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The Risk Premium and Long-Run Global Imbalances [⋆]

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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 each country maintains a fixed share of equity in its 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 risky assets abroad and issuing risk-free assets. 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 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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1. Introduction

In the literature, the debate on the sustainability of global imbalances is divided into three strands. First, Obstfeld and Rogoff (2000) argue that a reversal of the US trade deficit and a large dollar depreciation are inevitable. Second, Engel and Rogers (2006) propose that a future US GDP growth rate higher than the rest of the world (ROW) could justify global imbalances. The last strand of the literature is motivated by positive net investment income flows to the US, which suggest 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 has a stabilizing effect on the current account. The proposed causes of international differences in portfolio choices are the asymmetry of the supply of assets (Caballero et al. (2008) and Pavlova and Rigobon (2010)), the asymmetry of idiosyncratic shocks (Mendoza et al. (2009) and Angeletos and Panousi (2011)), and the asymmetry of credit constraints for financial intermediaries (Maggiori (2011)).

We contribute to the last strand of the literature by quantifying the valuation effect in a stochastic multi-country growth model with a focus on asymmetric international portfolios. Our focus is motivated by empirical evidence suggesting a wide range of portfolio heterogeneity across households both within a country and across countries (Campbell (2006), Guiso and Sodini (2012) and Christelis et al. (2010)). To emphasize the demand-side heterogeneity in portfolios, we assume that assets issued in every country are identical but that households face different restrictions on asset trade. Specifically, equity market participation is internationally asymmetric both in terms of the participation rate, or the extensive margin, and the portfolio share of equity, or the intensive margin.

These assumptions about equity market participation have real consequences for consumption dispersion. Due to the compensation for risk holding, households that take large (small) equity positions earn high (low) rates of return on their portfolios, accumulate large (small) amounts of wealth and enjoy high (low) levels of consumption. Hence, heterogeneity in households' portfolios induces consumption and wealth dispersion. Then, an aggregation of the household portfolios in each country translates into cross-country differences in portfolios. The model predicts that the country with higher equity holdings holds a larger amount of aggregate risk, earns higher average returns on its portfolio, consumes more than its output and runs trade deficits even in the long run.

In the quantitative part of our study, we consider two economies, the US and the ROW. The model is calibrated to match the US net foreign asset (NFA) position and the equity premium, using the equity share in household portfolios from international household finance data. The size of the equity premium and the asymmetric demand for risky and safe assets play important roles in our results. A high equity premium relies on the assumption of limited participation in the equity market, a global phenomenon supported by empirical studies. Of most importance, we realistically assume that equity market participation among US households is higher than among ROW households in terms of both the extensive margin and the intensive margin. In addition, in order to match the US NFA position resulting from asymmetric demand for risk-free assets, we rely on another type of asymmetry —international asymmetric idiosyncratic income risk. The importance of this assumption is first illustrated by Mendoza et al. (2009).

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 the asset-pricing literature. Our quantitative result 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 2.65% of output, which is half the average US trade deficit in 2000-2011. The trade deficit is highly countercyclical, as documented in the data. Furthermore, our finding is consistent with the empirical literature that documents a 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) and Gourinchas and Rey (2007a)). We consider the documented returns differential as evidence suggesting that US investors have loaded up more aggregate risk in foreign assets than in foreign liabilities. Moreover, Gourinchas and Rey (2007a) find that the US has financed risky investment abroad by issuing low-risk, short-run liabilities to the ROW over the past two decades.

Our main contribution to the literature is the integration of household finance into an explanation for global imbalances. Our model successfully matches both stock and flow characteristics of global imbalances. While Gourinchas et al. (2010) similarly offer a rare disaster model to account for global imbalances, their predicted scale of imbalances is small. Furthermore, we contribute to the theoretical literature on international portfolio choices. Specifically, we demonstrate the importance of household portfolio heterogeneity in open economies, while the majority of open-economy macroeconomic models rely on a representative agent framework. Therefore, our model is suitable to answer questions related to wealth and consumption dispersion across countries.

The rest of the paper is organized as follows. Section 2 discusses our main assumptions and the related literature. Section 3 describes the model. Section 4 contains the quantitative results from our benchmark model. We turn off some features to inspect the model mechanism in Section 5. Section 6 concludes our study.

2. Portfolio Heterogeneity and Related Literature

This section presents our main assumptions about household portfolio heterogeneities and their empirical motivation. Although these assumptions are in reduced form in our model, they are justified by micro-founded theories. In addition, recent studies have found that these assumptions help explain other facts about portfolio choices.

First, we assume that a large fraction of households does not participate in the equity market. This assumption is well motivated by the observed data from the US Survey of Consumer Finance (SCF). Historically, the participation rate from the SCF has not exceeded 50% (Campbell (2006)). The presence of a large amount of non-participants is likely due to participation costs resulting from the monetary costs of financial advisors or brokerage fees and the time costs of information acquisition (see the survey by Guiso and Sodini (2012)).

Second, we assume that most equity market participants are inactive and under-participate in the sense that their portfolio equity share is relatively small and constant over time. A small equity position is supported by the data. For example, Campbell (2006) shows that equities occupy 10% of the median household's portfolio and 20% of the 80th percentile household's portfolio by using the 2001 SCF. Moreover, Vissing-Jørgensen (2003) is the first to present compelling evidence that less sophisticated investors tend to deviate from the optimal portfolio. Subsequent studies have confirmed that a large fraction of equity market participants adjusts its portfolio shares only infrequently, even after large changes in asset returns (Ameriks and Zeldes (2004), Brunnermeier and Nagel (2008) and Calvet et al. (2009)). We conceptualize this fact by assuming that most market participants do not adjust their equity share in response to changes in the market price of risk.

Third, we assume that the equity market participation rate and the share of equity holdings among US households are higher than those among ROW households, as in the data. According to Guiso et al. (2001), in 1998 the equity market participation rate in the US was 49%, whereas the rates in Italy, the Netherlands and the UK in the same year were 19%, 35% and 31%, respectively.

In addition, Christelis et al. (2010) find that the average participation rate among the senior population in 12 European countries is only 26%. Van Rooij et al. (2011) and Iwaisako (2009) find low equity market participation rates in Holland, 23.8% and in Japan, 25%, respectively. As for the share of equity holdings, Christelis et al. (2010) show that US equity market participants hold larger equity positions than European participants in general.

In fact, our assumptions imply that the majority of households consistently choose suboptimal portfolios and are irresponsive to changes in market conditions. We argue these assumptions can be supported by introducing various types of participation costs, as documented in the literature. The rational inattention behaviors caused by costly information acquisition also help validate our assumptions. Gabaix and Laibson (2002) show that investors' delayed responses are motivated by decision costs and attention allocation costs. In the micro-founded model of inattention by Reis (2006), infrequent portfolio adjustment is a rational household's behavior in the presence of the costs of information acquisition. Recently, Abel et al. (2007) and Abel et al. (2013) have demonstrated that the period of inattention is prolonged by the costs of updating information. The impact of information costs on the decision to participate in the foreign equity market is studied in the model by Nechio (2014). Her model is motivated by her empirical finding that participants in foreign equity markets are more sophisticated in terms of sources of information than domestic equity market participants.

How large are the welfare costs underlying the suboptimal portfolios? In our calibrated model, the welfare costs of operating suboptimal portfolios are large. Welfare costs are reported as the percentage of consumption that households with optimal portfolios have to give up to become inactive households. The welfare cost is 9.65% for US traders holding a fixed share of equities, and 18.43% for US non-participants. These calculations assume the household starts with the average level of wealth. The welfare costs are monotonically increasing in initial wealth. A lower starting initial wealth might be more reasonable when we consider the life cycle. If we start the households off with only 20% of the average wealth, the welfare costs drop to 6.55% and 11.24%, respectively.

Our assumptions on suboptimal portfolio choices have been used in the existing literature and have been found useful to explain other facts. For example, in Guvenen (2009), limited equity market participation together with heterogeneity in the intertemporal elasticity of substitution successfully explains a high risk premium. Finocchiaro (2011) finds that infrequent portfolio adjustments help explain the large dispersion of the wealth distribution. Gust and López-Salido (2014) show that the presence of inactive households increases the risk compensation, and that the equity premium falls following a monetary expansion.

3. The Model

In this section, we first offer a detailed description of the model to be used in the quantitative exercise. Then, we describe a simple two-period model to illustrate the key mechanism and to build up intuitions.

3.1. 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 endowment 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 world aggregate endowment 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 or 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 $\sum_{i=1}^{I} \delta_i = 1$. The 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 the output is therefore given by $\gamma Y_t^i(z^t)\eta_t^i$, where γ denotes the share of nondiversifiable output.[1] 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

[1]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.

Markov and their probabilities are assumed to be independent:

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

3.2. Leverage and Assets Supply

There are two types 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 ($(1-\gamma)Y^i_t(z^t)$). The leverage ratio is constant over time and denoted by ϕ. Let $\overline{B}^i_t(z^t)$ denote the supply of a one-period risk-free bond in period t in country i and $W^i_t(z^t)$ 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 $\overline{B}^i_t(z^t)$ must be adjusted such that

$$\overline{B}^i_t(z^t) = \phi \left[W^i_t(z^t) - \overline{B}^i_t(z^t) \right].$$

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

$$\overline{D}^i_t(z^t) = (1-\gamma)Y^i_t(z^t) - R^f_{t,t-1}(z^{t-1})\overline{B}^i_{t-1}(z^{t-1}) + \overline{B}^i_t(z^t), \tag{1}$$

where $R^f_{t,t-1}(z^{t-1})$ 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, that must be reflected by $\overline{D}^i_t(z^t)$ in our model. Simply stated, $\overline{D}^i_t(z^t)$ includes both 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 on 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 et al. (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 the market portfolio, then they are more exposed to aggregate risk compared with the average. Otherwise, households take less than the 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, $R^d_{t,t-1}(z^t)$, is therefore given by

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

3.3. Heterogeneity in Portfolios

We impose different restrictions on the portfolio choices of households in order to capture the empirical facts. These restrictions apply both in terms of the menu as well as in terms of 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 household 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 household Mertonian traders. The second type of household 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 household 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 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.

3.4. 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:

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

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:

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

For simplicity, our calibrated model only considers two states in the aggregate shock. Therefore, 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.

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:

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

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 provided in the online appendix.

3.5. 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.

3.6. Law of Motion of Net Foreign Assets

Let the aggregate variables of country i be denoted by uppercase letters, where $X_t^i(z^t) = \sum_{j=me,et,np}\sum_{\eta^{i,t}} \mu_i^j x_t^i(z^t, \eta^{i,t})\pi(\eta^{i,t})$. Then, we define the NFE (NFB) position as the total equity (bond) holdings of country i minus the total equities (bonds) issued by country i:

$$\begin{aligned} NFE_t^i(z^t) &= S_t^i(z^t)V_t(z^t) - \overline{V}_t^i(z^t) \\ NFB_t^i(z^t) &= B_t^i(z^t) - \overline{B}_t^i(z^t) \end{aligned}$$

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

$$NFA_t^i(z^t) = NFE_t^i(z^t) + NFB_t^i(z^t). \quad (7)$$

By aggregating budget constraints (equations (4) and (6)) across all households in country i, together with assets supply (equation (1)), the law of motion of the NFA of country i is written as:

$$NFA_t^i(z^t) \quad = \quad R_{t,t-1}^d(z^t)NFE_{t-1}^i(z^{t-1}) + R_{t,t-1}^f(z^{t-1})NFB_{t-1}^i(z^{t-1}) + TB_t^i(z^t), \tag{8}$$

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

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

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

Then we rewrite the NFA in equation (8) using the following definition of excess return:

$$NFA_t^i(z^t) \quad = \quad R_{t,t-1}^f(z^{t-1})NFA_{t-1}^i(z^t) + RP_{t,t-1}(z^t)NFE_{t-1}^i(z^t) + TB_t^i(z^t). \tag{9}$$

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

Next, we deflate equation (8) by the output and obtain the change in the NFA-to-GDP ratio:

$$\Delta\frac{NFA_t^i(z^t)}{Y_t^i(z^t)} \quad = \quad \left(\frac{R_{t,t-1}^f(z^{t-1})}{g_t(z_t)} - 1\right)\frac{NFA_{t-1}^i(z^{t-1})}{Y_{t-1}^i(z^{t-1})} + \frac{RP_{t,t-1}(z^t)}{g_t(z_t)}\frac{NFE_{t-1}^i(z^t)}{Y_{t-1}^i(z^{t-1})} + \frac{TB_t^i(z^t)}{Y_t^i(z^t)} \tag{10}$$

In a stationary equilibrium, the average change in the NFA-to-GDP ratio in the left-hand side of equation (10) is zero. The time subscript is dropped from all variables to denote their long-run average. The long-run average of equation (10) is approximated by the following:

$$-\frac{TB^i}{Y^i} \quad \approx \quad \left(\frac{R^f}{g} - 1\right)\frac{NFA^i}{Y^i} + \left(\frac{RP}{g}\right)\frac{NFE^i}{Y^i}, \tag{11}$$

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 RP denotes the average risk premium. Evidently, a net debtor position ($NFA^i/Y^i < 0$) has a negative impact on the long-run trade balance when the risk-free rate is lower than the average growth rate of world output ($R^f < g$). Also, a positive NFE position ($NFE^i > 0$) help sustain the long-run trade deficit when the average risk premium is positive ($RP > 0$).

Next, we present a simple model to illustrate that a positive NFE position paying positive risk premium can result from the heterogeneity in trading technologies.

3.7. A Special Case: The Two-Period Model

This subsection describes a special case with two periods and a set of extreme assumptions as follows. First, there are two countries called the US and the ROW, and their residents face asymmetric trading technologies. Specifically, all US households are Mertonian traders, whereas all ROW households are non-participants in the equity market. This extreme assumption implies that the risky equity is held by US residents, and the risk-free bond is held by residents in both countries. Second, there are no idiosyncratic shocks. Third, the world endowment in period 1, or Y_1, is non-diversifiable, but the world endowment in period 2 is fully diversifiable and depends on the aggregate state $z \in (z_H, z_L)$, where $Y_2(z_H) > Y_2(z_L)$. Fourth, households choose consumption plans and purchase assets in period 1, and after the aggregate state is revealed in period 2, they consume and die. Finally, the supply of assets is subject to the leverage ratio in a similar way to that in the multi-period model.

Let the share of the US in the world endowment be δ, where $0 < \delta < 1$. Let W denote the world initial wealth, which is allocated to each country according to its size. The US household chooses consumption c_1 and c_2 to maximize the utility $u(c_1) + \beta u(c_2)$, subject to the following budget constraints:

$$\begin{aligned} \delta(Y_1 + W) &= c_1 + (S_1 V_1 + B_1) \\ c_2(z) &= R_2^d(z) S_1 V_1 + R_2^f B_1. \end{aligned}$$

Let the return on the US portfolio in period 2 be $R_2(z) = \omega R_2^d(z) + (1-\omega) R_2^f$, where ω is the share of equities in the US portfolio and is positive. The first order condition gives the Euler equation:

$$u'(c_1) = \beta E(u'(R_2(z) c_2(z))). \tag{12}$$

The ROW household's problem is a mirror image of the US household's problem. Note that the gross return on the ROW households' portfolio is the risk-free rate or R_2^f, since the ROW households hold only the risk-free bond. The market clearing condition requires that the sum of US and ROW consumption is identical to the world endowment in each period.

We can illustrate that there are returns differential across countries as well as positive risk premium. To see why, first we rewrite the Euler equation in (12) as

$$1 = E(\beta \frac{u'(c_2(z))}{u'(c_1)} R_2(z)) = E(\beta \frac{u'(c_2(z))}{u'(c_1)}) E(R_2(z)) + Cov(\beta \frac{u'(c_2(z))}{u'(c_1)}, R_2(z)). \tag{13}$$

We only consider the Euler equation of the US traders, because they are the marginal traders who pin down asset prices. To find the last term in (13), consider the market clearing condition in period 2. Since ROW consumption in period 2 is not state contingent and $Y_2(z_H) > Y_2(z_L)$, then $c_2(z_H) > c_2(z_L)$. Given a strictly concave utility function, $c_2(z_H) > c_2(z_L)$ implies that $u'(c_2(z_H)) < u'(c_2(z_L))$. Since $c_2(z_H) > c_2(z_L)$, the budget constraint in period 2 for the US household implies that $R_2(z_H) > R_2(z_L)$.

Such comparisons of the return on US portfolio and consumption across states implies the following. When the world endowment is high in period 2, the return on the US portfolio is high and the US households enjoy high consumption, and vice versa. With risk-free asset holdings, ROW households enjoy stable consumption by dumping the aggregate risk solely to US households. For this reason, US households must be compensated for holding risky equities. This is the reason why the return on the US portfolio is negatively correlated with the intertemporal marginal rate of substitution for US residents.

The negative covariance in the last term of equation (13) implies that

$$E(R_2(z)) > \left(E(\beta \frac{u'(c_2(z))}{u'(c_1)}) \right)^{-1} = R_2^f. \tag{14}$$

Notice that the intertemporal marginal rate of substitution for US households is the pricing kernel, so the right hand side of (14) is the risk-free rate. Hence, there is a returns differential between the US and the ROW. In addition, recall that $R_2(z)$ is the weighted average of $R_2^d(z)$ and R_2^f. Then, $E(R_2(z)) > R_2^f$ implies a positive equity risk premium, $E(R_2^d(z)) > R_2^f$, as a result.

Having established that the asymmetry in portfolios can result in the returns differential and risk premium, we can derive the trade balance by using (9) for $t = 2$ and imposing $NFA_2 = 0$ because there are only two periods. The expected trade balance is:

$$-E(TB_2) = R^f NFA_1 + (E(R_2^d(z)) - R_2^f) NFE_1, \tag{15}$$

where $NFE_1 = W(1 - \delta)/(1 + \phi) > 0$. According to equation (15), a debtor country of which $NFA_1 < 0$ can run a trade deficit on average if the risk premium is sufficiently high. The positive risk premium is critical to our results. Suppose there is no aggregate risk, then the return on equity is identical to the return on bonds, implying zero equity premium. The asymmetric international portfolios no longer matter, since portfolio returns are independent of portfolio choices between equities and bonds. In this case, a country with a negative NFA position in the long run must run trade surpluses, as indicated in equation (15).

In the next section, we quantify the scale of trade deficits sustained by the US economy in the long run.

4. Quantitative Results

This section evaluates the extent to which our model can account for US external balances, especially the trade balance in four steps. In subsection 4.1, we begin with a summary of key statistics of the US external accounts. Next, we explain how we calibrate idiosyncratic shocks and aggregate shocks in subsection 4.2. Subsection 4.3 describes the trader's pool in the benchmark case, which is chosen to match several key features of data in asset pricing and household portfolio behaviors. Finally, we report asset-pricing results and the model prediction of US external accounts in subsection 4.4.

4.1. US External Account Statistics

Table 1 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 averages of the US NFB and NFE positions during 2000-2011 are −40.42% of output and 15.34% of 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 1 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 the trade deficit, which amounts to 5.30% of output. The net factor income account is in surplus of 0.80% of output.

4.2. Calibration

We consider a two-country version of our model. Country 1 is the US and Country 2 is the ROW. The size of each country is measured by its share of world GDP. Table 2 displays the country size and other parameter values 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-sized developing countries. These 48 countries accounted for 83% of the actual world GDP in 1980-2009.

Our calibration 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 et al. (2001)). We 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.

The average output growth rate and its standard deviation are 2.54% and 3.02%, respectively, in our data set (See the online appendix 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 the 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 et al. (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 η, 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, of which the mean 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 indicates that the volatility of the ROW idiosyncratic process is slightly larger than that of the US, which is consistent with the findings of Mendoza et al. (2009).

All households 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 et al. (2009), the fraction of nondiversifiable output is set to 88.75%. As shown in Section 3, equity in our model is simply a leveraged claim to diversifiable income. Following Abel (1999) and Bansal and Yaron (2004), the leverage ratio parameter is set to 3.

4.3. The Trader's Pool in the Benchmark Case

In our benchmark model, the composition of traders' pool and the idiosyncratic shock process in the US differ from those in the ROW. We display the composition of traders' pool in the US and that in the ROW in the top panel in Table 3.

To match a high equity premium, 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. We set 50% of US investors as non-participants, as in the 2010 SCF data. As for the ROW, the equity market participation rate is significantly lower than that in the US even among many high-income countries (Guiso et al. (2001)). The rate is between only 20% to 30% in Europe and Japan (Christelis et al. (2010), Van Rooij et al. (2011) and Iwaisako (2009)). We set the fraction of non-participants in the ROW to 70%, which is modest given that the ROW consists of a large number 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 SCF data to calibrate the equity share of non-Mertonian equity traders in the US, which account for 45% of the population. We first sort the 50% of households holding equities in the data 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 both from the data and from our model that more sophisticated households tend to hold larger amounts of equities. Unfortunately, we do not have information about the equity share of non-Mertonian equity traders in the ROW. For this reason, we assume that the ROW non-Mertonian equity traders hold the market portfolio, which has a 25% equity share. This equity share is conservative, given that the equity shares among market participants are significantly higher in the US than in Europe in Christelis et al. (2010).

4.4. Benchmark Results

The benchmark asset-pricing results are shown in Panels A-C in Table 3. In Panel A, 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 $\sigma(R^f)$.

Next, Panel B 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 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.[2] 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 percentages of output.

Our benchmark economy produces a high equity premium as well as a low and stable risk-free rate. In Panel A in Table 3, 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.

In our model, the success of matching high risk premiums and low risk-free rates relies on two key frictions. 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 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 et al. (2011), who use a similar setup in a closed economy to explain the average level and volatility of risk premiums.

Panel B in Table 3 reports wealth returns and portfolio choices across traders and across countries. US Mertonian traders earn an average excess return of 5.31% by holding about 82% of equity in their portfolio. Because of the higher idiosyncratic risks faced by ROW investors, 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%. US non-Mertonian equity traders realize a higher excess wealth return, 2.20%, compared to 1.58% earned by ROW non-Mertonian equity traders earning because of the difference in the equity target shares, 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

[2] A dividend process is necessary to compute the net factor income account (NFIA). 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 3.

overall portfolio, which is higher than the 21.55% share among ROW investors. Since the market portfolio is 25% in equity, the average portfolio of US investors is riskier than that of average ROW 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 ROW investors. The higher average return earned by US investors has a significant impact on US external accounts as discussed below.

External account statistics are reported in Panel C in Table 3. The long-run average US trade balance is −2.65% of output, suggesting that the valuation effect through asset returns alone accounts for 50% of the trade deficit in the data, −5.30% of GDP. In addition, the US trade deficit is highly volatile and countercyclical. To demonstrate this effect, the top panel of Figure 1 plots a sample path for 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 households consume more during good aggregate states. When a recession hits, the trade balance improves greatly, indicating that US households 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 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 1. 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 ROW investors. Thus, the simple decomposition of the US NFA statistics into bonds and equities cannot truly reflect the total risk exposure by US investors. However, we can compare our predicted scale of long-run trade deficits with the scale implied by the estimates of returns differential 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 implied US long-run trade deficits would be 2.67% of output, which is quite close to our 2.65%.

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 country bearing more aggregate risk, which is the US, can enjoy the long-run trade deficit financed by the risk premium, despite its negative NFA position, as indicated by equation (11). We view our calibrated trade deficits as conservative because we use conservative parameters to capture the asymmetric risk-taking behavior of households across countries as documented by empirical studies.

In the next section, we turn off some features in order to inspect the mechanism of our model.

5. Inspecting the Mechanism

This section examines three sets of counterfactual exercises. First, in subsection 5.1 we consider a symmetric two-country model, in which both countries have identical portfolio restrictions and an identical idiosyncratic shock process. Next, in subsection 5.2 we consider identical rate of equity market participation across countries to highlight the role of the asymmetric equity market participation. Finally, subsection 5.3 displays the results of exercises in which we vary the equity market participation rate.

5.1. Symmetric Cases

To illustrate that cross-country asymmetry is essential to our main results, we consider a symmetric version in which the composition of traders and the idiosyncratic shock process are identical in the two countries. Given the symmetry, we consider three quantitative experiments, which differ according to the traders' pool. In Experiment 1, the pool of traders consists of 100% Mertonian traders in both countries. In the second experiment, 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 the market portfolio. The pool of traders of Experiment 3 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 4 reports the asset pricing results of all experiments. We report the statistics for asset pricing, portfolio returns, and US external balances, similar to the report of results in the benchmark case.

In the first experiment, all households face no trading restriction and hence have an identical portfolio choice. 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 4.[3] The risk-free rate is constant due to the unpredictable consumption growth rate, and the risk premium is only 2.11%, reflecting the equity premium puzzle shown by Mehra and Prescott (1985). To summarize, without restrictions on portfolio choices for all households, the asset-pricing result of our model 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 4 reports the results, which suggest that the equilibrium allocations and prices of the second experiment are identical to those of 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 saving. 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 4 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

[3] 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.

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 is 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 to encourage a small fraction of Mertonian traders to take on considerable extra risk. Eventually, Mertonian traders earn a higher average return and enjoy a higher level of consumption, while non-participants only earn the low risk-free return and consume little.

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 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 US bonds and equities are identical to ROW ones, 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, external accounts will no longer be balanced if we assume asymmetry across countries in portfolio restrictions and in the idiosyncratic process.

5.2. 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 the 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.

To illustrate the point, we consider two cases as follows. Case 1 assumes that the ROW has the same degree of equity market participation rate (extensive margin) and the same equity share of non-Mertonian traders (intensive margin) as the US data. Case 2 is the reverse of case 1, in which the US has the same degree of participation as observed in the ROW. The results are reported in columns 1 and 2 in Table 5, respectively.

Panel A in Table 5 indicates the negative relationship between market participation and the risk premium. Compared with the benchmark economy in Table 3, 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 slightly higher than those in the ROW. The higher idiosyncratic risk faced by ROW Mertonian traders induces them to hold less equity in their portfolios. Most importantly, the US runs a trade surplus on average, since both NFE and NFB positions turn to negative in both cases, as in Panel C.

The overall aggregate risk-taking by US traders is less than the benchmark, due to 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 US households has two opposite effects on overall equity holdings. First, it reduces the need for precautionary savings for US households and results in a negative net NFA position for the US. Given that the non-Mertonian traders' portfolios are the same for both cases, lower overall asset holding 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, the first effect dominates the second and consequently the US demands less risky assets than its supply. Cases 1 and 2 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.

5.3. Financial Deepening

We can use our model to examine the impact of financial deepening characterized by two counterfactual changes in the fraction of traders in each country. One case increases the fraction of Mertonian traders and the other increases the equity market participation rate in the ROW.

Increases in the Fraction of Mertonian Traders. Table 6 varies the fraction of Mertonian traders in the US and/or the ROW. The first column reports the benchmark case. The remaining columns show the results for the following cases: the fraction of US Mertonian traders increases to 10%, the fraction of Mertonian traders in the ROW increases to 10%, and the fraction of Mertonian traders in both the US and the ROW increases to 10%.

Panel A in Table 6 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 6, the optimal equity share of Mertonian traders decreases in all three cases because of the lower equity premium. Similar to our benchmark case, 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 than 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% because of the higher fraction of Mertonian traders. In contrast, 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 6 demonstrates effects on the US external account. The trade balance largely responds to the change in the fraction of Mertonian traders. 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 about double the benchmark. This occurs because the additional Mertonian traders hold mostly equity in their portfolios. When the change occurs in the ROW, as shown in the third column, the US trade deficit improves to a surplus of 0.12% of GDP. Note that 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.

Increases in the Equity Market Participation Rate. This subsection studies the impact of increasing equity market participation among non-Mertonian traders in the ROW. A decrease in the fraction of non-participants implies an increase in the fraction of non-Mertonian equity traders, given that other parameters remain unchanged. Table 7 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 7 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 is that fewer non-participants imply less residual risk, and hence the aggregate risk is spread out over a larger pool of equity market participants. The equity premium drops from 6.35% to 5.95% as the fraction of non-participants abroad changes from 70% to 50%. The equity share in the ROW portfolio increases from 21.95% in the benchmark case to 23.35%. Evidently, increasing the equity market participation rate 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 equity market participation rate 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 is the ROW. The US NFA position deteriorates from −28.16% in the benchmark case to −53.79%, with a 50% participation rate in the ROW.

6. Conclusion

We use a general equilibrium model with asset trading restrictions to demonstrate that global imbalances are related to asymmetric portfolio choices across households within a country and 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, we are able to generate a long-run trade deficit, whereas almost all of the existing models predict a long-run trade surplus. Considering the returns difference across assets distinguishes our model from the existing studies in the literature. On the quantitative side, our predicted US trade deficits account for more than half of the US trade deficit in 2000-2011. Nevertheless, we do not claim that asymmetric asset demands are the only cause of positive returns on the US NFA position. Our qualitative prediction is based on two simple conditions that are supported by a large body of empirical literature: (i) a positive risk premium and (ii) the willingness of average US traders to take on a relatively larger amount of aggregate risk than do average ROW traders. Therefore, we expect that any model that produces these two conditions will yield similar qualitative results.

We differentiate our explanation for global imbalances from those in Caballero et al. (2008) and Pavlova and Rigobon (2010) by focusing on the demand side in asset markets. Quantitatively, our predicted scale of long-run trade deficit and official current account deficit are 2.65% and 2.17% of GDP, respectively. Our result is in fact comparable to the supply-side model by Caballero et al. (2008). Their long-run official current account deficit is 1.8% (2.9%) of GDP when the shock on asset supply is temporary (permanent). However, the magnitude of the long-run trade deficit predicted by Pavlova and Rigobon (2010) is at most 1% of GDP, even when they consider the possibility that supply shocks may be correlated with preferences shocks.

To integrate shocks on asset supply in these studies into our model, we would have to introduce a permanent shock to the share of diversifiable output of the ROW. Conceptually, doing so would allow us to assess the combined effects of both demand-side and supply-side ingredients. However, solving such a model would be computationally challenging, because that would require computing a transition path from the initial stationary equilibrium to the new one in the presence of aggregate shocks and heterogeneous households, which do not exist in their models. For this reason, we leave the integrated model for future research.

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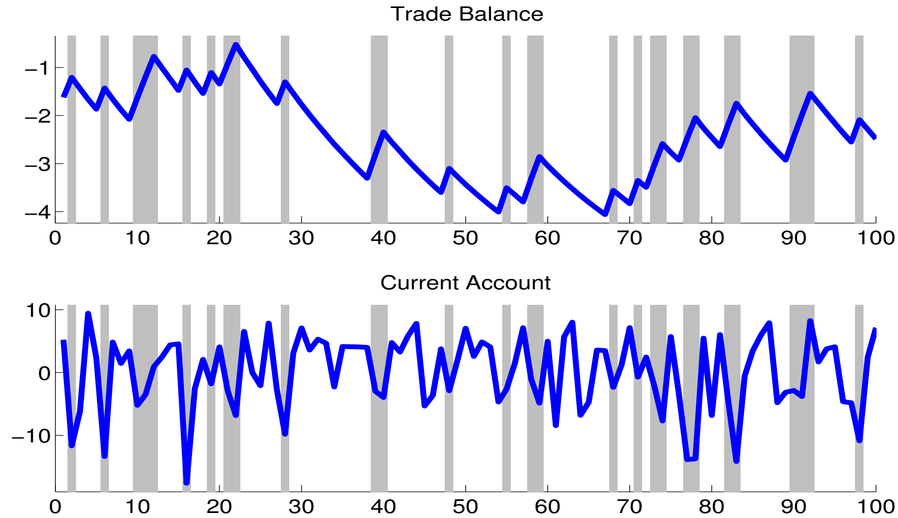
List of Figures

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.

List of Tables

Table 1: 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 2: 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 3: 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 4: 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 5: 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 (%)		
$E(\omega)_{me,US}$	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 6: 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 (%)			
$E(\omega)_{me,US}$	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 7: 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 (%)		
$E(\omega)_{me,US}$	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.