Limited Risk Sharing and International Equity Returns

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Jan 2016

Abstract

I study international consumption risk sharing with limited stock market participation in each country. Novel micro-level household consumption data in the U.S. and U.K. show that the stockholders' cross-country consumption growth correlation is considerably higher than that of the aggregate consumption growth. I develop an incomplete market model that features this new empirical evidence by incorporating limited risk sharing due to limited stock market participation. Moreover, the model generates high international equity return correlation, low aggregate consumption growth correlation, and salient features of asset prices (high and volatile equity premium, low and smooth risk free rate). Financial integration significantly improves the stockholders' international consumption risk sharing, reduces their consumption volatility, and increases their welfare. However, the benefits are almost all captured by the stockholders.

Keywords: comovement, consumption risk sharing, financial integration, limited stock market participation

JEL classification: F30, F41, F62, F65, G11, G12, G15

*School of Economics and Finance, The Univeristy of Hong Kong. Email: aszhang@hku.hk. This paper is part of my Ph.D. thesis at NYU Stern. I sincerely thank my committee, Matteo Maggiori, Thomas Mertens, Stijn van Nieuwerburgh (chair), and Robert Whitelaw for many valuable discussions. I am also grateful for Rui Albuquerque (discussant), Viral Acharya, David Backus, Aurel Hizmo, Anthony Lynch, Tarun Ramadorai, Christopher Telmer (discussant), Thomas Philippon, Jianfeng Yu, and Lu Zhang, as well as seminar participants at Georgetown McDonough, HKU FBE, Hofstra, Minnesota Carlson, NYU Stern, OSU Fisher, PSU Smeal, Purdue Krannert, SMU Lee Kong Chian, Tsinghua PBC, European Financial Association Annual Conferences (2015) and American Finance Association Annual Meetings (2016). All errors are my own. This paper was previously circulated under the title "The Implications of Limited Stock Market Participation for International Risk Sharing and Asset Prices".

How much do financial markets matter for international risk sharing? This question attracts great interest since Cole and Obstfeld (1991), but answering it is challenged by the disconnect of the international equity returns from macro quantities. First, stock markets around the world exhibit high return correlations relative to that of aggregate economic fundamentals (a.k.a. *International Equity Premium Puzzle* (Colacito and Croce, 2011)). In the post Bretton Woods period, the U.S. quarterly equity return has an average correlation of 0.6 with those of the other G7 countries, as shown in Table 1. The same correlation of their financial income growth is 0.02[1], and that of non-durable consumption growth is 0.09. Further, this gap between the financial and fundamental correlations has increased as the financial integration unfolds. For example, from 1997 to 2001, U.S. investors' holding of the U.K. market increased from 13% to 24%, and the return correlation of the U.K. with the U.S. market has increased significantly from 0.64 (1973-1996) to 0.88 (1997-2003)[2], however, there is no such trend in the fundamental correlations[3]. There is no upward trend in equity return correlation between the U.S. market and the markets that remain relatively segmented.

Therefore, the asset market and the macro quantity-based views disagree on 1) Is the current consumption risk sharing between financially integrated countries good or bad? 2) What is the potential (or the historical) gain from the global financial integration? Assessing the importance of financial markets requires bridging these two views. The typical approach is to consider alternative preferences or shocks regarding the representative agent in each country. What is largely abstracted away, often for modeling convenience or due to data restriction, is the heterogeneity within a country. In particular, only about 50% of individuals invest in the stock market either directly or indirectly in the U.S. (e.g., via investment vehicles for retirement or non-retirement accounts). The participation rate tends to be lower

[1]Financial income is defined as corporate profit minus investment (Coeurdacier and Gourinchas, 2011).

[2]Longin and Solnik (1995) finds correlation increase in G7 countries, and Bekaert, Hodrick, and Zhang (2009) finds correlation increase within Europe.

[3]The literature debates about the magnitude and direction of these correlation changes. For example, Heathcote and Perri (2004) documents that the correlation of GDP and consumption between U.S. and the rest or the world decreased from 0.76 and 0.51 pre-1986 to 0.26 and 0.13 post-1986. However, Kose, Otrok, and Prasad (2012) show that during the period of financial globalization (1985-2008), there is a small convergence of business cycle fluctuations among developed countries, but also a concomitant decline in the relative importance of the global factor.

in Europe (Grinblatt, Keloharju, and Linnainmaa, 2011).

The feature of limited stock market participation not only leads to imperfect risk sharing within a country, but also different risk sharing patterns across countries. A novel dataset built from the U.S. and U.K. household-level consumption survey reveals that from 1988 to 2007, the 12-quarter consumption growth correlation between U.S. and U.K stockholders is 0.6, compared to 0.4 for the non-stockholders. This gap in correlations persists from 4-quarter until 20-quarter horizons. In tradition of Obstfeld (1994), the observed consumption growth correlation and equity return correlation imply the current degree of risk sharing.[4] Therefore, focusing on stockholders, who are the marginal pricers of the equities, can potentially reconcile the asset market and the macro quantity view.

I construct an incomplete market model to quantitatively evaluate the conjecture. The key new feature is the limited risk sharing within, on top of between countries. There are two types of agents in each country: the non-stockholders can only trade in a global bond market, whereas the stockholders have access to both stock markets as well as the bond market. The imperfect risk sharing within a country arises due to the limited stock market participation. The risk sharing between countries is also imperfect, due to the non-diversifiable labor income risks as well as the borrowing constraints.

The model generates high cross-country equity return correlation and low aggregate consumption growth correlation. Home stockholders aggressively diversify their income risks with the foreign stockholders by directly holding the foreign equity, as well as actively rebalancing their equity positions. This generates high cross-country consumption growth correlation for the stockholders (0.6 in both model and data). Equity returns of these integrated stock markets are jointly determined by all stockholders, therefore, are highly correlated (0.8 in both model and data). Both the consumption growth and equity return correlations imply that the stockholders achieve good international risk sharing through the international stock markets. The non-stockholders are excluded from the stock market, and can only smooth their consumption *ex post* through the bond market. The risk-free bond can only help redistribute risks among agents, and hence is not a powerful risk sharing in-

[4]A more recent example is Lewis and Liu (2015).

strument. The lack of access to the stock market leads to low cross-country correlation in the non-stockholders' consumption growths (0.4 in both model and data). Further, it leads to low aggregate consumption growth correlations.

The model delivers a low and smooth risk-free rate, together with a high and volatile equity risk premium, thanks to both the market access heterogeneity and the preference heterogeneity. In the model, non-stockholders have lower elasticity of intertemporal substitution (EIS, 0.1) than that of stockholders (0.3), consistent with empirical estimates.[5] To smooth away consumption fluctuations due to the country idiosyncratic labor income risks, the non-stockholders actively borrow and lend with each other. For the global aggregate labor income risks, the stockholders provide insurance to the non-stockholders, because they are more willing to substitute intertemporally. Consequently, the global aggregate risk is concentrated on the stockholders, and they require a high equity risk premium for compensation.

The incompleteness within a country allows reassessing the welfare and the re-distributive effects of financial integration. When the stock market is closed to foreign investors (or, *financial segmentation*), the consumption smoothing has to go through the bond market. Since the bond is an inefficient way to achieve the purpose, the international consumption risk sharing is very limited for all agents, including the stockholders, which leads to the low equity return correlation. As soon as the stock market opens up to foreign investors(or, *financial integration*), stockholders can diversify away a significant amount of country-specific risks through the international equity market and achieve better international risk sharing, reflected by an increase in their consumption growth correlation. Naturally, the return correlation between countries dramatically rises also: The common discount rate effect dominates the low cash flow correlation. This is consistent with the increase of equity market comovement when stock markets open up (Bekaert and Harvey, 2000).

The stockholders reap a lot of welfare benefits from the financial integration. When stock markets are integrated, the stockholders only need to insure the non-stockholders against the

[5] See Attanasio, Banks, and Tanner (2002), Brav, Constantinides, and Geczy (2002) and Vissing-Jorgensen (2002).

global labor income shocks, but not the country-specific. Further, the stockholders invest in the foreign equity market, to diversify their financial income risks. So they not only need to provide less aggregate insurance, but also at a lower cost, which leads a fall in their consumption growth volatility. Nevertheless, the non-stockholders are excluded from this financial advance. They bear as much income risk as in the financial segmentation scenario and their consumption growth remains as volatile. Welfare calculation shows that, the financial integration favors different asset holders and in an extreme way: The stockholders capture almost all of the welfare gains from the financial integration.

The rest of the paper is organized as follows. After discussing my contribution in context of the literature, I describe the data and empirical results in Section 2. Section 3 presents the theoretical framework, and Section 4 to 5 discuss the benchmark results and channels, and explore the quantitative implications. I provide concluding remarks in Section 6.

1 Related Literature

My paper builds on the limited stock market participation literature in the closed economy. For example, Basak and Cuoco (1998), Gomes and Michaelides (2008) and Guvenen (2009) show that accounting for limited participation can help rationalize the equity risk premium puzzle.[6] I bring the limited stock market participation into the international context to explain the *international equity premium puzzle*, and provide, to my knowledge, the first empirical evidence on the different international risk sharing patterns by stockholders and non-stockholders.

The disconnect of asset prices from economic fundamentals in international finance draws a lot of attention, starting from Cole and Obstfeld (1991) in the endowment economy framework and Backus, Kehoe, and Kydland (1992) in the production economy framework. One strand of literature, for example Lewis (1998), Kehoe and Perri (2002) and Bai and Zhang (2012) among others, focuses on investigating the frictions required in order to generate the

[6]Empirically, Vissing-Jorgensen (2002), Attanasio, Banks, and Tanner (2002), Parker and Julliard (2005) and Malloy, Moskowitz, and Vissing-Jorgensen (2009) find evidence on the pricing ability of the stockholders consumption growth.

excessive low consumption correlation in data. Another strand of literature studies the risk sharing and asset prices jointly, such as Dumas (1992), Farhi and Gabaix (2008), Verdelhan (2010), Colacito and Croce (2011) and Pavlova and Rigobon (2007, 2012).[7] Most assume complete markets[8]. I instead take an incomplete market view and more importantly, deviate from the homogeneity assumption of each countrys population.

My research also contributes to the study of the pricing and welfare impacts of financial integration. For comovement effects, much discussion focuses on the emerging markets.[9] For example, Bekaert and Harvey (1997) document in event studies that the correlation between the emerging market and the world market increases after the domestic market opens up.[10] And Obstfeld (1998) is one of the first to examine the welfare impact of financial integration. More recent work, such as Colacito and Croce (2010), Favilukis, Ludvigson, and Van Nieuwerburgh (2010), Martin (2010) and Lewis and Liu (2015) attempts to estimate the *aggregate* welfare impacts in asset pricing context. I provide a theoretical framework that jointly rationalizes the pricing and funamental behaviors around the integration, and highlight the *distributional* perspective, i.e, who benefits more from this process.

My research is also part of the recent theoretical effort to incorporate portfolio choices in international macro finance models. The related literature includes Devereux and Sutherland (2009, 2011) and Pavlova and Rigobon (2010, 2012) among others.[11]

[7] Amongst others see also: Stathopoulos (2012), Hassan (2013), Martin (2011), Heyerdahl-Larsen (2012), Farhi et al. (2009).

[8] Notable exceptions include Alvarez, Atkeson, and Kehoe (2009) which studies time-varying levels of market segmentation, and Maggiori (2011) as well as Gabaix and Maggiori (2013) which examine the role of financial intermediation

[9] Karolyi and Stulz (2003) and Dungey et al. (2005) discuss the correlation analysis in more detail.

[10] There is another strand literature that studies the determinates and measurements of financial integration, see Stulz (1981), Schindler (2008), Bekaert et al. (2011) and Karolyi and Stulz (2003) etc.

[11] See also Bacchetta and Van Wincoop (2010), Tille and Van Wincoop (2010) and Mertens and Zhang (2014).

2 Empirical Evidence of Limited International Risk Sharing

This section describes the data sets adopted, and presents the empirical evidence of the the limited risk sharing within and between countries.

2.1 The Consumption Data

I start by introducing the two household-level consumption survey data from the U.S. and U.K..

The U.S. Consumption Data

I draw the U.S consumption data from the Consumer Expenditure Survey (CEX) data of the U.S. for the period 1982-2012. The quarterly consumption growth rates are calculated for stockholders and non-stockholders respectively. The CEX data over a shorter sample period have been used in previous studies, such as Vissing-Jorgensen (2002) and Malloy, Moskowitz, and Vissing-Jorgensen (2009) (MMV hence) among others.

The CEX data are available from 1980: Q1 to 2012: Q1. Each household in the sample was surveyed five times, three months apart. I identify stockholders, following Vissing-Jorgensen (2002), based on the response to the survey question indicating positive holdings of "stocks, bonds, mutual funds and other such securities" on the last day of last month. Households also report the change in positions from a year ago. Households are also required to hold a positive amount of securities a year ago. 27% of the households are classified as the stockholders. I discuss further details of the sample and data construction in the Appendix.

To aggregate the household consumption growth rates for stockholders and non-stockholders, I first calculate the non-durable consumption growth rates for each household. The quarterly consumption growth rate for a particular group g (stockholders/non-stockholders) from t to $t+1$ is defined as

$$\frac{1}{H_t^g} \sum_{h=1}^{H_t^g} \left(c_{t+1}^{h,g} - c_t^{h,g} \right)$$

where $c_t^{h,g}$ is the log quarterly consumption of household h in group g at time t, and H_t^g denotes the number of households of group g at time t.

The U.K. Consumption Data

The U.K. consumption data are drawn from the U.K. Family Expenditure Survey(FES) data from 1988 and 2000, and the U.K. Expenditure and Food Survey (EFS) data from 2001 to 2007. In 2001, the FES data is merged with the UK National Food Survey to create the Expenditure and Food Survey (EFS), and I refer to both datasets as FES in the text below. The data are used by Attanasio, Banks, and Tanner (2002) and Blundell and Etheridge (2010) among others.

Attanasio, Banks, and Tanner (2002) point out that it is important to adjust for the increase in the stock market participation in U.K.. They report that the increase in the level of direct share ownership in the U.K. is "precarious" during 1985 - 1987, due to a number of measures to promote "share-owning democracy". It starts to stabilize in 1988. Therefore, the year 1988 is chosen as the start point of the sample. Stockholders are identified by their response to the question "How much is invested in stocks/shares at present". 22% of the households are classified as the stockholders. I again discuss the details about data in the Appendix for brevity.

The FES data are repeated cross-section, rather than panel data, which forces me to assume a representative agent within each stockholder- and non-stockholder group, in order to determine the mean consumption growth rate of each group. I calculate the per capita non-durable consumption per period, equalized by the OECD (Organisation for Economic Co-operation and Development) adult equalization measure. The log consumption growth rate is calculated as

$$\log\left(\frac{1}{H^g_{t+s+1}}\sum_{h=1}^{H^g_{t+s+1}} C^{h,g}_{t+1+s}\right) - \log\left(\frac{1}{H^g_{t+s}}\sum_{h=1}^{H^g_{t+s}} C^{h,g}_{t+s}\right)$$

where C denotes the average per capita consumption level and H^g denotes the number of households in group g. To remove the impact of the change of survey sample, I regress the change in log consumption on the change in the average log family size and percentage of household heads with high-school education over the same sample period of time. To remove seasonality in the data, a set of monthly dummies is also included in the regressions, and the residuals are constructed quarterly consumption growth measure.

2.2 Stock Market Participation and Consumption Growth Correlation

I examine the risk sharing patterns by looking at the consumption growth correlations between and within countries. As the survey data can be noisy, I calculate the average consumption growth within each quarter, and aggregate the monthly data into the quarterly frequency.[12] Table 2 presents the summary statistics of the consumption growth for stockholders and non-stockholders. The stockholders' consumption growth volatility is significantly higher than that of non-stockholders in the U.S. and U.K, an observation first made by Mankiw and Zeldes (1991) for the U.S., and confirmed by Attanasio, Banks, and Tanner (2002) for the U.K.. The same is true for both the total income and the wage income growth.[13]

I then calculate the correlation of consumption growths for the U.S. and U.K. stockholders and non-stockholders over different horizons.[14] Results are reported in Table 3. Panel A reports the results using the aggregated quarterly frequency data. For comparison, I calcu-

[12] The 1-quarter consumption growth is very volatile, but smooths out when aggregated at the quarterly frequency, suggesting there is significant amount of noise in the short-term fluctuations.

[13] Due to data restrictions, the U.S. total income data only spans 2004 to 2007, and no consistent wage income data is available for the U.K.

[14] As Malloy, Moskowitz, and Vissing-Jorgensen (2009) finds, while the contemporaneous consumption growth is often adopted, the long-run consumption growth finds more success in for asset pricing.

late also the aggregate consumption growth correlations, using NIPA data. The aggregate correlation is low, but increases over longer horizons. The consumption growth correlation between the stockholders also increases over longer horizons, but is high across different horizons. In particular, it is significantly higher than that of the non-stockholders. For example, at 12-quarter horizon, the stockholders' consumption growth correlation is as high as 0.59, while the non-stockholders' consumption growth correlation is only 0.37, significantly lower by 0.22. The gap in consumption growth correlation persists around 0.2, from 4-quarter to very long horizons, and starts diminishing at 20-quarter horizon. Also, the stockholders' consumption growth correlation is consistently higher than the aggregate correlation until the spread converges at the very long horizon. For robustness, I report results using the monthly frequency data in Panel B. Results at longer horizons are similar to the quarterly results. For example, at 12-quarter horizons, the same gap in the correlations is 0.18.

As expected, the within-country correlation of the stockholders' and non-stockholders' consumption growths is very high, pointing to the consumption risk sharing within each country as in closed economy (see Guvenen (2009), Danthine and Donaldson (2002)). There is also a moderate amount of correlation in the home (foreign) stockholders' and foreign (home) non-stockholders' consumption growths.

3 An Incomplete Market Model with Limited Stock Market Participation

In this section, I construct a quantitative incomplete market model to explain the empirical facts, as well as jointly match the salient features of asset returns and macro quantities.

The main empirical facts that I want to explain are as follows:

Fact 1. International asset returns are highly correlated, while the cross-country correlation for the aggregate consumption growths is low;

Fact 2. The cross-country consumption growth rate correlations for the stockholders are significantly higher than that of the non-stockholders and the aggregate.

Fact 3. Stock market integration, together with the increase in cross-country asset positions accompanies the large increase in asset return correlations, with no obvious trend in aggregate consumption growth correlations;

3.1 Model Setup

There are two endowment economies. To high the limited stock market participation, I abstract from the exchange rate channel which is studied by a large literature, and assume that it is a one good economy. Each country is endowed with labor income and capital income (from a Lucas tree) each period. The capital income endowments of Home and Foreign country are $D_{h,t}$ and $D_{f,t}$, respectively, the log of capital income endowments of which (denoted by corresponding lower cases) are subject to normally distributed country specific risks u_h and u_f.

$$d_{h,t+1} = (1-\kappa_h)\bar{d_h} + \kappa_h d_{h,t} + u_{h,t+1} \quad (1)$$

$$d_{f,t+1} = (1-\kappa_f)\bar{d_f} + \kappa_f d_{f,t} + u_{f,t+1} \quad (2)$$

The labor income endowment of country i is denoted as $L_{i,t}$. The log (again in corresponding lower cases) follow the following processes:

$$l_{h,t+1} = (1-\rho_h)\bar{l_h} + \rho_h l_{h,t} + z_{h,t+1} \quad (3)$$

$$l_{f,t+1} = (1-\rho_f)\bar{l_f} + \rho_f l_{f,t} + z_{f,t+1} \quad (4)$$

There are three assets in the economies: one-period real global bonds B, and Home and Foreign stocks S_h and S_f. They trade at prices p^b_t, $p^s_{h,t}$, and $p^s_{f,t}$, respectively. Stocks are aggregate claims to home and foreign dividend/capital streams, and there is one home stock and one foreign stock outstanding, respectively. Zero-net supply real bonds give 1 unit of consumption next period.

Limited stock market participation is the key feature of the model. There are two types of agents in each country: non-stockholders, who get $1-\mu_i$ of country i's labor income, and stockholders, who get μ_i of country i's labor income. Non-stockholders can save or borrow only. Stockholders can invest in all three assets: the risk-free bond, and Home and Foreign stocks.

Non-stockholder's Optimization Problem

Non-stockholders choose saving (or borrowing) in the risk free bond $b^n_{i,t}$, and consumption $C^n_{i,t}$ to maximize their expected utility

$$\max_{C^n_{i,t},b^n_{i,t}} V^n_{i,t} = \left((1-\beta)(C^n_{i,t})^{1-\frac{1}{\sigma_n}} + \beta\left(E(V^n_{i,t+1})^{1-\gamma_n}\right)^{\frac{1-\frac{1}{\sigma_n}}{1-\gamma_n}}\right)^{\frac{1}{1-1/\sigma_n}}$$

where σ_n is the EIS of non-stockholders, subject to their budget constraint and borrowing constraint

$$\begin{aligned} C^n_{i,t} + p^b_t b^n_{i,t} &= (1-\mu_i)L_{i,t} + b^n_{i,t-1} \\ b^n_{i,t} &\geq \underline{b}^n \end{aligned}$$

where $\underline{b}^n$ denotes the borrowing constraint. The borrowing constraint is motivated by frictions, such as private information and limited commitment (e.g., Hart and Moore (1988), Mendoza, Quadrini, and Ríos-Rull (2009) and Chatterjee, Corbae, and Rios-Rull (2008), etc). I abstract from the microeconomic modeling, but build on the conclusions and impose the exogenous borrowing constraints. The borrowing constraint also stabilizes the wealth distribution and enables the computation of the moments of the equilibrium objects.

Stockholder's Optimization Problem

The utility-maximizing representative stockholder of country i chooses his saving $W_{i,t}$, the consumption of goods $C^s_{i,t}$, shares of Home and Foreign stocks to hold $s_{ih,t}$ and $s_{if,t}$, and units of the real bond to buy $b_{i,t}$:

$$\max_{C^s_{i,t},W_{i,t},b_{i,t},s_{ih,t},s_{if,t}} V^s_{i,t} = \left((1-\beta)(C^s_{i,t})^{1-\frac{1}{\sigma}} + \beta\left(E(V^s_{i,t+1})^{1-\gamma}\right)^{\frac{1-\frac{1}{\sigma}}{1-\gamma}}\right)^{\frac{1}{1-1/\sigma}}$$

where σ is the EIS of stockholders, subject to his budget constraint and borrowing constraints:

$$\begin{aligned} s_{ih,t}p^s_{h,t} + s_{if,t}p^s_{f,t} + b_{i,t}p^b_t + C^s_{i,t} &= \mu_i L_{i,t} \\ &\quad + b_{i,t-1} + s_{ih,t-1}(p^s_{h,t} + D_{h,t}) + s_{if,t-1}(p^s_{f,t} + D_{f,t}) \\ b_{i,t} &\geq \underline{b}^s \\ s_{ij,t} &\geq 0 \end{aligned}$$

Stockholders are required not to short the foreign market, which is non-binding.

Market Clearing

The economy needs to satisfy the resource constraints

$$C^n_h + C^n_f + C^s_h + C^s_f = Y_h + Y_f \tag{5}$$

And market clearing conditions for assets are given by:

$$b^n_h + b^n_f + b_h + b_f = 0 \tag{6}$$

$$s_{hh} + s_{fh} = 1 \tag{7}$$

$$s_{ff} + s_{hf} = 1 \tag{8}$$

One of the market clearing conditions above is redundant due to Walras' Law.

3.2 Equilibrium

This economy is incomplete in several ways: First, there are three assets and four shocks; second, part of the population does not participate in the stock market; last but not least, all agents in the economy are subject to borrowing constraints. Therefore, in addition to the exogenous shocks, I also need to keep track of the wealth of agents, as well as the portfolio composition.

The equilibrium of this open economy consists of optimal consumption policy functions for home and foreign non-stockholders and stockholders C_h^n, C_f^n, C_h^s and C_f^s, and optimal portfolio policy functions W_h, W_f, b_h, b_f, b_h^w, b_f^w s_{hh}, s_{hf}, s_{fh} and s_{ff}; as well as asset prices p^b, p_h^s and p_f^s such that:

1. Consumption/saving decisions are optimal
2. Portfolio decisions are optimal
3. All individuals' budget constraints are satisfied
4. The asset markets clear
5. The good market clears

3.3 Solution Method

This model is challenging to solve, due to the large set of state variables, especially endogenous ones, as well as the indeterminacy of the portfolio positions in the non-stochastic steady state.

I solve the model using the perturbation method. First, I write a generic policy function G as a function of the state vector $G(X)$. Then, starting from the non-stochastic steady state, I take the Taylor expansion of the equilibrium conditions around the steady-state value of the state vector X_{ss}, and build the first and higher-order approximation of the state variable $G(X)$. I use the Barrier approach to smooth the borrowing constraints, which makes the construction of Taylor expansion possible. Higher-order approximation is necessary for at least two reasons. First, the risk premium is inherently a second-order object. Second, the portfolio positions can only be solved in the higher-order approximation, which I explain below.

The portfolio allocation problem of stockholders brings a subtle computation complication. At the non-stochastic steady state, the optimal portfolio position is indeterminate, as the Implicit Function Theorem does not apply. Intuitively, absent the risks in the model, different assets carry the same returns, therefore, the optimal portfolio position is indeterminate. As I show in Figure 1 a), in the deterministic economy, every point on the Share-axis (or the entire blue line) is an optimal portfolio position. Hence, there is no steady-state value of portfolio positions to build the Taylor series around.

I deal with the issue applying the Bifurcation Theorem. The theorem implies that, there exists a unique bifurcation point around which we can build the Taylor series (Judd and Guu, 2001), and it can be identified at the second-order approximation. For example, in Figure 1 a), there is only one deterministic optimal portfolio A that is consistent with the limit portfolio when the volatility of the economy tends to 0. Mertens and Zhang (2014) shows that the Bifurcation Theorem in R^n space applies to the case with multiple state variables. In Figure 1 b), any point in the $Volatility = 0$ plane (or the blue plane) is an optimal portfolio position in the non-stochastic steady state. However, there is only a boundary BB' (the bifurcation boundary), or a unique point w.r.t. each state variable/vector, that is consistent with the limit portfolios when the volatility of the economy tends to 0. This boundary is also the only boundary place the L'Hospital's rule holds. The dynamics of the portfolio positions is further solved at the 3rd order and higher.[15] I describe the solution for the bifurcation boundary in detail in the Appendix.

4 Benchmark Calibration and Model Properties

I now discuss the benchmark calibration, results, and the properties of the model. I focus on the first two empirical facts:

Fact 1. International asset returns are highly correlated, while the cross-country correlation for the aggregate consumption growths is low;

Fact 2. The cross-country consumption growth rate correlations for the stockholders are significantly higher than that of the non-stockholders and the aggregate.

[15] At 3rd order approximation, the model is solved at the accuracy that the Euler equation errors is below 0.01% even in extreme situations.

4.1 Benchmark Calibration

I start by explaining the estimation of benchmark parameters and calibration procedures.

4.1.1 Estimation of Stockholders' Labor Income Share

The income shares of stockholders are estimated from the Survey of Consumer Finance data (SCF) for the U.S. for the following years: 1989, 1995, 2001, 2007 and 2010. Stockholders are those who hold (1) stock mutual funds, (2) bond funds (excluding Treasury and Municipal bond funds), (3) Combination funds that hold both stocks and bonds, (4) All other funds (mutual funds, hedge funds, or Real Estate Investment Trusts (REITs)), (5) individual stocks. The composition of Individual Retirement Account (IRA) is not explicitly surveyed. The estimation results are reported in Table 4.

Due to the international setting of my analysis, I focus on the wealthy stockholders and stockholders who invest in international stock markets. The SCF data reveals that, they not only have higher labor income, but also hold the majority of the stock market. Also they hold more diversified portfolios: They are less likely to focus on the stocks of their own companies, and more likely to diversify their positions, hold mutual funds and international equity directly.

For the benchmark measure, I follow Vissing-Jorgensen (2002) to focus on the top one-third of stockholders by their stock wealth. Among the rest of the population, less than 1% directly holds the international stocks, while this fraction for the top one-third is more than 25%. The average corresponding labor income sharing over the sample is 48.05%. Alternatively, I consider the stockholders who directly hold international stocks. Their labor income share, 16.82%, is a lower bound of the stockholders' labor income share. I construct a third measure, where I calculate the labor income share of households that directly hold foreign stocks, or have mutual fund holdings (the mutual funds can be domestic focused, or internationally diversified). This fraction 54.28%, is an upper bound of the labor income share[16]. I adopt the average labor income share of the top one-third stockholders as the

[16] The 1989 survey does not identify whether stock holdings include foreign stocks, therefore, I do not

stockholders' labor income share, and conduct sensitivity analysis.

4.1.2 Parameter Calibration

The financial and labor income data are estimated from the seaonally-adjusted series in U.S. and U.K. quarterly national accounts data from 1980. From the asset pricing point of view, the income stream of agents investing in the firm is gross operating profit, minus investments (Santos and Veronesi (2006), and Coeurdacier and Gourinchas (2011)). I define the labor income as the total compensation for employees.

The financial and labor income shocks are extracted in the following equations (Coeurdacier and Gourinchas, 2011):

$$\begin{aligned} \log(\text{Financial Income}_t) &= c_1 + \phi_1 \log(\text{Financial Income}_{t-1}) + \varepsilon_{1,t} \\ \log(\text{Labor Income}_t) &= c_2 + \phi_2 \log(\text{Labor Income}_{t-1}) + \varepsilon_{2,t} \end{aligned}$$

I conduct the Johansen test for cointegration between labor income and capital income. No evidence for cointegration is identified. The unit root tests strongly reject that there is a unit root. Therefore, I consider an AR process as the appropriate specification.

Moments are reported in Table 5. The financial income shock is more than twice as volatile as the labor income shock (Figure 2). The labor income shocks comove strongly with the GDP shocks (extracted again from AR(1) processes), while the financial income shocks tend to be negative during positive labor income shocks. The correlation of financial ($\varepsilon_{1,i}$) and labor ($\varepsilon_{2,i}$) income shocks within each country is slightly negative (-0.14). The cross-country correlation in labor income shocks ε_2^h and ε_2^f is 0.3, which emphasizes cross-country spillover in labor productivity. The cross-country correlation between ε_1^h and ε_2^f is 0.28, slightly lower than the correlation in labor income shocks. Heathcote and Perri (2005) shows that, in the post-Bretton Woods era, the observed correlation of country real shocks is low, and the improved international risk sharing through financial markets further leads to a decrease in the correlation of dividend payouts.

report estimates for alternative measures.

Large amount of empirical evidence for preference heterogeneity is found in the empirical literature. For example, Barsky et al. (1997), Blundell, Browning, and Meghir (1994) identify that the top income population has higher EIS. Vissing-Jorgensen (2002) and Brav, Constantinides, and Geczy (2002) estimate that the stockholders' EIS is higher than that of the non-stockholders from their consumption-saving decisions. In particular, Barsky et al. (1997) find the average EIS of the population to be below 0.2, and Vissing-Jorgensen (2002) obtains estimates of the EIS that are greater than 0.3 for stockholders, while the estimates for remaining households are small and insignificantly different from zero. I set the non-stockholders' EIS to be 0.1, and that of stockholders to be 0.3, three times higher.

I set the risk aversion to be 5, and the discount factor to the standard value 0.985. Borrowing constraints are calibrated to one period of labor income to match the asset price moments, as well as the volatility of asset positions.

4.2 Calibration Results

Table 6 contains the the long-run distribution of the model and the moments of the benchmark calibration. I simulate the model for 10,000 periods, drop the first 500 periods, and compute the moments for the rest of the simulated data.[17] All data moments are the average of the estimates for for the U.S. and the U.K.. The correlation of the real per capital consumption growth rates is calculated for the U.S. and U.K. household level survey data. I use the 1-quarter consumption growth correlation as target moments, and calculate the counterparts in simulation. Notice that the correlation stabilizes over 8-quarter to 20-quarter horizons, and the relevant empirical patterns (*Fact 2.*) exist over different horizons.

The model quantitatively replicates patterns in *Fact 1* that international asset returns are highly correlated, while the correlation for the consumption growth is low. As the markets are fully integrated, the equity in each country is jointly priced by the pricing kernels of both stockholders. The cross-country correlation in equity returns is high, and reflects the high correlation in the stockholders discount rates, or their high level of consumption risk

[17] The model has non-degenerate wealth distribution in the long run, thanks to the borrowing constraints.

sharing.

The stockholders' consumption growth rates are indeed highly correlated across countries, although slightly higher than the data. In the integrated financial markets, stockholders share their consumption risk in three ways. First, they invest in the foreign stock market. Although the cross-country labor income growth correlation is low, the cross-country aggregate income growth correlation for the stockholders is significantly higher, through their cross-border equity holding. Notice that, since the within country labor and financial income shock correlation is more negative than the cross-country correlation, and the stockholders' portfolio shows home bias in equity positions. Following the convention, the home bias is defined as

$$\text{home bias} = 1 - \frac{\text{share of foreign asset in home portfolio}}{\text{share of foreign asset in world portfolio}} \tag{9}$$

Therefore, the implied equity home bias is 68%, close to 77%, the empirical average home bias for the U.S. and U.K.. Second, the stockholders actively rebalance the equity portfolios, which moves the equity prices and further their total wealth. Third, they also use a small amount of the bond margin.

The correlation of consumption between non-stockholders is significantly lower at 0.36, compared to 0.26 in the data. The cross-county country of non-stockholders' income growth is 0.3, lower than their consumption growth correlation. The non-stockholders borrow and save aggressively in bonds in order to smooth their consumption. Different from the closed economy models, the main lending and borrowing take place between home and foreign non-stockholders, since their incomes are as volatile, and their income correlation is low. The calibration shows that, the non-stockholders take the major part of the net bond positions. The volatility of the net bond positions is 3.21% in calibration, almost twice as high as 1.71% in the data, but still generates a low level of risk sharing, which shows that the bond isn't very efficient for risk sharing due to the precautionary saving motives. The model also successfully generates the high within country consumption growth correlation between the stockholders and the non-stockholders, and a mild correlation for home (foreign) stockholders and foreign (home) non-stockholders.

The model falls short in matching the macro quantities in a couple of ways: First, it fails in matching that the stockholders' consumption growth is much more volatile than the non-stockholders' consumption growth. In the model, although the financial income is more volatile than the labor income, a lot of the variations are country-specific and diversified away across countries through the equity market. This leads to relatively smooth consumption growth rates for the stockholders. Further, my models makes the simplifying assumption that all agents' labor income growths are perfectly correlated and as volatile. However, the household-level survey (Table 2) shows that the stockholders' wage income growths is about 1.5 times as volatile as that of the non-stockholders. Taking into account this difference would help generate more volatile consumption growth for stockholders than non-stockholders. Second, in the model the consumption growth correlations is always higher than that of the income growth correlations, so it cannot explain the puzzle that the aggregate consumption growth correlations is lower than that of the output growth rate correlations (Backus and Smith, 1993).

The model also matches the salient features of asset prices, which has been a challenge for the international finance literature. The model implied risk-free rate is low (0.55% vs. 1.62% in the data); and the equity risk premium is high (5.52% vs. 5.84% in the data). The risk-free rate is smooth, with a volatility of 1.36% (vs. 0.67% in the data), and the risk premium is reasonably volatile, with a volatility of 12.80% (vs. 17.84% in the data). The success comes from both the cash flow and the discount rate channels. From the cash flow perspective, I calibrate my income process to the data, where the financial income is much more volatile than the labor income. The sheer amount of risk embedded in the financial income makes the claim risky to begin with. Further, the risk sharing relation with respect to the aggregate shocks in this model further drives up the risk premium. When it is a bad time of the economy for non-stockholders in both countries, both non-stockholders would want to borrow to consume. The non-stockholders are less willing to substitute intertemporally, so their demand for bonds is relatively inelastic. The stockholders have higher EIS, and take the supply side of the bond positions and provide insurance to the non-stockholders, as in the closed economy. The willingness of the stockholders to provide insurance pushes down the return and volatility of the bond returns. However, the concentration of the aggregate risk on the stockholders induce them to demand a high equity risk premium. In fact, stockholders tend not to use the bond margin, except to provide risk sharing to the non-stockholders.

I highlight the channels that help generate the dichotomy in asset prices and consumption behaviors as well as the salient features of the asset prices further in the following sections.

4.2.1 The Role of Limited Stock Market Participation

Limited stock market participation is the key feature of the model and gives rise to key features of the data. I analyze an alternative scenario, where all agents in each country participate in the stock markets. In other words, there is one representative agent in each country. The preference parameters of representative agents are the same as the stockholders in the benchmark case, and results are reported in Table 7.

As is discussed in the previous text, the stockholders provide insurance to the non-stockholders. This concentration of the aggregate risk generates high equity premium. Absent the limited stock market participation, the aggregate risk is borne by the representative agents equally (or proportional to wealth). At the same time, during the bad times of the economies, both representative agents demand bond for consumption smoothing, however, nobody is more willing to supply the bonds. Therefore, the risk-free rate is significantly higher, and the equity risk premium collapses.

Moreover, the representative agent economy generates excessively high correlation in aggregate consumption growths across countries. In the benchmark case, the non-stockholders are restricted from the stock market, therefore the correlation of their consumption growths across countries is low, which further gives rise to the low correlation in the aggregate consumption growths. Therefore, the feature of the limited stock market participation is key to generate the low aggregate consumption growth correlation, despite the high return correlation.

4.2.2 The Role of Heterogeneous Preferences

Now I maintain the assumption of limited stock market participation, and examine the effects of heterogeneity in the EIS and risk aversion parameters on risk sharing and asset prices. Table 8 reports different experiments. First, I eliminate the preference heterogeneity by reducing the EIS of the stockholders to 0.1. Now the stockholders are as unwilling to substitute intertemporally as the non-stockholders, they adjust their portfolio positions more aggressively to smooth their consumption, and load on less aggregate labor income risks. As a result, the stockholders' consumption is smoother relative to the non-stockholders now, and the consumption growth correlation between the home and foreign stockholders jumps drastically. As the stockholders are now unwilling to insure the non-stockholders against aggregate shocks, the non-stockholders' consumption volatility increases, although they use their bond margins more aggressively also. The risk-free rate decreases due to less supply of the risk-free bond, and its volatility increases at the same time as the supply is more inelastic also. Balancing out the effects of EIS and the amount of consumption risk borne, The equity premium decreases slightly, while the equity return volatility blows up.

Second, I eliminate the preference heterogeneity by increasing the non-stockholders' EIS to 0.3 (second column). The consumption growth volatility of the non-stockholders increases, as they no longer have strong demand for consumption smoothing. They use the bond margin much less, which reduces the bond volatility. The stockholders also insure the non-stockholders less during bad times, and no longer require a high risk premium. Therefore, we see a sharp jump in the risk-free rate, and a collapse of the equity risk premium. Less constraint by the insurance provision to the non-stockholders, the stockholders share more consumption risks across countries, and their consumption growth correlation slightly increases.

To summarize, the results demonstrate that the heterogeneity in the EIS is important to match both the consumption correlation and the equity premium, which are the key statistics that the model seeks to explain. The low EIS of the non-stockholders plays an important role in generating the the low risk free rate and the high risk premium, while the relatively higher EIS of the stockholders is central to generate the relatively high (but not excessively high) consumption correlation between the stockholders, as well as the smooth risk free rate.

Last, I examine the effect of non-stockholder risk aversion by increasing it to 10, twice of the benchmark parameter 5. Comparing the "Alt RA" column to the "Benchmark" column shows that this change has a minor effect, similar to Guvenen (2009). The unconditional moments of risk premium barely change, as the supply and demand for consumption smoothing as well as assets are largely determined by their EIS, rather than their risk aversion.

4.2.3 The Role of Stock Market Participation Rates

In the benchmark calibration, the stockholders' labor income share is calibrated to be 48.05%. I conduct the robustness check of the stockholders' labor income share, or the stock market participation rate. Two alternative values are adopted: the lower bound of 16.82% (the fraction that hold foreign individual stocks directly), and the higher bound of 54.28% (the fraction that holds either foreign individual stocks or any mutual funds). Results are presented in Table 9.

As the stock market participation rate increases but the financial-labor income ratio is constant, the labor income constitutes a larger fraction of the stockholders' total income. Therefore, more home bias is needed in order to hedge the labor income risk embedded, which further leads to a decrease in the stockholders' cross-country consumption growth correlation. When the stock market participation rate is low, the stockholders can achieve almost perfect correlation in consumption growth with the foreign counterparts. With the increase of the stock market participation, a larger fraction of the economy provides insurance of the decreasing population of non-stockholders, so all agents' consumption growth volatility drops. The decrease in the demand for the consumption insurance and the increase in the supply are also reflected in the increase in the risk-free rate, and the slight decrease in the equity risk premium.

4.2.4 Implied Shadow Exchange Rate

Real exchange rates have played a central role in previous analysis of international risk sharing. In particular, Brandt, Cochrane, and Santa-Clara (2006) argues that the marginal utility growth must be volatile and highly correlated across countries to justify the high equity risk premium and the smoothness of the real exchange rate between countries. My model abstracts from the exchange rate channel to highlight the limited participation channel, by assuming that it is a one good economy. In this part, I calculate the shadow exchange rate implied by the stockholders.

I calculate the log shadow exchange rate in the limited participation framework as the cross-country difference of the log-stochastic discount factors[18].

$$\Delta e_{t+1} = m_{t+1}^{f} - m_{t+1}^{h} \tag{10}$$

where the pricing kernel composes of both the consumption growths and the return to wealth.

Different from Saito (1996) and Basak and Cuoco (1998), the stockholders have labor income flow also, the wealth portfolio composes of both the financial and human wealth. I back out the return to human wealth such that the agent willingly holds his own human wealth. The human wealth is larger than the financial wealth, and makes up 59% of the stockholders' total wealth. Further, as the market is incomplete, I follow Brandt, Cochrane, and Santa-Clara (2006) and project the pricing kernels onto the asset space composed of the global bond and both equities to obtain the unique m^* that is spanned by the tradeable asset space.

Results are reported in Table 10. The return to human wealth as well as the total wealth is highly volatile, and correlated across the countries; dominated by the discount rate effect. The pricing kernel m^* is therefore volatile and highly correlated. The implied exchange rate volatility is 15.22, which is higher than the volatility of the US-UK real exchange rates

[18]This equation only holds exactly under complete markets, as Backus, Foresi, and Telmer (2001) and Lustig and Verdelhan (2007) show that among others

(11.21), however, much lower than the huge volatility as is implied in Brandt, Cochrane, and Santa-Clara (2006).

5 Quantitative Analysis of Financial Integration

This section quantitatively evaluates the impact of the financial integration through the stock market integration. I examine the effects on consumption behaviors and asset returns. In particular, I try to examine the *Fact 3*: Stock market integration, together with the increase in cross-country asset positions accompanies the large increase in asset return correlations, with no obvious trend in aggregate consumption growth correlations;

5.1 Comparative Statics between Financial Integration and Segmentation

I consider a financially segmented economy (the bond economy), where the two economies have integrated bond but not stock markets.; and further compare it with the integrated economy (the benchmark model).

Parameters are the same as in the benchmark calibration. Moments for the bond economy are reported in Table 11. The equity return correlation collapses dramatically. As is shown in data, the dividend innovation correlation is low. In the segmented economy, there is no joint pricing kernels any more. That is, the equity is only priced by the own-country stockholders' pricing kernel, but not by that of the other country. Further, in the financially segmented economy, the cross-country correlation of consumption growths (and discount rates) is significantly lower in the segmented markets due to the poor risk sharing. The stockholders' consumption growth correlation sharply decreases, and is actually lower than that of the non-stockholders. The drop comes from two sources. On the one hand, home (foreign) stockholders are excluded from directly holding the foreign (home) equity, which leads to a decrease in the income correlation. On the other hand, the stockholders can no longer diversify risk with each other through equity portfolio rebalancing. It demonstrates that the high correlation of stockholders' consumption growth rates can only take place among financially integrated countries. As the stockholders only take up roughly half of the labor income, the aggregate consumption growth correlation drops, but not as much. To sum up, the financial integration can generate a sharp increase the equity return correlations, but only a mild increase in the aggregate consumption growth rate correlations (*Fact 3*).

Deprived of this one powerful instrument for consumption smoothing, the stockholders' consumption volatility sharply increases also. Moreover, the stockholders provide less insurance to all members of the economy. The consumption growth correlations among almost all pairs of agents drop at the same time.

Due to the strengthened precautionary saving motive and the increase in the amount of risk borne by the stockholders, the risk free rate slightly decreases, while the risk premium shoots up. There are two reasons. First, the stockholders suffer from the restriction on consumption risk sharing, therefore the discount rate effect pushes up the equity risk premium. Second, now the stockholders have to hold on to the risky cash flow, or the dividends from their own countries. Specifically there are two kinds of risks embedded: the undiversifiable global risk and the country-specific risk. In the integrated economy, the country-specific risk can be diversified away through holding a global portfolio. As this global diversification becomes impossible, the equity is now a much more risky claim. Consequently, the equity risk premium jumps upward. This is empirically consistent with the decline in the expected equity risk premium in the past three decades, as the financial globalization unfolded (see Fama and F. (2002), Stambaugh and Pastor (2001), etc).

5.2 Welfare Analysis

The financial integration changes the risk sharing landscape as well as the welfare of different agents. I calculate the expected utility for both types of agents in the pre- and post-financial integration steady states. Calculations find stark contrast between the groups: the expected utility of the non-stockholders does not move at all, up to the 4th digit approximation. However, the stockholders' welfare improves by 0.1% of permanent consumption. The number is larger than what is estimated for consumption risk sharing with power utilities, but still small in magnitudes, as the shocks is around the business cycle frequency.

When the stock markets open up, the stockholders bear much less consumption risk, as their consumption growth volatility decreases by 0.6%, while that of the non-stockholder barely moves. Moreover, stockholders share a significant amount of consumption risk with each other, evidenced by both the increase in their consumption growth correlation, and the decrease in the equity risk premium.

In sum, almost all the welfare gains of financial integration are captured by the stockholders, and the potential cost of a financial sanction would be borne all by the stockholders alone also.

5.3 Financial Integration and Equity Pricing

In this section, I compare asset returns in the segmented to integrated economy to examine the impact of financial integration on the equity pricing. The model is simulated for 10,000 periods, and 300 continuous periods are sampled (in order to match the small sample size in the actual data).

Hansen & Singleton (1983) show that, for the case of CRRA preference, the EIS can be calculated as

$$EIS = \frac{dE_t[\log(C_{t+1}/C_t)]}{dE_t[\log(1 + R_{i,t})]} \tag{11}$$

Attanasio and Weber (1989) give a similar derivation for the Epstein-Zin utility case, and conclude that it remains valid as an approximation, for more general cases. Therefore, I estimate the following equation:

$$\log(C_{t+1}/C_t) = \alpha_i + EIS \log(1 + R_{i,t}) + \varepsilon_{i,t} \tag{12}$$

Following the literature, I adopt two specifications: first, I run the simple linear regression; second, I use the lagged PD ratio as the instrument variable.[19] Results are presented in

[19] I do robustness check with further instruments variables in the model, such as the risk free rate. Results are similar, and omitted for brevity.

Table 12.

First, I examine the case of segmented stock markets is reported in Panel A. I focus on pricing the foreign stocks. For the foreign stockholders, the implied EIS is slightly higher than the true EIS in both specifications, and the R^2 in the OLS specification is close to 1. However, for the home investors, the EIS estimates are far from the true EIS, and not statistically significant in the IV specification. The corresponding R^2 is very low also, which comes from the cross-country consumption growth correlation for the stockholders. For the non-stockholders, the EIS estimates are again not stable, and not significant in some cases. The R^2 for the home non-stockholders is positive though low, which comes from the positive within country consumption growth correlation for the stockholders and non-stockholders.

The case of integrated stock markets (the benchmark case, Panel B). I again focus on using the foreign stock as the test asset. For the foreign stockholders, the implied EIS is around the true EIS 0.3 in both specifications, and the R^2 is high also. Results for the home stockholders are similar, although the R^2 is lower. The EIS estimates for non-stockholders are less stable and far from the true values. The results are consistent with the empirical literature that, financial integration leads to common pricing across countries (Bekaert and Harvey (1997), Henry (2000), etc).

6 Conclusion

In this paper, I show that taking into account the limited stock market participation can help explain a series of facts in international risk sharing and asset prices. Household-level survey data shows that the correlation of stockholders' consumption growth is significantly higher than that of the aggregate, and helps rationalize the high correlation in international stock markets despite the low correlation in the aggregate consumption (*International Equity Premium Puzzle*).

A quantitative incomplete market model featuring limited participation is able to account for the empirical facts above, as well as match the asset price, position and macro quantity moments. The model also generates the result that the stock market integration (measured by asset positions) accompanies increases in the asset return correlation, as I document in the data.

Several extensions to the current framework can be made. First, the model can be extended to allow for the different labor income processes for stockholders and non-stockholders. I estimate the processes using the household-level survey data, and find that, in particular, the stockholders' income growth is more volatile than the non-stockholders'. Second, the asymmetry in country sizes can be introduced. It would bring the model closer to the data, where the U.S. is a significantly bigger country than the U.K., to study the risk sharing properties and welfare implications in more generic cases.

The preliminary evidence discussed in the paper shows that the limited participation can also be a fruitful avenue to help us understand the many exchange rate puzzles. Currently, I am extending my work to incorporate exchange rate dynamics. This will allow me to study the volatility of exchange rates (Brandt, Cochrane, and Santa-Clara, 2006), the Backus-Smith puzzle (the low correlation between changes in the real exchange rate and aggregate consumption growth differentials) (Backus and Smith, 1993) and the uncovered interest rate parity deviations (the observation that high interest rate currencies tend to appreciate) (Hansen and Hodrick (1980) and Fama (1984), etc).

Also, I plan to endogenize the income processes in a production economy framework. My results in the endowment economy framework shows that the limited participation is able to explain the puzzling low correlation in the aggregate consumption. By introducing the production, I can further explore whether this channel can explain the consumption correlation puzzle (the observation that consumption is much less correlated across countries than output) (Backus and Smith, 1993).

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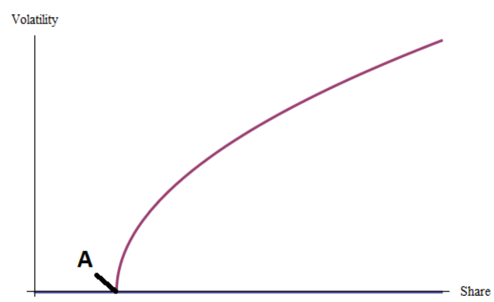
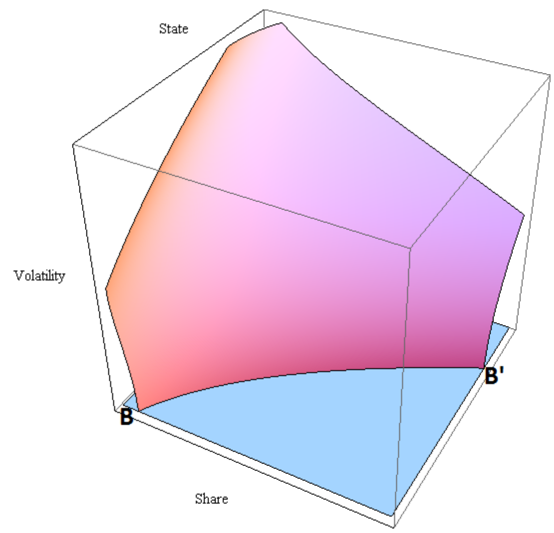
Tables and Figures

Figure 1: Illustration of Bifurcation Point and Boundary

In Figure a), the y-axis shows the volatility of shocks, and the x-axis shows the shares of the risky asset by the agent. In the deterministic economy, any point on the entire blue line is an optimal portfolio. In the stochastic economy, the blue line is the set of optimal portfolio positions. The point A is the bifurcation point.
In Figure b), the z-axis shows the volatility of shocks, the y-axis a state variable, and the x-axis shows the shares of the risky asset held by the agent. In the deterministic economy, any point on the blue surface is an optimal portfolio. In the stochastic economy, the red manifold are the optimal portfolio positions. The curve BB' is the bifurcation boundary.



a) The Bifurcation Point



b) The Bifurcation Boundary

Figure 2: Labor and Financial Income Innovations

This figure plots the GDP, labor and financial income innovations for the U.K. and the U.S.. The GDP and labor income innovations are on the left axis, and the financial income innovations are on the right axis. The data spans 1973Q1 to 2015Q1.

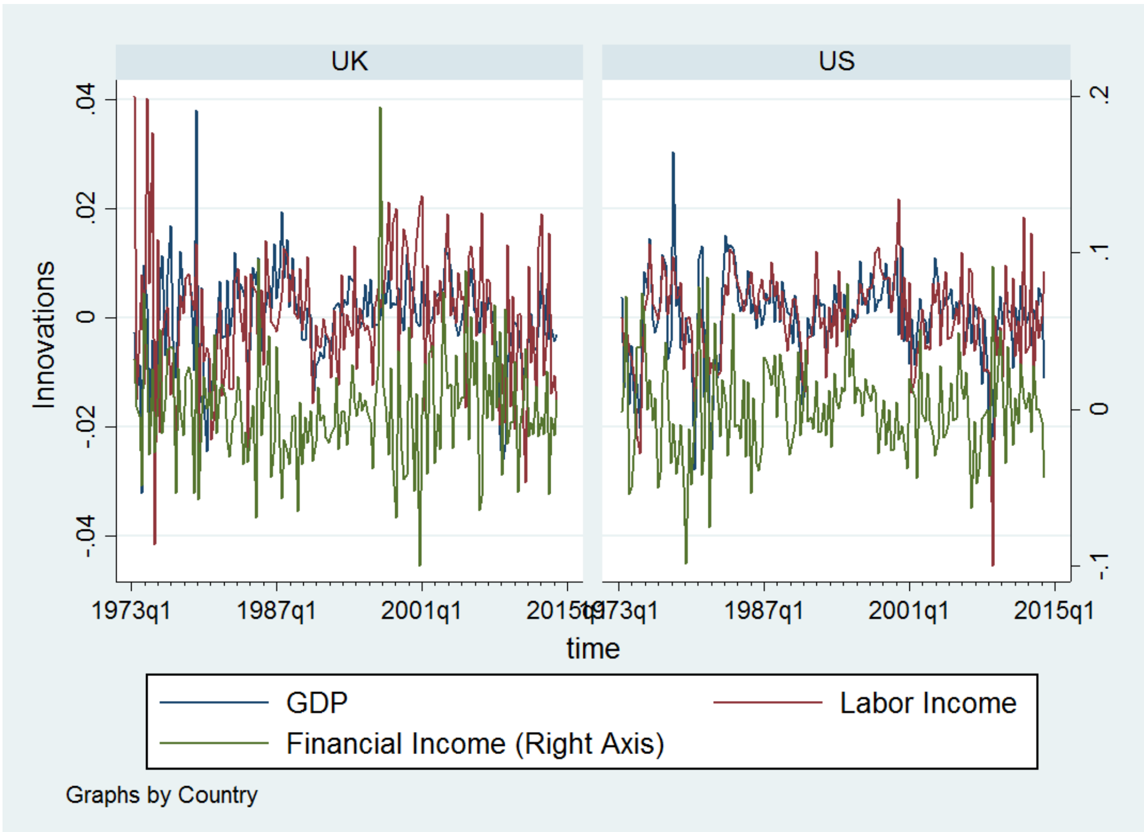


Table 1: Return and Fundamental Correlation with the U.S.

The table displays each country's correlation with the comparative variable of the U.S. The sample period is from Q1 1973 to Q4 2010. Gross financial income is defined as Gross operating profit minus Gross capital formation minus Tax.

	AUS	CAN	FRA	DEU	ITA	GBR
Equity Return	0.66	0.66	0.69	0.52	0.46	0.70
Gross Financial Income Growth	0.06	-0.02	-0.02	0.01	-0.06	0.14
Non-durable Consumption Growth	0.29	0.17	0.43	-0.16	-0.38	0.18

Table 2: Volatility of the Consumption Growth Rates

This table reports the annualized standard deviations of the per capita consumption growth rates per period for the aggregate, stockholders, and the non-stockholders in the United States and the United Kingdom. The aggregate data is drawn from the Quarterly National Accounts Data from 1959 to 2007. The survey data starts in Jan, 1988, and ends in Dec, 2007. Due to data availability, the U.S. total income data only spans 2004 to 2007. Results are in percentage points(%). All series are seasonally adjusted, and denominated in real U.S. dollars.

	U.S.	U.K.
Aggregate consumption	1.3	2.7
Stockholders' consumption	4.8	7.2
Non-stockholders' consumption	3.4	5.6
Stockholders' total income	5.0	22.0
Non-stockholders' total income	3.2	14.1
Stockholders' wage income	4.7	
Non-stockholders' wage income	3.2	

Table 3: U.S. and U.K. Consumption Growth Correlations

The table reports the consumption growth correlations for the aggregate (Agg, from quarterly NIPA Data), stockholders (S) and non-stockholders (N) in the United States and United Kingdom at 1, 4, 8, 12, 16 and 20 quarter horizons. The sample period spans Jan, 1988 to Dec, 2007. Panel A and B report consumption growth correlation at quarterly and monthly frequencies respectively. The last rows of corresponding panels report the difference between $corr(\Delta C^S_{US}, \Delta C^S_{UK})$ and $corr(\Delta C^N_{US}, \Delta C^N_{UK})$ (or $corr(\Delta C^{Agg}_{US}, \Delta C^{Agg}_{UK})$ where available), with bootstrapped standard errors. 1%, 5% and 10% significance are denoted by ***, **, and *.

Panel A: Quarterly Frequency Consumption Growths						
	1Q	4Q	8Q	12Q	16Q	20Q
Aggregate Correlations (NIPA data)						
$(\Delta C^{Agg}_{US}, \Delta C^{Agg}_{UK})$	0.09	0.25	0.28	0.33	0.40	0.50
Within Country Correlations						
$(\Delta C^S_{US}, \Delta C^{NS}_{US})$	0.53	0.42	0.38	0.42	0.41	0.39
$(\Delta C^S_{UK}, \Delta C^{NS}_{UK})$	0.23	0.30	0.60	0.56	0.61	0.66
Between Country Correlations						
$(\Delta C^S_{US}, \Delta C^S_{UK})$	0.40	0.46	0.55	0.59	0.62	0.62
$(\Delta C^{NS}_{US}, \Delta C^{NS}_{UK})$	0.20	0.22	0.29	0.37	0.40	0.48
$(\Delta C^S_{US}, \Delta C^{NS}_{UK})$	0.19	0.29	0.41	0.44	0.42	0.57
$(\Delta C^{NS}_{US}, \Delta C^S_{UK})$	0.29	0.27	0.33	0.33	0.34	0.36
(S, S) − (N, N)	0.19	0.24**	0.25**	0.22*	0.21*	0.14
	(0.14)	(0.12)	(0.10)	(0.12)	(0.13)	(0.14)
(S, S) − (Agg, Agg)	0.30**	0.21*	0.28**	0.27*	0.22	0.12
	(0.13)	(0.15)	(0.14)	(0.15)	(0.14)	(0.13)
Observations	79	78	77	76	74	73
Panel B: Monthly Frequency Consumption Growths						
Within Country Correlations						
$(\Delta C^S_{US}, \Delta C^{NS}_{US})$	0.05	0.42	0.40	0.43	0.41	0.36
$(\Delta C^S_{UK}, \Delta C^{NS}_{UK})$	0.35	0.24	0.46	0.52	0.56	0.57
Between Country Correlations						
$(\Delta C^S_{US}, \Delta C^S_{UK})$	0.28	0.43	0.52	0.56	0.60	0.56
$(\Delta C^{NS}_{US}, \Delta C^{NS}_{UK})$	0.23	0.23	0.27	0.37	0.39	0.47
$(\Delta C^S_{US}, \Delta C^{NS}_{UK})$	0.15	0.28	0.30	0.32	0.34	0.35
$(\Delta C^{NS}_{US}, \Delta C^S_{UK})$	0.13	0.24	0.38	0.42	0.40	0.39
$(S, S) - (N, N)$	0.04	0.20**	0.23***	0.18**	0.21***	0.08
	(0.09)	(0.08)	(0.07)	(0.08)	(0.09)	(0.08)
Observations	237	234	230	226	222	218

Table 4: Labor Income of Stockholders (%)

This table reports the wage income share for each group surveyed, drawing data from the Survey of Consumer Finance (SCF). Stockholders include holders of (1) stock mutual funds, (2) bond funds (excluding Treasury and Municipal bond funds), (3) combination funds that hold both stocks and bonds, (4) all other funds (mutual funds, hedge funds, or REITs (Real Estate Investment Trusts)), (5) individual stocks. Top 3rd stockholders identify stockholders whose stock positions are among the top third of the stockholders.

	1989	1995	2001	2007	2010	Average
All stockholders	66.29	73.18	79.93	79.53	69.94	
Top 3rd stockholders	39.98	54.60	54.70	55.74	41.24	48.05
Holders of foreign individual stocks		24.30	14.75	18.86	12.2	16.82
Holders of foreign individual stocks and all mutual funds		49.32	55.05	61.90	63.83	54.28
Ratio of labor income per household of the identified group to ...						
... non-stockholders						
Stockholders v.s. Non-stockholders	3.71	4.70	5.24	6.05	3.42	
... other stockholders						
Top 3rd stockholders	5.12	8.59	7.18	8.42	6.92	
Holders of foreign individual stocks		5.56	2.54	2.67	2.43	
Holders of foreign individual stocks and all mutual funds		3.19	3.04	4.61	8.14	

Table 5: Benchmark Calibration: Parameters

This table lists the parameters for the baseline calibrations. The upper panel is estimated from the U.S. and U.K. quarterly national accounts data.

Parameters	
Mean of Wage Share	$L_0 = \log 0.75$
Mean of Dividend Share	$D_0 = \log 0.25$
Persistence of Wage	$\rho = 0.99$
Persistence of Dividend	$\kappa = 0.91$
Vol of Wage Shock	$vol(z) = 1.2\%$
Vol of Dividend Shock	$vol(u) = 3.5\%$
Corr of Wage and Dividend Shock	$corr(u_i, z_i) = -0.24$
Cross Corr of Wage Shock	$corr(z_1, z_2) = 0.39$
Cross Corr of Dividend Shock	$corr(u_1, u_2) = 0.13$
Cross Corr of the Two Shocks	$corr(u_i, z_j) = -0.04$
Non-stockholder EIS	$\sigma_n = 0.1$
Stockholder EIS	$\sigma = 0.3$
Risk aversion	$\gamma_i = 5$
Discount factor	$\beta = 0.985$
Income Share of Stockholders	$\mu = 0.48$
Non-stockholder Borrowing Limit	$\underline{b_n} = -0.39$
Stockholder Borrowing Limit	$\underline{b_s} = -0.36$

Table 6: Benchmark Calibration Results

All data moments are annualized, and computed at quarterly frequency for the U.S. and the U.K.. The correlation of the per capital real consumption growth rates is calculated for the U.S. and U.K. household-level survey data. All results, except the correlations, are in percentage points (%).

Moments	Model	Data
Correlation(R_h^s, R_f^s)	0.75	0.78
Correlation($\Delta C_{h,12Q}^{agg}, \Delta C_{f,12Q}^{agg}$)	0.43	0.33
Correlation($\Delta C_{h,12Q}^{s}, \Delta C_{f,12Q}^{s}$)	0.58	0.59
Correlation($\Delta C_{h,12Q}^{n}, \Delta C_{f,12Q}^{n}$)	0.36	0.37
Correlation($\Delta C_{h,12Q}^{s}, \Delta C_{f,12Q}^{n}$)	0.10	0.38
Correlation($\Delta C_{h,12Q}^{s}, \Delta C_{h,12Q}^{n}$)	0.48	0.49
Mean of Risk-free Rate	0.52	1.62
Mean of Equity Risk Premium	5.52	5.84
Volatility of Risk-free Rate	1.36	0.67
Volatility of Stock Return	12.80	17.84
Vol($\Delta C_{i,agg}$)	2.16	2.00
Vol($\Delta C_{n,i}$)	2.53	3.40
Vol($\Delta C_{s,i}$)/Vol($\Delta C_{n,i}$)	1.02	1.41
Home Bias	68	77
Vol(Net Bond Position$_i$)	3.21	1.71
Vol(Net Equity Position$_i$)	1.68	2.97

Table 7: The Role of Limited Stock Market Participation

This table compares the case of a representative agent in each country to the benchmark case with the limited stock market participation. All calibration parameters are the same as in the benchmark case, and the EIS of the representative agent is the same (0.3) as that of the stockholders' in the benchmark calibration. All results, except the correlations, are in percentage points (%).

Moments	Rep Agent	Benchmark	Data
Correlation(R_h^s, R_f^s)	0.96	0.75	0.78
Correlation($\Delta C_{h,12Q}^{agg}, \Delta C_{f,12Q}^{agg}$)	0.96	0.43	0.33
Mean of Risk-free Rate	5.61	0.52	1.11
Mean of Equity Risk Premium	0.15	4.79	5.65
Volatility of Risk-free Rate	1.06	1.12	1.59
Volatility of Stock Return	5.37	12.80	17.24
Vol($\Delta C_{i,agg}$)	2.05	2.16	2.00
Home Bias	48	68	77
Vol(Net Bond Position$_i$)	0.01	3.21	1.71
Vol(Net Equity Position$_i$)	0.7	1.68	2.97

Table 8: The Role of Preference Heterogeneity

This table reports results for alternative preference parameters, compared to the benchmark calibration. All other calibration parameters are kept the same as the benchmark parameters, and the parameters modified are listed at the top panel. All results, except the correlations, are in percentage points (%).

Moments	Alt EIS. (0.1, 0.1)	Alt. EIS (0.3, 0.3)	Alt. RA γ=5	Benchmark (0.1, 0.3)	Data
Correlation(R^s_h, R^s_f)	0.43	0.75	0.75	0.75	0.78
Correlation($\Delta C^{agg}_{h,12Q}, \Delta C^{agg}_{f,12Q}$)	0.49	0.43	0.42	0.43	0.33
Correlation($\Delta C^{s}_{h,12Q}, \Delta C^{s}_{f,12Q}$)	0.70	0.60	0.58	0.58	0.59
Correlation($\Delta C^{n}_{h,12Q}, \Delta C^{n}_{f,12Q}$)	0.37	0.33	0.36	0.36	0.37
Correlation($\Delta C^{s}_{h,12Q}, \Delta C^{n}_{f,12Q}$)	0.11	0.09	0.10	0.10	0.38
Correlation($\Delta C^{s}_{h,12Q}, \Delta C^{n}_{h,12Q}$)	0.50	0.48	0.48	0.48	0.49
Mean of Risk-free Rate	0.37	5.66	0.56	0.52	1.62
Mean of Equity Risk Premium	4.92	0.38	5.52	5.52	5.5.84
Volatility of Risk-free Rate	1.87	0.94	1.36	1.36	0.67
Volatility of Stock Return	31.97	12.87	12.80	12.80	17.84
Vol($\Delta C_{i,agg}$)	2.14	2.17	2.16	2.16	2.00
Vol of $\Delta C_{n,i}$	2.51	2.59	2.53	2.53	3.40
Vol($\Delta C_{s,i}$)/Vol($\Delta C_{n,i}$)	0.98	0.95	1.02	1.02	1.41
Home Bias	68	68	68	68	77
Vol(Net Bond Position$_i$)	3.37	0.06	3.21	3.21	1.71
Vol(Net Equity Position$_i$)	3.62	0.14	1.68	1.68	2.97

Table 9: The Role of Stock Market Participation Rate

This table reports results for different stock market participation rates (μ). All other calibration parameters are the same as the benchmark parameters, and the modified values of μ are listed at the top panel. All results, except the correlations, are in percentage points (%).

μ_i	Lower bound	Higher bound	Benchmark	Data
	16.82	54.28	48.05	
Correlation(R_h^s, R_f^s)	0.98	0.65	0.75	0.78
Correlation($\Delta C_{h,12Q}^{agg}, \Delta C_{f,12Q}^{agg}$)	0.67	0.43	0.43	0.33
Correlation($\Delta C_{h,12Q}^{s}, \Delta C_{f,12Q}^{s}$)	0.97	0.52	0.58	0.59
Correlation($\Delta C_{h,12Q}^{n}, \Delta C_{f,12Q}^{n}$)	0.33	0.41	0.36	0.37
Correlation($\Delta C_{h,12Q}^{s}, \Delta C_{f,12Q}^{n}$)	-0.06	0.13	0.14	0.38
Correlation($\Delta C_{h,12Q}^{s}, \Delta C_{h,12Q}^{n}$)	0.33	0.42	0.48	0.49
Mean of Risk-free Rate	0.29	0.68	0.52	1.62
Mean of Equity Risk Premium	5.74	5.35	5.52	5.84
Volatility of Risk-free Rate	1.58	1.36	1.36	0.67
Volatility of Stock Return	16.47	12.58	12.80	17.84
Vol($\Delta C_{i,agg}$)	2.18	2.16	2.16	2.00
Vol($\Delta C_{n,i}$)	2.59	2.48	2.53	3.40
Vol($\Delta C_{s,i}$)/Vol($\Delta C_{n,i}$)	1.41	1.04	1.02	1.41
Home Bias	8	72	68	77
Vol(Net Bond Position$_i$)	0.06	9.73	3.21	1.71
Vol(ΔNet Equity Position$_i$)	3.48	0.08	1.68	2.97

Table 10: Implied Shadow Exchange Rates

This table reports the annualized moments of the return to wealth, and the implied exchange rates. All parameters are the benchmark parameters. All volatility moments are in percentage points (%).

	Model	Data
Volatility of Shadow FX Growth	15.22	11.21
Volatility of Stockholders' m^*	36.43	
Correlation of Stockholders' m^*	0.91	
Volatility of Stockholders' Total Wealth Return	36.90	
Correlation of Stockholders' Total Wealth Return	0.97	
Volatility of Stockholders' Human Wealth Return	42.63	
Correlation of Stockholders' Human Wealth Return	0.98	

Table 11: Stock Market Integration

This table compares the case of financial segmentation to integration. All parameters are the same across the two cases. In the financially segmented economy, the stock markets are closed to the foreign investors, while the bond market is open (or trade is allowed). The stock markets open to foreign investors in the financially integrated economy. All results, except the correlations, are in percentage points (%).

Moments	Segmented (Bond)	Integrated (Benchmark)	Data
Correlation(R_h^s, R_f^s)	0.13	0.75	0.78
Correlation($\Delta C_{h,12Q}^{agg}, \Delta C_{f,12Q}^{agg}$)	0.23	0.43	0.33
Correlation($\Delta C_{h,12Q}^{s}, \Delta C_{f,12Q}^{s}$)	0.15	0.58	0.59
Correlation($\Delta C_{h,12Q}^{n}, \Delta C_{f,12Q}^{n}$)	0.34	0.36	0.37
Correlation($\Delta C_{h,12Q}^{s}, \Delta C_{f,12Q}^{n}$)	0.11	0.10	0.38
Correlation($\Delta C_{h,12Q}^{n}, \Delta C_{h,12Q}^{s}$)	0.38	0.48	0.49
Mean of Risk-free Rate	0.09	0.52	1.62
Mean of Equity Risk Premium	6.35	5.52	5.84
Volatility of Risk-free Rate	1.26	1.36	0.67
Volatility of Stock Return	13.73	12.80	17.84
Vol($\Delta C_{i,agg}$)	2.89	2.16	2.00
Vol($\Delta C_{n,i}$)	2.55	2.53	3.40
Vol($\Delta C_{s,i}$)/Vol($\Delta C_{n,i}$)	1.25	1.02	1.41
Home Bias	100	68	77
Vol(Net Bond Position$_i$)	2.92	3.21	1.71
Vol(Net Equity Position$_i$)	0	1.68	2.97

Table 12: Pricing of Simulated Data

The test asset is the foreign equity. The test equation is as follows:

$$\log(C_{t+1}/C_t) = \alpha_i + \text{EIS}\log(1 + R_{i,t}) + \varepsilon_{i,t}$$

Panel A reports the results for the financially segmented case, and Panel B reports the financially integrated case. In each panel, the upper half presents the estimation results of the simple linear regression, and the lower panel uses the lagged PD ratio as the instrument variable. Hodrick (1992) standard errors are presented in brackets.

	Panel A: Financial Segmentation			
	Stockholder^F	Stockholder^H	Non-stockholder^F	Non-stockholder^H
	OLS Regression			
EIS	0.35	0.11	0.02	0.23
	(0.01)	(0.02)	(0.02)	(0.02)
Adj R^2	0.92	0.08	0.00	0.07
	IV Regression			
EIS	0.31	0.05	2.5	2.66
	(0.01)	(0.03)	(0.21)	(0.17)
	First stage $R^2_{PDratio} = 0.07$			

	Panel B: Financial Integration			
	Stockholder^F	Stockholder^H	Non-stockholder^F	Non-stockholder^H
	OLS Regression			
EIS	0.31	0.24	-0.11	0.08
	(0.01)	(0.01)	(0.03)	(0.02)
Adj R^2	0.88	0.50	0.02	0.01
	IV Regression			
EIS	0.29	0.24	2.75	2.92
	(0.01)	(0.03)	(0.34)	(0.33)
	First stage $R^2_{PDratio} = 0.03$			