.03
$\frac{E(R^d - R^f)}{\sigma(R^d - R^f)}$	47.66	45.44	42.90	41.26
$E(R^f)$	2.32	2.41	2.32	2.38
$\sigma(R^f)$	0.08	0.09	0.08	0.08
	B. Portfolio and return (%)			
$E(R^w - R^f)_{me,US}$	5.31	4.99	4.56	4.26
$E(R^w - R^f)_{me,ROW}$	5.14	4.81	4.38	4.09
$E(R^w - R^f)_{et,US}$	2.20	2.09	1.96	1.87
$E(R^w - R^f)_{et,ROW}$	1.58	1.51	1.41	1.35
$E(R^w - R^f)_{US}$	1.93	2.11	1.49	1.64
$E(R^w - R^f)_{ROW}$	1.36	1.14	1.32	1.17
$E(\omega)_{me,US}$	82.37	81.27	79.32	77.55
$E(\omega)_{me,ROW}$	79.83	78.45	76.28	74.44
$E(\omega)_{et,US}$	34.70	34.70	34.70	34.70
$E(\omega)_{et,ROW}$	25.00	25.00	25.00	25.00
$E(\omega)_{US}$	30.64	35.09	26.57	30.49
$E(\omega)_{ROW}$	21.55	18.97	23.55	21.69
	C. External balance (%)			
$E(\frac{TB}{Y})_{US}$	−2.65	−5.49	0.12	−1.92
$E(\frac{CA}{Y})_{US}$	0	0	0	0
$E(\frac{CA^o}{Y})_{US}$	−2.17	−2.55	−1.85	−2.18
$E(\frac{NFIA}{Y})_{US}$	0.48	2.94	−1.97	−0.27
$E(\frac{NFE}{Y})_{US}$	46.55	104.25	−2.08	41.52
$E(\frac{NFB}{Y})_{US}$	−74.72	−77.08	−75.33	−79.58
$E(\frac{NFA}{Y})_{US}$	−28.17	27.18	−77.41	−38.06

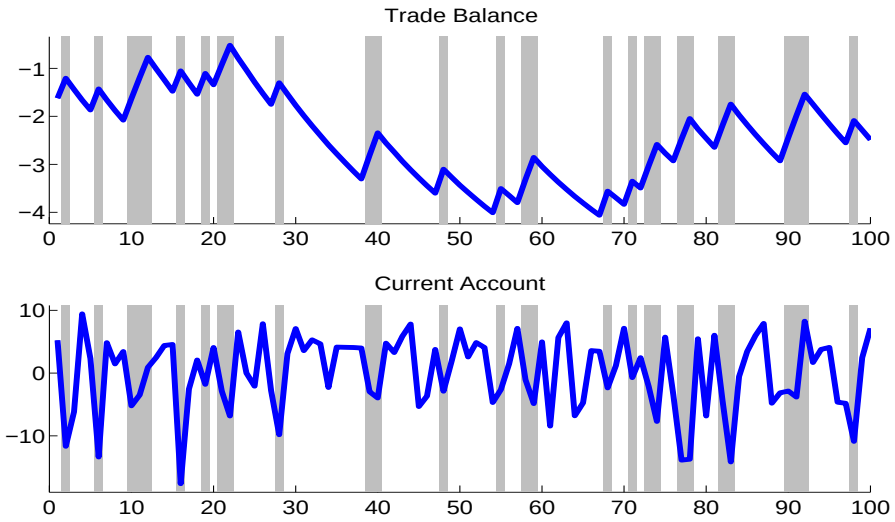
Notes:
Abbreviations for external balance: TB = trade balance, CA = current account, CA^o = official current account, $NFIA$ = net factor income account, NFE = net foreign equities, NFB = net foreign bonds, NFA = net foreign assets.
The simulation results are generated by an economy with 18,000 agents for each type and 10,000 periods.

Table VIII: Effects of Equity Market Participation

	Share of traders (%)		
	Benchmark	Case 1	Case 2
US Mertonian	5.00	5.00	5.00
US Non-Mertonian equity	45.00	45.00	45.00
US Non-Participant	50.00	50.00	50.00
ROW Mertonian	5.00	5.00	5.00
ROW Non-Mertonian equity	25.00	35.00	45.00
ROW Non-Participant	70.00	60.00	50.00
	A. Asset-pricing result (%)		
$E(R^d - R^f)$	6.31	6.13	5.08
$\sigma(R^d - R^f)$	13.24	13.16	12.81
$\frac{E(R^d - R^f)}{\sigma(R^d - R^f)}$	47.66	0.47	0.40
$E(R^f)$	2.32	2.37	2.28
$\sigma(R^f)$	0.08	0.07	0.06
	B. Portfolio and return (%)		
$E(R^w - R^f)_{me,US}$	5.31	5.18	4.94
$E(R^w - R^f)_{me,ROW}$	5.14	5.00	4.76
$E(R^w - R^f)_{et,US}$	2.20	2.13	2.05
$E(R^w - R^f)_{et,ROW}$	1.58	1.54	1.47
$E(R^w - R^f)_{US}$	1.93	1.82	1.67
$E(R^w - R^f)_{ROW}$	1.36	1.37	1.35
$E(\omega)_{me,US}$	82.37	82.42	82.07
$E(\omega)_{me,ROW}$	79.83	79.71	79.18
$E(\omega)_{et,US}$	34.70	34.70	34.70
$E(\omega)_{et,ROW}$	25.00	25.00	25.00
$E(\omega)_{US}$	30.64	29.61	28.34
$E(\omega)_{ROW}$	21.55	22.38	23.04
	C. External balance (%)		
$E(\frac{TB}{Y})_{US}$	-2.65	-1.74	-0.84
$E(\frac{CA}{Y})_{US}$	0	0	0
$E(\frac{CA^o}{Y})_{US}$	-2.17	-1.97	-1.78
$E(\frac{NFIA}{Y})_{US}$	0.48	-0.24	-0.94
$E(\frac{NFE}{Y})_{US}$	46.55	31.69	16.97
$E(\frac{NFB}{Y})_{US}$	-74.72	-72.78	-70.75
$E(\frac{NFA}{Y})_{US}$	-28.17	-41.09	-53.79

Notes:
Abbreviations for external balance: TB = trade balance, CA = current account, CA^o = official current account, $NFIA$ = net factor income account, NFE = net foreign equities, NFB = net foreign bonds, NFA = net foreign assets.
The simulation results are generated by an economy with $18,000$ agents for each type and $10,000$ periods.

Figure 1: US Trade Balance and Current Account as a Fraction of US GDP



Notes: The top panel shows the US trade balance as a fraction of US GDP. The bottom panel shows the theoretical current account as a fraction of US output. This is the benchmark calibration. The shaded areas indicate recessions.

Appendices

A Details on the Household Problem

A.1 Saddle Point Problem

It is convenient to write household problems in the fashion of time zero trading (see Chien, Cole, and Lustig (2011) for a detailed discussion). From the aggregate state-contingent prices on consumption, we can derive the time zero price of a consumption claim on state z^t:

$$P(z^t)\pi(z^t) = Q(z_t, z^{t-1})Q(z_{t-1}, z^{t-2})\cdots Q(z_1, z^0)Q(z_0),$$

where $Q_t(z_{t+1}, z^t)$ denotes the price of a unit claim to the final good in aggregate state z^{t+1} acquired in aggregate state z^t. Hence, the asset position of any trader given the history state can be written as

$$-a_t^i(z^t, \eta^{i,t}) = \sum_{\tau \geq t} \sum_{(z^\tau, \eta^\tau) \succeq (z^t, \eta^t)} \widetilde{P}(z^\tau, \eta^{i,\tau}) \left[\gamma Y^i(z^\tau)\eta_\tau^i - c_\tau^i(z^\tau, \eta^{i,\tau})\right]$$

where $\widetilde{P}(z^t, \eta^{i,t}) = \pi(z^t, \eta^{i,t})P(z^t)$. By the above equation we are able to write down the household problem in the form of time zero trading fashion as shown below.

Mertonian traders Start with the Mertonian traders' problem in country i. There are three constraints. Let χ denote the multiplier on the present value budget constraint, $\nu(z^t, \eta^{i,t})$ the multiplier on the restrictions of asset holding in node $(z^t, \eta^{i,t})$, and finally, let $\varphi(z^t, \eta^{i,t})$ denote the multiplier on the debt constraint. Given the assumption of our calibrated model that there are only two states in the aggregate shock, trading equities and bonds without portfolio restrictions, in fact, spans the aggregate state space, implying that the Mertonian traders are able to trade aggregate state contingent claims in our benchmark economy. The saddle point problem of a Mertonian

trader in country i can be stated as follows:

$$
\begin{aligned}
L \;=\; & \min_{\{\chi,\nu,\varphi\}} \max_{\{c,a\}} \sum_{t=1}^{\infty} \beta^t \sum_{(z^t,\eta^{i,t})} u(c_t^i(z^t,\eta^{i,t}))\pi(z^t,\eta^{i,t}) \\
& + \chi \left\{ \sum_{t=1}^{\infty} \sum_{(z^t,\eta^{i,t})} \widetilde{P}(z^t,\eta^{i,t}) \left[\gamma Y_t^i(z^t)\eta_t^i - c_t^i(z^t,\eta^{i,t})\right] + a_0(z^0) \right\} \\
& + \sum_{t=1}^{\infty} \sum_{(z^t,\eta^{i,t})} \nu_t^i(z^t,\eta^{i,t}) \left\{ \begin{array}{c} \sum_{\tau\geq t} \sum_{(z^\tau,\eta^{i,\tau})\succeq(z^t,\eta^{i,t})} \widetilde{P}(z^\tau,\eta^{i,\tau}) \left[\gamma Y_\tau^i(z^t)\eta_\tau^i - c_\tau^i(z^\tau,\eta^{i,\tau})\right] \\ +\widetilde{P}(z^t,\eta^{i,t}) a_t(z^t,\eta^{i,t-1}) \end{array} \right\} \\
& - \sum_{t=1}^{\infty} \sum_{(z^t,\eta^{i,t})} \varphi_t^i(z^t,\eta^{i,t}) \left\{ \sum_{\tau\geq t} \sum_{(z^\tau,\eta^{i,\tau})\succeq(z^t,\eta^{i,t})} \widetilde{P}(z^\tau,\eta^{i,\tau}) \left[\gamma Y^i(z^\tau)\eta_\tau^i - c_\tau^i(z^\tau,\eta^{i,\tau})\right] \right\}.
\end{aligned}
$$

The first-order condition with respect to consumption is given by

$$\beta^t u'(c_t^i(s^t,\eta^{i,t})) = \zeta(z^t,\eta^{i,t})P(z^t) \text{ for all } z^t,\eta^{i,t}, \tag{14}$$

where $\zeta(z^t,\eta^{i,t})$ is defined recursively as

$$\zeta(z^t,\eta^{i,t}) = \zeta(z^{t-1},\eta^{i,t-1}) + \nu\left(z^t,\eta^{i,t}\right) - \varphi(z^t,\eta^{i,t}), \tag{15}$$

with initial $\zeta_0 = \chi$. (See Marcet and Marimon (1999) for this recursive method).

The first-order condition with respect to total asset holdings is

$$\sum_{\eta^{i,t}} \nu_t^i(z^t,\eta^{i,t})\pi(\eta^{i,t}) = 0 \text{ for all } z^t,\eta^{i,t}.$$

It is easy to show that this is a standard convex programming problem, so the first-order conditions are necessary and sufficient.

Non-Mertonian Equity Traders Compared with the Mertonian traders' problem, non-Mertonian traders face the same budget constraints and solvency constraints as Mertonian traders, but they face an additional restriction on their total asset holdings. The total asset holding in the beginning of period t should be equal to the asset holding at the end of the previous period multiplied by the overall return, which is constrained by the exogenous portfolio choice. Given the same definition

of multipliers as in the Mertonian trader problem, the saddle point problem of an equity target trader with target share ω^* in country i can be stated as

$$\begin{aligned} L \;=\; & \min_{\{\chi,\nu,\varphi\}} \max_{\{c^i, ae^i\}} \sum_{t=1}^{\infty} \beta^t \sum_{(z^t,\eta^{i,t})} u(c_t^i(z^t,\eta^{i,t}))\pi(z^t,\eta^{i,t}) \\ & + \chi \left\{ \sum_{t=1}^{\infty} \sum_{(z^t,\eta^{i,t})} \widetilde{P}(z^t,\eta^{i,t}) \left[\gamma Y_t^i(z^t)\eta_t^i - c_t^i(z^t,\eta^{i,t})\right] + a_0(z^0) \right\} \\ & + \sum_{t=1}^{\infty} \sum_{(z^t,\eta^{i,t})} \nu_t^i(z^t,\eta^{i,t}) \left\{ \begin{array}{c} \sum_{\tau \geq t} \sum_{(z^\tau,\eta^{i,\tau}) \succeq (z^t,\eta^{i,t})} \widetilde{P}(z^\tau,\eta^{i,\tau}) \left[\gamma Y_\tau^i(z^t)\eta_\tau^i - c_\tau^i(z^\tau,\eta^\tau)\right] \\ + \widetilde{P}(z^t,\eta^t) R_{t,t-1}^{p,\omega^*}(z^t) a e_{t-1}^i(z^{t-1},\eta^{i,t-1}) \end{array} \right\} \\ & - \sum_{t=1}^{\infty} \sum_{(z^t,\eta^{i,t})} \varphi_t^i(z^t,\eta^{i,t}) \left\{ \sum_{\tau \geq t} \sum_{(z^\tau,\eta^{i,\tau}) \succeq (z^t,\eta^{i,t})} \widetilde{P}(z^\tau,\eta^{i,\tau}) \left[\gamma Y^i(z^\tau)\eta_\tau^i - c_\tau^i(z^\tau,\eta^{i,\tau})\right] \right\}, \end{aligned}$$

where

$$R_{t+1,t}^{p,\omega^*}(z^t) = \omega^* R_{t,t-1}^d(z^t) + (1-\omega^*) R_{t,t-1}^f(z^{t-1}).$$

The first-order condition with respect to consumption is given by

$$\beta^t u'(c_t^i(s^t,\eta^{i,t})) = \zeta(z^t,\eta^{i,t}) P(z^t) \text{ for all } z^t, \eta^{i,t},$$

where $\zeta(z^t,\eta^{i,t})$ is defined as in equation (15). The first-order condition with respect to consumption is independent of trading restrictions. The first-order condition with respect to total asset holdings at the end of period $t-1, ae_{t-1}^i(z^{t-1},\eta^{i,t-1})$ is

$$\sum_{(z^t,\eta^{i,t})} R_{t,t-1}^{p,\omega^*}(z^t) \nu_t^i(z^t,\eta^{i,t}) P(z^t) \pi(z^t,\eta^{it}) = 0 \text{ for all } z^t, \eta^{i,t}. \tag{16}$$

This condition varies according to different trading restrictions.

Non-Participants Non-participants face the same optimization problem as the non-Mertonian traders expect their return on assets is the risk-free rate. Their problem is simply set as the return of portfolio, $R_{t+1,t}^p(z^t)$ equal to $R_{t,t-1}^f(z^{t-1})$. The first-order condition with respect to consumption

is the same as in equation (14) and the first-order condition with respect to asset holding is

$$\sum_{(z^t,\eta^{i,t})} R^f_{t,t-1}(z^{t-1})\nu^i_t(z^t,\eta^{i,t})P(z^t)\pi(z^t,\eta^{it}) = 0 \text{ for all } z^t,\eta^{i,t}. \tag{17}$$

A.2 Stochastic Discount Factor

We start from the common first-order condition for consumption:

$$c^i_t(z^t,\eta^{i,t}) = u'^{-1}\left[\frac{\zeta^{i,t}(z^t,\eta^{i,t})P(z^t)}{\beta^t}\right].$$

In addition, the sum of individual consumption for all households or the aggregate consumption of country i is

$$C^i_t(z^t) = \sum_{j=me,et,np}\mu^j_i\sum_{\eta^{i,t}} c^i_t(z^t,\eta^{i,t})\pi(\eta^{i,t})$$

and worldwide aggregate consumption is

$$\sum_{i=1}^{I}\delta_i C^i_t(z^t) = C_t(z^t).$$

With CRRA preferences, this implies that the household consumption share relative to aggregate consumption with history $(z^t,\eta^{i,t})$ is given by

$$\frac{c^i_t(z^t,\eta^{i,t})}{C_t(z^t)} = \frac{\zeta^i(z^t,\eta^{i,t})^{\frac{-1}{\alpha}}}{h(z^t)},$$

where

$$h_t(z^t) = \sum_{i=1}^{I}\delta_i\sum_{j=me,et,np}\mu^j_i\sum_{\eta^{i,t}}\zeta^i_t(z^t,\eta^{i,t})^{\frac{-1}{\alpha}}\pi(\eta^{i,t}).$$

Hence, the $-1/\alpha-$ th moment of the multipliers summarizes risk-sharing within this economy. The stochastic discount factor (SDF) is given by the Breeden-Lucas SDF and a multiplicative adjustment:

$$m(z^{t+1}|z^t) \equiv \frac{P_{t+1}(z^{t+1})}{P_t(z^t)} = \beta\left(\frac{C_{t+1}(z^{t+1})}{C_t(z^t)}\right)^{-\alpha}\left(\frac{h_{t+1}(z^{t+1})}{h_t(z^t)}\right)^{\alpha}. \tag{18}$$

B First Two Moments of Output Growth Rate

Our world consists of 48 countries. The data range is from 1980 to 2009 at an annual frequency. The household consumption expenditure series (C_{it}) and the GDP deflator series (P_{it}) are from the International Monetary Fund's *International Financial Statistics*. The population series (N_{it}) is from the World Bank's *World Development Indicators*. The GDP share data are from the US Department of Agriculture's Economic Research Service Database. We calculate the world average of the first two moments of the growth rate of per capita real consumption in three steps.

First, we obtain the growth rate of real consumption per capita for each country: $g_{it} = c_{it}/c_{i,t-1} - 1$, where $c_{it} = C_{it}/(P_{it}N_{it})$. Next, we calculate the standard deviation of g_{it} and denote it as $\sigma_i(g_{it})$. Finally, we calculate the weighted average of the country-specific standard deviation of the growth rate of real consumption per capita using the GDP share as the weight. Let $\sigma(z_t)$ denote the world average standard deviation of the country-specific growth rate of real consumption per capita. Hence,

$$\sigma(z_t) = \sum_{i=1}^{48} w_i \sigma_i(g_{it}),$$

where $w_i = \sum_{t=1980}^{2009} w_{i,t}/30$ and $w_{i,t} = GDP_{i,t}/\sum_{i=1}^{48} GDP_{i,t}$. Based on our dataset, the average growth rate of consumption is 2.54% and its standard deviation is 3.02%.