Country Size, Currency Unions, and International Asset Returns*

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Abstract

The fact that economies differ in size has important implications for international asset returns. I solve for the spread on international bonds and stocks in an endowment economy with complete asset markets and non-traded goods. The model predicts that larger countries have lower real interest rates because their bonds provide insurance against shocks that affect a larger fraction of the world economy. Larger countries' bonds must therefore pay lower excess returns in equilibrium and uncovered interest parity fails. By a similar logic, stocks in the non-traded sector of larger countries also tend to pay lower excess returns. If asset markets are segmented, the introduction of a currency union lowers real interest rates and expected returns on stocks in the non-traded sector of participating countries. I test the predictions of the model for a panel of OECD countries and show that they are strongly supported by the data: Investors earn lower excess returns on bonds and stocks in the non-traded sector of larger countries. Similarly, excess returns on EMU member countries' bonds and stocks in the non-traded sector fell after European monetary integration.

JEL Classification: F3, G0

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1 Introduction

The traditional approach to theoretical and empirical work in international finance is to abstract from the fact that countries and currency areas differ in size. The objective of this paper is to show that this very basic asymmetry has profound implications for international asset returns and that acknowledging it may help us explain some puzzling features of the data.

A number of recent empirical findings suggest that bonds denominated in the world's largest currencies may have good hedging properties. For example, Campbell, de Medeiros, and Viceira (2007) find that the Euro and the Dollar are better hedges against the risk faced by a global equity investor than other currencies. Similarly, Lustig and Verdelhan (2007) suggest that portfolios of bonds denominated in low interest-rate currencies tend to be good hedges against US consumption risk; and an analysis of the currencies that make up the low interest-rate portfolios in their paper shows that these tend to be issued by economically large countries.[1] Moreover, there is an emerging literature on international return differentials, which was in part sparked by a finding in Gourinchas and Rey (2007) that foreign investors seem to be earning surprisingly low returns on US bonds.

As a first pass at the data, I regress the quarterly interest rate differential of 27 OECD countries to the United States, 1980-2007, on a set of time fixed effects and the share that each of these countries contributes to total OECD output.

Regression	β	*Std. err.*	R^2
$r_t^i - r_t^{US} = \delta_t + \beta\theta_{it} + \varepsilon_{it}$	-.227	.065	0.28
$r_t^i - r_t^{US} = \delta_t + \beta\theta_{it} + X_{it}\gamma + \varepsilon_{it}$	-.190	.062	0.39
$r_t^i + \Delta\tilde{s}_{t+1}^{i,US} - r_t^{US} = \delta_t + \beta\theta_{it} + X_{it}\varsigma + \varepsilon_{it}$	-.228	.075	0.67

r_t^i is the annualized interest rate on 5-year government bonds of country i at time t. $\Delta\tilde{s}_{t+1}^{i,US}$ is the change in the nominal exchange rate with the US Dollar, δ_t is a complete set of time fixed effects, θ is a country's share in total OECD output, and X_{it} is a vector of controls. The number of observations is 1365. See section 5.1 for detials.

There is a strong negative correlation between this simple measure of country size and interest rates. The coefficient of -.227 suggests that a country that contributes 10% of OECD output (such as Germany) on average tends to have a 2.27 percentage points lower interest rate differential to the US than a country that contributes only a negligible share of OECD output. This negative correlation is statistically significant at the 1% level, where the standard errors are clustered by country. The coefficient changes only slightly, to -.190 when I control for

[1] I would like to thank the Hanno Lustig and Adrien Verdelhan for sharing details of the composition of the portfolios in their paper with me. These portfolios are numbered from 1 to 8, where portfolio number 1 contains the currencies with the lowest interest rate at any given time. Using only the OECD countries in their sample, I regress the number of the portfolio in every year, 1980-2002, on countries' share in OECD GDP and a constant term. The resulting coefficient is -16.08 with a standard error (clustered by year) of .815.

the country's credit rating; the variance of its nominal exchange rate to the US Dollar; and the liquidity of its currency as measured by the bid-ask spread. Moreover, this pattern in interest rate differentials maps directly into a significant departure from uncovered interest parity, where US investors earn significantly lower excess returns on bonds of larger countries than they do on bonds of smaller countries.

Motivated by these features of the data the paper first addresses the implications of differences in country size within the standard complete-markets international asset pricing model, showing that even in this simple model larger countries' bonds are better hedges against consumption risk and thus pay lower expected returns in equilibrium. I then depart from market completeness, discuss the relevance of the size of currency areas for international asset returns, and show that the introduction of a currency union lowers risk-free and nominal interest rates within the participating countries.

Real Model In the baseline model, asset markets are complete and households in each country receive stochastic endowments of both a traded and a non-traded consumption good. Assets in this economy are priced with a unique stochastic discount factor, which is the ratio of marginal utilities from traded goods. This marginal utility responds to all of the endowments received in the different countries: It rises when the world endowment of tradables is low; and if households are sufficiently risk-averse, it also rises if the average endowment of non-tradables is low.

The important observation that underlies all the results in this model is that a given percentage change in the endowment of a large country must have a relatively larger impact on this marginal utility than the same change in the endowment of a smaller country: Bad times in a large country are more likely bad times for the world investor than bad times in a small country.

While the stochastic discount factor rises proportionately more in states of the world in which a larger country has a low endowment of non-tradables, the relative price of non-tradables rises whenever the domestic supply of non-tradables is low, without regard to the size of the country. When this happens, the domestic consumption bundle appreciates as it becomes more expensive relative to foreign consumption bundles. It immediately follows that larger countries' currencies tend to appreciate whenever marginal utility from tradables is high, i.e. when times are bad. Larger countries' bonds are therefore better hedges against consumption risk, and they must thus pay lower expected returns in equilibrium. This implies that large economies should have lower risk-free interest rates than small economies, and that uncovered interest parity fails unless all countries are of the same size. Another way of stating the intuition for this result is that bonds provide insurance, and insuring against shocks that affect a large fraction of the world economy must be more expensive than insuring against shocks that affect only a small fraction of the world economy. Larger countries' bonds must thus pay lower returns in equilibrium.

After deriving this central result of the paper I turn to solving for the difference in equilibrium returns between international stocks. Interestingly, the model predicts that stocks in the non-traded sector of larger countries (or equivalently consumption claims on non-traded goods of larger countries) also tend to pay lower expected returns for a large range of parameters. While this result is slightly weaker than that derived for bonds, it relies on a very similar logic: If the relative price of non-tradables is sufficiently elastic with respect to changes in the endowment of non-tradables, the tradable value of dividends rises whenever the non-tradable endowment is low. Since a low endowment of non-tradables in a large country raises the stochastic discount factor proportionately more than a low endowment in a smaller country, stocks in the non-traded sector of larger countries are better hedges against consumption risk than those of smaller countries.

Monetary Extension The standard international asset pricing model with complete markets thus delivers rich predictions for a link between country size and international asset returns. However, it allows no role for monetary shocks to influence the equilibrium allocation, which makes the question of which currency is used in which part of the world almost meaningless. I therefore proceed to relax the complete-markets assumption in order to explore the link between the size of currency areas and asset returns.

Specifically, I follow Alvarez, Atkeson, and Kehoe (2002) in assuming that a subset of households in each country ("inactive" households) are precluded from accessing the complete asset markets; and that all households have a cash in advance constraint, i.e. they require currency in order to settle their transactions. Inactive households must therefore rely on the nominal money balances carried over from the previous period when purchasing consumption goods. When inflation rises, they have fewer real balances available and must therefore consume less. They thus pay an inflation tax.

Since inflation has no bearing on the real endowments available in the economy, this inflation tax must in equilibrium go to the benefit of their "active" counterparts who consume proportionately more whenever inflation is high. This has two important consequences: First, assets are now priced with the marginal utility of active households. This marginal utility falls whenever inflation is high, because inflation shifts consumption from inactive to active households. Moreover, marginal utility falls proportionately more in response to inflationary shocks that hit larger currency areas. Second, international risk-sharing among active households requires that some of the additional tradables that become available in response to a rise in inflation are shipped to active households in other countries, while the additional non-tradables must remain in the country. This implies that the domestic relative price of non-tradables falls whenever inflation is high, and the domestic currency depreciates in both real and nominal terms. Large currencies thus tend to depreciate when marginal utility is low and appreciate when marginal utility is high. Again, bonds denominated in large currencies are thus good hedges against consumption risk. More broadly, I show that the monetary model reinforces the conclusions of the real model, albeit without placing any restrictions on the parameter space.

As a corollary to this result, I show that the introduction of a currency union between two countries lowers risk-free and nominal interest rates, as well as expected returns on stocks in the non-traded sector within the participating countries.

Empirical Evidence The theoretical part of the paper thus yields four testable predictions: (1) bonds issued in the currencies of larger countries should pay lower expected returns; (2) the introduction of a currency union should lower expected returns on bonds within the union; (3) stocks in the non-traded sector of larger countries should pay lower expected returns than those of smaller countries; and (4) the introduction of a currency union should lower expected returns on stocks in the non-traded sector of participating countries.

I proceed to test these four predictions using a quarterly panel dataset of OECD countries 1980-2007, using countries' share in OECD GDP as a proxy for their economic size. I first document that US investors indeed earn systematically lower excess returns when investing in bonds of larger countries. This systematic deviation from uncovered interest parity is driven by a persistent interest rate differential between larger and smaller countries and cannot be explained by likely alternate channels, such as default risk premia; liquidity premia; or the variance of the bilateral exchange rate. Moreover, I document this effect for the entire yield curve, ranging from 3-month interbank lending to 5-year government bonds. The estimation is robust to dropping different countries and groups of countries from the sample and using different estimation techniques. I then show that excess returns to US investors from investing in bonds of EMU member countries fell by an average of 1.5 percentage points after European monetary integration. This drop cannot be explained by improvements in credit default risk or liquidity due to the accession to the Euro.

I then construct portfolios of industry return indices that proxy for returns in the traded and the non-traded sector of the countries in my sample and document that US investors earn systematically lower excess returns in the non-traded sector of larger countries. Moreover, the data show that returns on stocks in the non-traded sector of EMU member countries fell after European monetary integration.

Related Literature To my knowledge, this paper is the first to address the relevance of asymmetries in country size within the standard international asset pricing model and to systematically document the empirical relationship between country size and international returns on stocks and bonds.

On the theoretical side, the most closely related papers are those of Cochrane, Longstaff, and Santa-Clara (2008) and Martin (2007) who solve models in which representative agents consume stochastic endowments from Lucas trees that vary in size. The main difference to their work is that I consider the asset pricing implications of movements in exchange rates by introducing country-specific non-tradable consumption goods.

In spirit, the model in this paper is close to the work by Martin and Rey (2004). In their model, international asset markets are segmented through a financial transaction cost. They show that under certain conditions stocks issued in larger countries pay lower expected returns due to a financial "home-market effect".

This paper continues a long tradition of pricing international assets with non-traded goods and complete markets. This literature goes back to Lucas (1982); Stulz (1987); and Stockman and Dellas (1989). Some more recent examples are Tesar (1993); Stockman and Tesar (1995); Baxter, Jerman, and King (1998); and Collard et al. (2007). The monetary extension of the model borrows heavily from a more recent literature that introduces market segmentation into the traditional complete-markets setup: Alvarez, Atkeson, and Kehoe (2002, 2008) and Lahiri, Singh, and Vegh (2007).

The paper also relates to an emerging empirical literature focusing on the US current account deficit and the role of international return differentials in stabilizing it: Gourinchas and Rey (2005); Hausmann and Sturzenegger (2007); Bosworth, Collins, and Chodorow-Reich (2007); and Curcuru, Dvorak, and Warnock (2007). However, the focus of this literature is mainly on the empirical characteristics of US investors' portfolios, whereas the present paper is concerned with international return differentials on specific assets. Related theoretical works on international return differentials are Caballero, Farhi, and Gourinchas (2006) and Mendoza, Quadrini, and Rios-Rull (2007).

Since the model in this paper predicts large and persistent deviations from uncovered interest parity, it also relates to a large literature on the forward premium puzzle, and especially to the work by Lustig and Verdelhan (2007) and Burnside (2007).

Although I do not perform explicit welfare calculations in this paper, the prediction that the creation of a currency union leads to a fall in real interest rates within the participating countries has some bearing on the literature on optimal currency areas. Recent references in this area are Frankel and Rose (2002); Alesina and Barro (2002); Alesina, Barro, and Tenreyro (2002); and Barro and Tenreyro (2007).

The remainder of this paper is organized as follows: Section 2 derives spreads on international stocks and bonds within the standard complete-markets model; section 3 extends the model and discusses the relevance of monetary shocks and currency areas. Section 4 introduces the dataset; section 5 tests the four central predictions of the model; and section 6 concludes.

2 Complete Markets Model

In this section I set up a standard Lucas-tree endowment economy with complete asset markets. Households consume a bundle of a freely traded good and a country-specific non-traded good. The non-traded component in consumption allows the consumption price index to differ across countries; and the real exchange rate between any two countries is the ratio of their consumption price indices. The only respect in which I depart from standard formulations of this type of international asset pricing models is that I allow for countries to differ in the size of their economies.

I assume that each household receives an endowment of a specific variety of a tradable intermediate input and of the country-specific non-traded consumption good. The traded consumption good is produced from the intermediate inputs using a CES technology. Varieties of the intermediate are thus specific to individuals and not countries such that each individual variety is in the same supply in expectation.[2] The role of the tradable intermediates is thus to preserve symmetry in all but the economic size of countries in an environment which allows for arbitrary elasticities of substitution between tradables of different countries.

In order to provide closed-form solutions; I furthermore assume that households receive transfer payments before trading in complete asset markets commences such that the initial distribution of wealth exactly decentralizes a Social Planner's problem with unit Pareto weights. In the main part of the paper I therefore do not consider the effects that asymmetries in country size may have on the distribution of initial wealth across countries.[3] Moreover, I log-linearize the model. Appendix H gives a numerical solution of the model and demonstrates that neither of these two simplifications matter for the results in any meaningful way.

2.1 Economic Environment

The model economy exists at two discrete periods of time $t = 1, 2$. It is populated with a set of identical households on the interval $[0, 1]$. The set of households is partitioned in N subsets Θ^n of measure θ^n, $n = 1, ..., N$. Each subset represents the constituent households of a country n.

At the beginning of the second period, households receive a stochastic endowment of their unique variety of the tradable intermediate and a stochastic endowment of the country-specific non-traded good. Shocks to endowments are common within each country such that all households living in a country n receive the same amount, Y^n_{T2}, of their respective traded intermediate variety and the same amount, Y^n_{N2}, of their country-specific non-traded good. The vector of world endowments is log-normally distributed with

$$[y_{T,2}, y_{N,2}]' \sim N(\eta, \Omega), \tag{1}$$

where y_T and y_N are the vectors of country traded and non-traded endowments respectively, $\eta = -\frac{1}{2} diag(\Omega)$, and Ω is the variance-covariance matrix of endowments. Throughout the paper, lowercase variables stand for logs and uppercase variables stand for levels. In the main part of the paper, I assume that endowments are uncorrelated internationally and between

[2] The alternative would be to specify that varieties are specific to countries, but then varieties originating in large countries would systematically trade at a lower price than more scarce varieties originating in smaller countries.

[3] Since the asymmetry between countries has direct implications for asset returns and therefore households' wealth, the Social Planner's problem with unit Pareto-weights does not correspond to the competitive equilibrium in which each household owns its own endowments.

tradables and non-tradables, but allow for the variance of endowments to differ between countries.[4] In order to simplify notation, call ω the configuration of second period endowments and let $g(\omega)$ be the associated density. The endowments in the first-period are not stochastic and households receive exactly one unit of both their intermediate variety and of the non-traded consumption good. Furthermore, endowments cannot be stored but must be consumed in the period in which they were received. International trade in both tradable intermediates and the traded consumption good is costless. Throughout the paper I use the traded consumption good as the numéraire.

Households exhibit constant relative risk aversion according to

$$U(i) = \frac{1}{1-\gamma} C_1(i)^{1-\gamma} + e^{-\delta} \frac{1}{1-\gamma} E\left[C_2(i)^{1-\gamma}\right], \tag{2}$$

where E is the rational expectations operator conditional on all information available in period 1, δ is the time preference rate, and $C_t(i)$ is a consumption index for household i at time t. I assume that households are risk-averse with $\gamma > 0$. The consumption index is defined as

$$C_t(i) = \left[\tau C_{T,t}(i)^{\alpha} + (1-\tau) C_{N,t}(i)^{\alpha}\right]^{\frac{1}{\alpha}}, \ \alpha < 1, \tag{3}$$

where C_N is consumption of the country-specific non-traded good, C_T stands for consumption of the traded good, and $\tau \in (0,1)$ is the weight of the traded good in the consumption index. The elasticity of substitution between traded and the non-traded good is $\varepsilon_\alpha = (1-\alpha)^{-1}$, and the consumption-based price index for country n is therefore

$$P_t^n = \left(\tau^{\varepsilon_\alpha} + (1-\tau)^{\varepsilon_\alpha} \left(P_{N,t}^n\right)^{1-\varepsilon_\alpha}\right)^{\frac{1}{1-\varepsilon_\alpha}}, \tag{4}$$

where P_N^n is the (relative) price of the non-traded good in country n at time t.[5]

A **representative firm** has access to a technology which transforms the tradable intermediates into the traded consumption good according to

$$\bar{Y}_T = \left[\int_0^1 I_T(j)^{\xi} dj\right]^{\frac{1}{\xi}}, \ \xi \leq 1, \tag{5}$$

where $I_T(j)$ stands for the input of tradable intermediate $j \in [0,1]$ and $\bar{Y}_T$ denotes world output of the traded good.[6] The elasticity of substitution between any two tradable intermediates is $\varepsilon_\xi = (1-\xi)^{-1}$. The representative firm takes prices as given and chooses quantities of inputs $\{I_T(j)\}_j$ to maximize profits.

[4] I return to this issue in section 3.5.

[5] Ideal real price indices are obtained by minimizing the expenditure required to obtain one unit of C.

[6] This representative firm is introduced mainly for notational convenience. Alternatively, one might interpret equation (5) as a definition of a country-specific tradable consumption index. See Grossman and Helpman (1991) for a discussion of these alternative interpretations.

2.2 Market structure and equilibrium

At the beginning of the first period, households may trade a complete set of state-contingent securities. Before trading commences, individuals receive a country-specific transfer that decentralizes the Social Planner's allocation with unit Pareto weights.

Households take prices as given and maximize their lifetime utility (2) subject to their intertemporal budget constraint

$$C_{T1}(i) + P_{N1}C_{N1}(i) + \int_{\omega} Q(\omega)\left(C_{T2}(\omega,i) + P_{N2}(\omega)\, C_{N2}(\omega,i)\right) d\omega = W_1(i), \tag{6}$$

where $Q(\omega)$ is the first period price of a state-contingent security that pays one unit of the traded good if state ω occurs in the second period. P_N and P_T denote the spot prices of the non-tradable and traded good respectively, and $W_1(i)$ stands for the net present value of household i's endowments, net of the country-specific transfer.[7]

The economy is at an equilibrium when all economic actors behave according to their optimal program and goods markets clear. The market clearing conditions for intermediate inputs are

$$I_T(j) = Y_T^n \quad \forall j \in \Theta^n,\ n = 1, ...N; \tag{7}$$

the international market for the traded consumption good clears if world production equals world demand

$$\bar{Y}_T = \int_{i\in[0,1]} C_T(i)\, di; \tag{8}$$

and the market for non-tradables must clear in each country according to

$$\int_{i\in\Theta^n} Y_N^n di = \int_{i\in\Theta^n} C_N(i)\, di,\ n = 1, ...N. \tag{9}$$

2.3 Optimal Behavior and International Spreads

Households' optimal behavior is characterized by the Euler equation

$$Q(\omega) = e^{-\delta}\frac{\Lambda_{T2}(\omega)}{\Lambda_{T1}} g(\omega) \quad \forall \omega, \tag{10}$$

where $\Lambda_{T,t} = C_t(i)^{1-\gamma-\alpha}\, C_{T,t}(i)^{\alpha-1}$ is the marginal utility from tradable consumption at time t. This expression reflects the standard result that the price of a state-contingent security that pays off in state ω equals a stochastic discount factor weighted by the probability that state ω occurs. However, it also gives two important insights: First, this stochastic discount factor consists only of the ratio of marginal utilities from *tradable* consumption in the two

[7] Formally, $W_1(i) = Y_{T1}^n + P_{N1}^n Y_{N1}^n + \int_{\omega} Q(\omega)\left(Y_{T2}^n(\omega) + P_{N2}^n(i,\omega)\, Y_{N2}^n(\omega)\right) d\omega + \kappa^n$, where κ^n is the country specific transfer in period one and $\sum_{n=1}^{N} \theta^n \kappa^n = 0$.

periods. This is a direct consequence of the fact that all international assets must ultimately be settled in terms of tradable output. Households thus value assets that have a high payoff when marginal utility from tradables is high; and non-tradable consumption impacts asset prices only through its effect on the marginal utility from tradable consumption. Second, since all households in the world face the same prices, $Q(\omega)$, the equilibrium stochastic discount factor must be identical for all households. We thus obtain a unique stochastic discount factor despite the presence of non-traded goods.

It follows that all the information needed to price any asset in this economy is contained in Λ_T. Based on this result, we can make a general statement about the spread on any two international assets:[8]

Lemma 1 *The difference in log expected returns between two arbitrary assets with log-normally distributed payouts X and Z equals the difference in covariances of their log payouts with the the log of the marginal utility of tradable consumption.*

$$\log ER_X - \log ER_Z \approx cov\left(\lambda_{T2}, z\right) - cov\left(\lambda_{T2}, x\right), \tag{11}$$

where $R_{X,Z}$ refers to the return of assets X, Z in terms of traded goods, and a first-order approximation of λ_{T2} is normally distributed.

Proof. See appendix A. ■

This lemma follows directly from the observation that households prefer assets that pay off high whenever additional traded goods are sorely needed (marginal utility from tradables consumption is high). Moreover, since λ_{T1} is known at the time when assets are traded it does not enter into the covariance terms and is irrelevant for the spread between assets. Whichever asset has the higher covariance with the marginal utility of tradable consumption must therefore pay a lower return in equilibrium.

Although I use the traded good as numéraire throughout the paper and calculate returns in these terms, it is worth noting that the left hand side of (11) is the log of a ratio of two returns and therefore has no units. The results on international spreads which I derive in this paper are thus invariant to the numéraire chosen.

2.4 Allocation

The key to understanding international return differentials in this model is to understand the stochastic properties of λ_T. As asset markets are complete in this economy, we can obtain the equilibrium allocation and thereby a solution for λ_T by solving the Social Planner's problem.

[8] In the following, I refer to difference in log expected returns somewhat loosely as the "spread" between the assets with payoff X and Y.

Given that endowments cannot be carried over from the first period to the second, the Social Planner's problem is the same in each period and invariant to the state of the world. I therefore concentrate on the second period and omit the time subscript from here on. We can further simplify the problem by showing the following lemma:

Lemma 2 *All individuals within a given country n consume the same bundle $\left(C_{T2}^{n}(\omega), C_{N2}^{n}(\omega)\right)$ in the second period.*

Proof. Since endowments are country-specific and the representative firm is a price-taker, all intermediate varieties originating within one country fetch the same real price on the world market, $P_T(j) = P_T^n \quad \forall j \in \Theta^n$. Therefore, all residents of any given country receive the same revenue and thus face identical budget constraints. See appendix B for a formal proof. ■

The Social Planner's problem can therefore be written as

$$\max \sum_{n=1}^{N} \theta^n \frac{1}{1-\gamma} \left[\tau \left(C_T^n\right)^{\alpha} + (1-\tau)\left(C_N^n\right)^{\alpha}\right]^{\frac{1-\gamma}{\alpha}} \tag{12}$$

subject to the economy's resource constraints (7), (8), and (9). Because this problem has no known explicit analytical solution, I log-linearize the first-order conditions and resource constraints around the point at which $[y_T, y_N]' = 0$ in order to provide closed-form solutions.[9]

We can gain intuition for how households share risk in this economy by looking at equilibrium consumption. Equation (13) shows the equilibrium consumption of the traded good in an arbitrary country h, which we may think of as the home country (recall that lowercase variables indicate logs):

$$c_T^h = \bar{y}_T + \frac{\left(\gamma - \varepsilon_{\alpha}^{-1}\right)(1-\tau)}{\varepsilon_{\alpha}^{-1}(1-\tau) + \tau\gamma} \left(\bar{y}_N - y_N^h\right), \tag{13}$$

where $\bar{y}_N = \sum_{n=1}^{N} \theta^n y_N^n$ is the average of log endowments of non-tradables across countries, and $\bar{y}_T$ is the log world supply of tradables in equilibrium. As one may expect, home consumption of the traded good moves one for one with the world supply. Since tradables can be freely shipped around the globe, it does not matter which country has a better or worse endowment of intermediate inputs, as long as $\bar{y}_T$ is constant. Households thus perfectly share risk when it comes to tradable endowments. However, the second term of (13) shows that they also use the traded good in order to insure against risk in their non-tradable endowments: If the home country's non-tradable endowment is either higher or lower than the world average, its tradable consumption adjusts. The adjustment is positive if the following condition holds:

Condition 1 *Households are sufficiently risk-averse such that $\gamma\varepsilon_{\alpha} > 1$.*

[9] Appendix C gives details on the optimization and appendix E.2 gives the log-linearized system of equations.

This condition ensures that agents are sufficiently risk-averse such that the cross-partial of marginal utility from tradable consumption with respect to the non-traded good is negative. Loosely speaking, it means that relative risk aversion cannot be so low as to be "undone" by a low elasticity of substitution between tradable and non-tradable consumption.[10] As most empirical applications of consumption-based asset pricing models find a relative risk aversion significantly larger than one, I follow the literature in assuming that this condition is met, but refer to it whenever it is relevant (see Coeurdacier (2006) for a detailed discussion). If relative risk aversion is sufficiently high, households in the home country thus receive additional tradables whenever they have a lower than average endowment of non-tradables. Although non-tradables cannot be shipped and residents of each country are bound to consuming their respective endowments, they purchase insurance in world markets in the form of compensating deliveries of tradable output.

This risk-sharing behavior is reflected in the equilibrium marginal utility from tradable consumption,

$$\lambda_T = -((1-\tau)\varepsilon_\alpha^{-1} + \tau\gamma)\sum_{n=1}^{N}\theta^n y_T^n - (1-\tau)(\gamma - \varepsilon_\alpha^{-1})\sum_{n=1}^{N}\theta^n y_N^n + \log(\tau).^{11} \tag{14}$$

First note that the equilibrium λ_T is indeed normally distributed, since it is a linear function of the log of all tradable and non-tradable endowments, which are normally distributed. The first term on the right hand side shows how marginal utility from tradables consumption unambiguously falls with the world supply of tradable intermediates. The second term states that the same is true for the average non-tradable endowment, as long as condition 1 holds. Thus λ_T tends to be low in "good" states of the world. Note, however that not every shock to endowments has the same influence on λ_T. Since larger countries account for a larger share of the world endowment, they have a larger influence on marginal utility, while shocks to the endowment of a small country have little impact on marginal utility. It is this simple asymmetry that is at the heart of all the results I derive: Bad times in a large country are likely bad times for the average world investor, while bad times in a smaller country are not necessarily bad times for the average world investor.

2.5 Prices and Exchange Rates

Since we now know the price of risk in this economy, the last step before we can work out spreads on international assets is to understand the behavior of relative prices and exchange

[10] Another way of stating this intuition is that the two goods are "substitutes" in the production theory sense of the word. Note, however, that this condition does not require that they are substitutes in the strict, Hicksian demand, sense which is a much stronger condition.

[11] I have substituted back in for $\bar{y}_T$ and $\bar{y}_N$ in order to emphasize that endowment shocks to larger countries have a larger impact on marginal utility.

rates. From the Lagrange multipliers associated with the Social Planner's problem we can obtain equilibrium prices of the goods traded in this economy. Keeping in mind that we use the traded good as numéraire, the price of all tradable intermediate varieties originating in country h is given by

$$p_T^h = \varepsilon_\xi^{-1} \left(\bar{y}_T - y_T^h \right). \tag{15}$$

Varieties that are in relatively short supply fetch a higher price and vice versa and the degree to which input prices respond to variations in relative supply depends inversely on the elasticity of substitution between intermediate varieties. The equilibrium price of the non-traded good is slightly more complex:

$$p_N^h = \varepsilon_\alpha^{-1} \bar{y}_T + \frac{\varepsilon_\alpha^{-1}(1-\tau)\left(\gamma - \varepsilon_\alpha^{-1}\right)}{\varepsilon_\alpha^{-1}(1-\tau) + \tau\gamma} \bar{y}_N - \frac{\varepsilon_\alpha^{-1}\gamma}{\varepsilon_\alpha^{-1}(1-\tau) + \tau\gamma} y_N^h - \log(\frac{\tau}{1-\tau}) \tag{16}$$

The first term on the right hand side of the equation shows that the relative price of non-tradables rises with the world supply of tradable goods. The second term shows that (given condition 1) p_N^h also rises with the average (log) supply of non-tradables: If the world average endowment of non-tradables is high, more tradables are delivered to the domestic economy, diminishing the relative supply of the non-traded good within the country and hence making it relatively more expensive. Finally, third term shows that the higher the endowment of the non-traded good, the lower its price.

The the real exchange rate between two countries, call them f and h, is defined as the ratio of their respective price indices,

$$s^{f,h} = p^f - p^h, \tag{17}$$

where a log-approximation of (4) around the point at which $[y_T, y_N]' = 0$ yields

$$p^h = \log\left(\frac{(1-\tau)^{\tau-1}}{\tau^\tau} \right) + (1-\tau)\, p_N^h. \tag{18}$$

The real exchange rate between any two countries thus depends only their relative non-tradable endowments. If the home country has a relatively large endowment of the non-traded good, p_N^h falls and the domestic consumption bundle becomes cheaper relative to foreign consumption bundles, i.e. it depreciates.

2.6 Spread on International Bonds

From lemma 1 we know that determining the spread between any two assets is a matter of determining how their second period payoffs co-vary with the marginal utility of consumption. A bond which is risk-free in terms of consumption is defined as follows:

Definition 1 *A country n risk-free bond is an asset that pays exactly the number of traded* *goods required to purchase one unit of the country n consumption bundle in the second period, regardless of the state of the world.*

While the home country's risk-free bond always pays exactly the equivalent of one unit of the home consumption bundle, the economic value of this payoff is equal to the home price index, p^h, and therefore depends on the state of the world which is realized ex-post. When the domestic endowment of non-tradables is high, the home consumption bundle is relatively cheap and the ex-post payoff from the risk-free bond is relatively low. By the same logic, the ex-post payoff from the risk-free bond is relatively high when the non-tradable endowment is low. These movements in the relative price of the domestic consumption bundle are independent of country size. To see this note that only the first two terms in equation (16) depend on θ, and both of these terms are common to all countries and thus have no influence on the real exchange rate in equation (17). However, a given percentage rise in the non-tradable endowment of a large country lowers λ_T proportionately more than the same rise in the endowment of a smaller country. Large-country bonds thus tend to pay off high when marginal utility is low. For the case in which the variance of endowment shocks is the same in all countries, it follows immediately that, large-country bonds are better hedges against consumption risk since they have a larger covariance with λ_T than small-country bonds. More generally, this is the case if the following condition holds:

Condition 2 *The variance adjusted measure of differences in country size* $\sigma_h^2\theta^h - \sigma_f^2\theta^f$ *is monotonous in the actual difference in country size* $\left(\theta^h - \theta^f\right)$*, i.e.* $\sigma_h^2\theta^h > \sigma_f^2\theta^f$ *iff* $\theta^h > \theta^f$ *for any country pair* h, f.

This condition on the variances of endowments is very mild. It means that σ^2 must decrease less than linearly with country size. For example, such a linear relationship would arise in a model in which there are no country-specific shocks and endowments to each individual are i.i.d.. As long as there is some country-specific element to shocks faced by households, condition 2 will thus typically hold.

Proposition 1 *The difference in log expected returns of two countries' risk-free bonds is given by*

$$r^f + \Delta E s_2^{f,h} - r^h = \frac{\varepsilon_\alpha^{-1}(\gamma - \varepsilon_\alpha^{-1})}{\varepsilon_\alpha^{-1}(1-\tau) + \tau\gamma}\gamma(1-\tau)^2\left(\sigma_h^2\theta^h - \sigma_f^2\theta^f\right), \tag{19}$$

where r^n *is the country n real interest rate in terms of the country n final consumption bundle, and* $\Delta E s_2^{f,h} = \log E\left(S_2^{f,h}/S_1^{f,h}\right)$ *is the log expected change in the real exchange between countries* f *and* h*.*

Given conditions 1 and 2, the larger country's risk-free bond pays systematically lower expected returns.

Proof. Use lemma 1 together with (16) and (18). The left hand side of (19) follows from the fact that $\log ER_{P^h} - \log ER_{P^f} = r^f + \Delta E s_2^{f,h} - r^h$. ■

I have re-written the left hand side of (19) in terms of the two countries' national interest rates in order to illustrate the profound implications Proposition 1 has for uncovered interest parity (UIP). It states that, UIP fails unless countries are of the same size. This departure from UIP stems from a systematic interest rate differential where larger countries tend to have lower risk-free interest rates. The difference in log expected returns rises unambiguously with the difference in size, with relative risk aversion, and with the fraction of non-tradables in the economy. Moreover, a carry trade strategy shorting a larger country's risk-free bond and going long in a smaller country's risk-free bond yields positive expected returns; and these positive expected returns are a compensation for consumption risk.

2.7 Spread on International Stocks

We may also use this model to price stocks:

Definition 2 *Country n stocks in the non-traded and traded sectors are claims to one resident's second period endowment of the non-traded good and of the tradable intermediate variety, respectively.*

The economic payoff from holding a stock in the **non-traded sector** thus consists of two components; the relative price and the endowment of the non-traded good: $P_N^n Y_N^n$. We have already established that large country assets which co-move with the first component are good hedges against consumption risk. The only question with regards to stocks in the non-traded sector is therefore whether the stochastic properties of the second component, Y_N^n, may undo these insurance properties. A sufficient condition to ensure that this is not the case is

Condition 3 *The elasticity of the payoff $P_N^n Y_N^n$ with respect to Y_N^n is negative, $\left(\varepsilon_\alpha^{-1} - \tau\right)\gamma > \varepsilon_\alpha^{-1}\left(1-\tau\right)$.*[12]

This condition requires that the fall in P_N^n in response to a rise in Y_N^n must be sufficiently large, such that whenever Y_N^n is rises, the tradable value of the non-tradable endowment falls.

Proposition 2 *The difference in log expected returns of stocks in the non-traded sector is given by*

$$\rho_N^{h,f} = (1-\tau)(\gamma - \varepsilon_\alpha^{-1}) \frac{\left(\varepsilon_\alpha^{-1} - \tau\right)\gamma - \varepsilon_\alpha^{-1}\left(1-\tau\right)}{\varepsilon_\alpha^{-1}\left(1-\tau\right) + \tau\gamma} \left(\sigma_h^2 \theta^h - \sigma_f^2 \theta^f\right), \tag{20}$$

where $\rho_N^{h,f}$ is a shorthand for $\log ER_{P_N^h Y_N^h} - \log ER_{P_N^f Y_N^f}$.
Given conditions 1, 2, and 3, stock in the larger country's non-traded sector thus pays lower log expected returns.

[12] The fraction in equation (20) is just the negative of the elasticity of $P_N^n Y_N^n$ with respect to Y_N^n.

Proof. Use lemma 1 with $X = P^h Y_N^h$, $Y = P^f Y_N^f$ and follow the proof of Proposition 1. ■

Figure 1 plots the restrictions on the parameter space required in Proposition 2 for $\tau = 0.3$: All combinations north-east of the broken line satisfy condition 1 and the combinations above the solid line satisfy condition 3. If either relative risk aversion or the elasticity of substitution between tradables and non-tradables are large enough, both conditions typically hold. While Proposition 2 refers to the areas A and B, stocks in the non-traded sector of larger countries also pay lower expected returns if both conditions are simultaneously violated, as in area C.

Finally, we can also solve for the difference in expected returns on stocks in the **traded sector**. These stocks pay $P_T^n Y_T^n$ and we have that:

$$\rho_T^{h,f} = \left(\varepsilon_\xi^{-1} - 1\right)\left((1-\tau)\varepsilon_\alpha^{-1} + \tau\gamma\right)\left(\sigma_h^2\theta^h - \sigma_f^2\theta^f\right), \tag{21}$$

where $\rho_T^{h,f} = \log ER_{P_T^h Y_T^h} - \log ER_{P_T^f Y_T^f}$. The sign of the spread on stocks in the traded sector depends only the elasticity of substitution between tradable intermediate varieties. If it $\varepsilon_\xi > 1$, the relative price of a variety in (15) does not move enough to offset the gains from a larger endowment and stocks pay off high whenever the endowment of the variety in question is large. Since the larger country's endowment is more negatively correlated with λ_T, stock in a larger country's traded sector is a bad hedge against consumption risk in this case and it must pay a *higher* expected return in equilibrium. This finding is similar to that in Cochrane, Longstaff, and Santa-Clara (2008), where tradable varieties of two countries are perfect substitutes. However, if $\varepsilon_\xi < 1$ these dynamics reverse and stock in a larger country's traded sector is a better hedge against consumption risk.

3 Monetary Model with Segmented Markets

In the previous section we have established two central implications of country size for international return differentials under complete asset markets. While the complete-markets model is to the present day the workhorse model of international finance and an important benchmark, it allows no role for monetary shocks to influence the equilibrium allocation. This feature of the model makes the question of which currency is used in which part of the world almost meaningless; and it is also at the heart of what many economists perceive as its two main empirical shortcomings: First, real exchange rates seem much to volatile as to be rationalized by only real (endowment) shocks (Chari, Kehoe, and McGrattan (2002)). Second, it predicts a counterfactually high correlation between real exchange rates and relative aggregate consumption between countries (Backus and Smith (1993)).

In this section, I relax the complete-markets assumption and concentrate on the link between the size of currency areas and international return differentials. The extension of the model follows Alvarez, Atkeson, and Kehoe (2002) in assuming that only a subset of households within each country have access to international asset markets and that households are required to hold currency in order to undertake economic transactions.

3.1 Extending the Model

Each country has a central bank which emits a national currency. Central banks introduce fresh liquidity through open market operations in a complete set of state contingent bonds denominated in their respective currencies. Within each country, a fixed proportion ϕ of ("active") households has access to world asset markets where households and central banks trade the state contingent bonds. Denote the subset of active households in country n with Φ^n. The complementary set of ("inactive") households has no access to the asset markets. Currencies are freely convertible without restriction.

All goods must be exchanged for cash. More specifically, I assume that all goods must be paid for in the home currency of the country from which they originate.[13] In the second period, the cash in advance constraint for active households is

$$\tilde{P}^n_{T2}\left(C_{T2}\left(i\right)+P^n_{N2}C_{N2}\left(i\right)\right)\leq\tilde{M}^n_1\left(i\right)+\tilde{P}^n_{T2}B\left(\omega,i\right)\quad\forall\omega,i\in\left\{\Phi^n\right\},\ n=1,...N,\tag{22}$$

where $\tilde{P}^n_T$ is the nominal price of the traded good in country n, $\tilde{M}^n_2\left(i\right)$ are the nominal money holdings of a household i in terms of the national currency of its home country n, and $B\left(\omega,i\right)$ is the quantity of state-contingent bonds that pay one unit of the traded good in state ω held by the household. Since inactive households are precluded from trading in asset markets, their cash in advance constraint in both periods is simply

$$\tilde{P}^n_{T,t}\left(C_{T,t}\left(i\right)+P^n_{N,t}C_{N,t}\left(i\right)\right)\leq\tilde{M}^n_{t-1}\left(i\right)\quad,i\in\left\{\Theta^n\cap\backslash\Phi^n\right\},\ n=1,...N.\tag{23}$$

All households within a given country start the first period with identical cash holdings, $\tilde{M}^n_0$, where the appropriate transfers required to de-centralize the allocation resulting from a utilitarian welfare function are made between active households.[14]

The market clearing conditions for the goods markets remain unchanged, while the money market clearing conditions are given by

$$\int_{i\in\Theta^n}\tilde{P}^n_{T,t}\left(P_{T,t}\left(i\right)Y^n_{T,t}+P^n_{N,t}Y^n_{N,t}\right)di=\bar{M}^n_t,\quad\forall n,t\tag{25}$$

[13] I need to make some assumption on which currency is used when households from different countries engage in transactions. The reverse assumption generates identical results.

[14] The first period constraint for active households is therefore given by

$$\tilde{P}^n_{T1}\left(C_{T1}\left(i\right)+P^n_{N1}C_{N1}\left(i\right)+\int_{\omega}Q\left(\omega\right)B\left(\omega,i\right)\right)\leq\tilde{M}^n_0\left(i\right)+\tilde{P}^n_{T1}\kappa^n\ ,\tag{24}$$

where $\tilde{P}^n_{T1}\kappa^n$ reflects the nominal value of transfers of claims to tradable output between active households of different countries.

where $\bar{M}_t^n = \int_i \tilde{M}_t^n(i)\,di$.The central bank may change the monetary base in the second period through open market operations

$$\tilde{P}_2^n(\omega)\,B_2^n(\omega) = \bar{M}_2^n - \bar{M}_1^n,$$

where $B_2^n(\omega)$ is the total payout of tradables in state ω from bonds issued by central bank n. The central banks' budget constraint is

$$0 = \int Q(\omega)\,B_2^n(\omega)\,d\omega.$$

I assume that the central banks target inflation between the first and second period at some positive level μ, but generate net monetary shocks, such that realized inflation, $\tilde{\mu}_2^n$, is normally distributed around its target level μ with variance $\tilde{\sigma}_n^2$. For simplicity I further assume that this target level is sufficiently high such that inactive households' cash in advance constraint always binds in the first period, $\mu > \delta/(\gamma-1)$ (see appendix D for details). Moreover, I assume for now that inflation rates are uncorrelated between countries and with the vector of endowments. (Section 3.5 discusses the case in which real and monetary shocks are correlated.) The state of the world in the second period is characterized by the vector $\omega = \left([y_{T2}, y_{N2}]', \tilde{\mu}_2\right)$.

3.2 Consumption under Segmented Markets

Active households maximize their lifetime utility (2) subject to their constraints (22) and (24). However, since they have access to complete asset markets they are never nominally cash constrained and are able to hedge their portfolio against inflation. Inactive households on the other hand are nominally cash constrained and vulnerable to inflation. By solving for both active and inactive households' policies we can show the following lemma about their patterns of consumption:

Lemma 3 *In the second period, all active households within a given country n consume the same bundle $(C_{T2}^n(\omega), C_{N2}^n(\omega))$, and all inactive households consume the bundle*

$$\hat{C}_{T2}^n = \frac{\exp(-\tilde{\mu}^n)}{\tau\left(1+\left(P_{N2}^n\right)^{\frac{-\alpha}{1-\alpha}}\left(\frac{1-\tau}{\tau}\right)^{\frac{1}{1-\alpha}}\right)}, \quad \hat{C}_{N2}^n = \frac{\exp(-\tilde{\mu}^n)}{\tau P_{N2}^n\left(\left(\frac{1-\tau}{\tau}\right)^{\frac{-1}{1-\alpha}}\left(P_{N2}^n\right)^{\frac{\alpha}{1-\alpha}}+1\right)}. \tag{26}$$

Proof. See appendix D. ■

From equations (26) we can see how a monetary expansion acts as an "inflation tax" on inactive households. The higher inflation, the less their money holdings are worth and the less they are able to consume. However, since monetary shocks have no bearing on the real endowments available for consumption, this reduction of consumption on the part of the inactive households must go to the benefit of the active households in equilibrium. In order to understand the asset pricing implications of this shift in consumption we must again solve for the equilibrium allocation.

3.3 Computing the Equilibrium Allocation

Although the first theorem of welfare economics fails in this economy, we may nevertheless obtain the equilibrium allocation by solving a Social Planner's problem for the active subset of households, subject to the constraint that the inactive households follow their optimal program. Applying lemma 3, we can write this Social Planner's problem as

$$\max \phi \sum_{n=1}^{N} \theta^n \frac{1}{1-\gamma} \left[\tau \left(C_T^n\right)^\alpha + (1-\tau)\left(C_N^n\right)^\alpha\right]^{\frac{1-\gamma}{\alpha}}$$

subject to the economy's resource constraints (7), (8), and (9), as well as the behavior of inactive households from (26). As before, the problem is now time-separable and we can henceforth omit the time subscripts.

I obtain closed-form solutions by log-linearizing the model around the point at which $[y_{T,2}, y_{N,2}, \tilde{\mu}_2]' = 0$.[15] The analytical expressions detailing the impact of the endowment shocks on the equilibrium are now slightly more involved, as risk is now shared only by a subset of households. However, the economic mechanisms are identical to those discussed in the previous section. The only relevant difference is that conditions 1 and 3 are modified slightly. I therefore focus on impact of nominal shocks in the following discussion by reproducing the results for the special case in which $[y_{T,2}, y_{N,2}]' = 0$. Appendix F contains unabridged analytical solutions.

3.4 Monetary Shocks and International Spreads

We have already seen that inflation shifts consumption from inactive to active households. Since only a fraction ϕ of households trades with central banks in their open market operations, the securities that insure against inflationary shocks trade below their actuarially fair price, thus re-distributing the inflation tax from inactive to active households via the marketplace. This shift in consumption has important implications for asset prices: Since only active households trade in asset markets, it is now the covariance with their marginal utility that determines the spread on international assets,

$$\lambda_T = -\frac{1-\phi}{\phi} \gamma \sum_{n=1}^{N} \theta^n \tilde{\mu}^n, \tag{27}$$

where λ_T is now the marginal utility from traded goods of active households. This expression is similar to (14) in that inflationary shocks unambiguously lower λ_T, but their impact is proportional to the size of the country in which they originate. Inflationary shocks in larger

[15] Appendix E gives details on the Social Planner's problem and the log-linearization.

countries thus have a larger impact on the stochastic discount factor than inflationary shocks in smaller countries.

We can get a better idea of the risk-sharing behavior that underlies these movements in λ_T by solving for active households' equilibrium consumption of tradables:

$$c_T^h = \frac{1-\phi}{\phi}\tilde{\mu}^h + \frac{(1-\phi)\,\gamma\left[\varepsilon_\alpha + \frac{1-\phi}{\phi}\left(1-\tau\left(1-\varepsilon_\alpha\right)\right)\right]}{\left(1-\tau\left(1-\varepsilon_\alpha\right)\right)\gamma-(\gamma-1)\left(1-\tau\right)\phi}\left(\bar{\mu}^n - \tilde{\mu}^h\right), \tag{28}$$

where $\bar{\mu} = \sum_{n=1}^{N}\theta^n\tilde{\mu}^n$ is the weighted average rate of inflation across all countries N. The first term on the right hand side reflects the immediate rise in active households' consumption which is proportional to $\frac{1-\phi}{\phi}$, the number of inactive households per active household. However, risk-sharing among active households requires that some of the initial rise in consumption is shared internationally, which is reflected in the second term on the right hand side. Both the numerator and the denominator of the large fraction are unambiguously positive. Whenever domestic inflation exceeds weighted average inflation $\bar{\mu}$, the home country ships tradables to the rest of the world, reducing the initial rise in domestic tradables consumption.

This form of risk-sharing among active households has important implications for international relative prices: Since inflation increases the availability of both the traded and the non-traded consumption good to domestic active households, and only the former can be shipped internationally, the domestic relative price of non-tradables must adjust. Whenever inflation is higher in the home country than the world weighted average, the non-traded good becomes relatively more abundant at home and its relative price must fall:

$$p_N^h = \frac{\gamma\,(1-\phi)}{\left(1-\left(1-\varepsilon_\alpha\right)\tau\right)\gamma-(\gamma-1)\left(1-\tau\right)\phi}\left(\bar{\mu} - \tilde{\mu}^h\right). \tag{29}$$

It immediately follows that that the domestic currency *depreciates* in real terms whenever inflation is high, and this depreciation happens regardless of the size of the country in question. To see this note that $\bar{\mu}$ (the only argument in (29) that depends on θ) is common to all countries and thus has no impact on the real exchange rate in (17).

It immediately follows that a larger country's risk-free bond is a better hedge against consumption risk. It tends to pay off low when λ_T is low and it tends to pay off high when λ_T is high. Moreover, the same is true for stocks in the non-traded sector: Since monetary shocks move only the price of non- tradables and have no impact on Y_N^h, stocks in the non-traded sector pay off proportionally to the relative price of non-tradables. Both larger countries' risk-free bonds and larger countries' stocks in the non-traded sector must therefore pay lower expected returns in equilibrium. Proposition 3 formalizes these findings.

Proposition 3 *In the presence of only nominal shocks, the difference in log expected returns* *on two countries' stocks in the non-traded sector is given by*

$$\tilde{\rho}_N^{h,f} = \frac{\gamma^2(1-\phi)^2}{((1-(1-\varepsilon_\alpha)\,\tau)\,\gamma-(\gamma-1)\,(1-\tau)\,\phi)\phi}\left(\tilde{\sigma}_h^2\theta^h-\tilde{\sigma}_f^2\theta^f\right), \tag{30}$$

Moreover, the difference in log expected returns on risk-free bonds is $\tilde{\rho}^{h,f}=(1-\tau)\,\tilde{\rho}_N^{h,f}$. *Given the equivalent of condition 2 for nominal shocks, both risk-free bonds and stocks in the non-traded sector of larger countries pay lower log expected returns.*

Proof. Use (27), (29) and follow the proof of Proposition 1. ∎

It is striking that these conclusions are not only qualitatively the same as in the purely real model, but that they are actually slightly stronger. Unlike in Propositions 1 and 2 we require no restrictions on γ or ε_α to find that larger countries' assets pay lower expected returns. In the purely real model, we needed condition 1 to ensure that households are sufficiently risk averse relative to the elasticity of substitution between tradable and non-tradable consumption, such that an increase in non-tradable endowment would lower the marginal utility of tradables consumption. But since inflation directly affects the amount of tradables available to active households, it must always lower marginal utility, regardless of the relationship between γ and ε_α.

Since we now have a well-defined notion of currency in our model, we may also solve for the equilibrium spread on nominal bonds, which have a real ex-post payoff of $P^n/\tilde{P}_T^n$ traded goods. Since the nominal price level rises with domestic inflation, the nominal component merely reinforces the correlation between the risk-free bond and λ_T. The spread between nominal bonds of different countries must thus always be larger than the spread on risk-free bonds.[16] Finally, note that nominal shocks have no implications for the spread on stocks in the traded sector as no component of their ex-post payoff is affected by inflation.

3.5 International Spreads with Real and Monetary Shocks

We may thus conclude that (with the exception of parameter combinations for which the modified conditions 1 or 3 are violated) both real and nominal shocks induce correlations that make bonds and stocks in the non-traded sector of larger countries better hedges against consumption risk than those of smaller countries.[17] The underlying intuition in both cases is the same: that bad times for active investors in a larger country are likely to be bad times for active investors in smaller countries, but not vice versa. In the presence of both real

[16] Formally, it is given by

$$\tilde{\rho}_{\text{nominal}}^{h,f} = \frac{\gamma\,(1-\phi)\,((1-\phi)\,[(1-\tau)\,\gamma+(\gamma-1)\,(1-\tau)]+(1-\tau\,(1-\gamma\varepsilon_\alpha)))}{((1-(1-\varepsilon_\alpha)\,\tau)\,\gamma-(\gamma-1)\,(1-\tau)\,\phi)\phi}\left(\tilde{\sigma}_h^2\theta^h-\tilde{\sigma}_f^2\theta^f\right).$$

[17] The modified conditions are $g>\varepsilon_\alpha^{-1}\frac{\phi}{1-\varepsilon_\alpha^{-1}(1-\phi)}$ and $g(\varepsilon_\alpha^{-1}\,(1-(1-\phi)\,(1-t))-t)>\phi\varepsilon_\alpha^{-1}(1-t)$, respectively.

and nominal shocks, spreads on international bonds and stocks in the non-traded sector are therefore a normalized sum of those given in Propositions 1 and 3, and Propositions 1 and 2 respectively. Appendix F gives the detailed analytical expressions.

Correlated Real and Monetary Shocks The model generalizes easily to the case in which endowments and monetary shocks are correlated within each country. For example, one may expect monetary expansions to occur in states of the world in which y_T is large, $corr(\tilde{\mu}, y_T) > 0$. In this case, a given depreciation of the domestic currency due to a high $\tilde{\mu}$ is associated with a larger movement in λ_T, which (in proportion to country size) now drops for two reasons: The shift in consumption from inactive to active households, and the higher availability of tradable goods in equilibrium. Large country bonds and stocks in the non-tradable sector are therefore even better hedges against consumption risk if $corr(\tilde{\mu}, y_T) > 0$. A similar logic also holds for the correlation between monetary expansions and the endowment of the non-tradable good, as well as for the correlation between domestic endowments y_T and y_N. In fact, appendix G shows that:

Given conditions 1, 2, and 3, international spreads on bonds and stocks in the non-traded sector increase linearly with the within-country correlation between endowments and monetary expansions, as well as with the within-country correlation between endowments in the traded and non-traded sectors.

3.6 Monetary Unions

So far we have assumed that all transactions in the goods market are settled in the seller's domestic currency. In this sense, we have not drawn a distinction between the size of a country and the size of its currency area. However, there are many examples of countries in which households de facto settle their transactions using a foreign country's currency. The US Dollar for example is used extensively outside the United States. Similarly, a number of smaller countries might form currency unions, such as the Euro Area. A simple extension of the model in this section highlights the implications of such policies for asset returns:

Assume that the world consists of three countries of equal size, in which endowments and monetary shocks are uncorrelated and of variance σ^2 and $\tilde{\sigma}^2$ respectively. In this case, log expected returns on stocks and bonds of all three countries are identical. Now assume that two out of these three countries announce a currency union at the beginning of the first period. It is a simple extension of Proposition 3 to show the following corollary:

Corollary 1 *The formation of a currency union lowers the expected returns on (a) risk-free and nominal bonds as well as on (b) stock returns in the non-traded sector of all participating countries.*

Bonds denominated in larger currencies are thus better hedges against consumption risk. Note that this finding is independent of any possible harmonization of real shocks among the countries participating in the currency union. If endowment shocks were indeed to harmonize due to the introduction of a common currency, expected returns on the three types of assets would fall further, as suggested by Propositions 1 and 2.

4 Data

The empirical analysis relates excess returns on stocks and bonds to the economic size of countries and their currencies. The sample consists of quarterly data for OECD countries ranging from 1980 to 2007. Countries enter the sample upon joining the OECD or when data becomes available. I deliberately focus on OECD countries, as these have reasonably open financial markets throughout the period and good quality data is widely available. I exclude Turkey and Mexico from the sample as their level of financial development and GDP per capita are significantly lower than those of the other member countries throughout the sample period. Since the model developed in this paper has only two time periods, I interpret the panel as a series of cross-sections and make the appropriate econometric adjustments. As is customary in the literature I choose the perspective of a US investor when calculating excess returns and I use the US Dollar as the base currency.

The main independent variable is a country's share in OECD GDP:

$$\hat{\theta}_t^j = \frac{GDP_t^j}{\sum_{n=1}^{N} GDP_t^n}, \tag{31}$$

where GDP_t^j is country j's Gross Domestic Product in quarter t in terms of US Dollars as sourced from Global Financial Data (GFD). Table 1 gives summary statistics for this and all other main variables used. The average GDP Share in the sample is 5.5%, where the smallest observation is Iceland in 1997 with 0.01% and the largest is the United States in 1984 with 45.8%. Figure 2 gives the evolution of this variable over time for the largest economies in the sample. In this figure, I treat the Euro Area as a single economy after the introduction of the Euro in 1998. However, in specifications that explicitly distinguish between the size of a country's economy and the size of its currency area, I retain the individual member countries in the sample, assigning them their national GDP Shares, but the Euro Area's M1 Share. M1 Share is a country's share in the total OECD M1 money aggregate in terms of US Dollars and is calculated in the same way as GDP Share. The data on monetary aggregates is sourced from the IMF's International Financial Statistics (IFS). The reason I use M1 is that internationally harmonized measures of money are not available for broader aggregates, especially at the beginning of the sample period. Both M1 Share and GDP Share are adjusted for imbalances in the panel, where countries that enter the sample late are assigned their 1992 shares before they enter.

The main dependent variables are annualized real excess returns to a US investor on bonds of different maturities and portfolios of stock return indices. The former are calculated as

$$\hat{\rho}^j_{d,t} = \tilde{r}^j_{d,t} + \Delta\tilde{s}^j_{t+d} - \tilde{r}^{US}_{d,t} - \Delta cpi^{US}_{t+d}, \tag{32}$$

where $\tilde{r}^j_{h,t}$ is the nominal interest rate of a bond of maturity d issued at time t, $\Delta\tilde{s}^j_{t+d}$ is the ex-post realized change (log difference) in the nominal exchange rate with the US Dollar between the time of emission and the maturity of the bond (IFS), and Δcpi^{US}_{t+h}, is the log difference in the US consumer price index over the same time period (GFD). For simplicity, I do not adjust these excess returns for Jensen's inequality. However, doing so has no significant bearing on the empirical results. At horizons of less than one year I use interbank rates (GFD) and at horizons longer than one year I use government bond yields sourced from GFD and Thompson Financial Datastream (DS). The main specifications of the paper focus on bond returns at the three month horizon. The average annualized rate on these bonds is 8.1% in the sample, and the rates range from almost zero in Japan in 2004 to 34.4% in Italy in 1981.

Similarly, I calculate annualized real excess returns on portfolios of stock return indices in the traded and non-traded sectors as

$$\hat{\rho}^j_{m,t} = dr^j_{m,t+1} + \Delta\tilde{s}^j_{t+1} - dr^{US}_{m,t+1} - \Delta cpi^{US}_{t+1},$$

where $m = T, N$ indicates the sector and $dr^j_{m,t+1}$ is the value-weighted domestic-currency return of the portfolio in sector m between t and $t+1$. I construct these portfolios from industry stock return indices provided by Thompson Financial Datastream. These indices cover all countries in the sample except Iceland; Luxembourg; and the Slovak Republic. I subsume the 'Health Care'; 'Consumer Services'; and 'Financials' industries under the non-traded sector as these can broadly be seen to provide localized services; and I take the 'Basic Materials'; 'Consumer Goods'; and 'Industrials' industries to represent the traded sector.[18] This very high-level division between sectors is necessarily imperfect, where a lot of companies in the non-traded sector also produce tradable output and vice versa. However, it is likely that any errors in this sorting should go against finding patterns in the data.[19] The portfolios of traded and non-traded industries on average pay quarterly returns of 3.0% and 3.5%.

Throughout the empirical analysis I control for likely alternate drivers of cross-country return differentials. When it comes to bonds, clearly the default risk of the borrower is an

[18] Additional indices for the telecommunications industry, utilities, and the high-technology sectors are also available, but I do not use them as these are more recent and have very limited coverage. Moreover, I exclude the 'Oil and Gas' index as most countries in my sample do not produce significant amounts of fossil fuels.

[19] While it is fairly common practice in the trade literature to classifiy plants as producing either traded or non-traded output according to the trade share in their corresponding SIC code, there has to my knowledge not been an attempt to do the same for firms or stock return indices. The difficulty arises from the fact that firms generally have a complex bundle of activities, some of which may be considerd producing traded and some non-traded output. Generating a detailed mapping between high-resolution stock-return indices and the trade data therefore remains a challenge for future research.

important concern. I thus convert the country credit ratings by Moody's and Standard & Poor's to a scale of 0 to 20, where 20 represents an AAA/Aaa rating and 0 represents no rating. I use the average of these two ratings if both are available or the single available rating if the country has only been rated by one agency. The average credit rating excluding the unrated observations is 18.95, which is close to a AA rating. Another obvious concern is the liquidity of different currencies. Investors might ask a premium for holding assets denominated in Danish Crowns as they may be harder to sell than Euros for example. Following Burnside et al. (2006), I proxy for differences in liquidity with the difference of the bid and offer rates against the British Pound in the London market (DS), where the liquidity of the British Pound is measured with the bid-ask spread against the US Dollar. Other control variables include countries' GDP per capita measured in US Dollars (which I calculate using population data from GFD), the variances of the bilateral exchange rate to the US Dollar, the variance of real GDP growth, and the variance of inflation as calculated from consumer price indices. Further details on the dataset are given in appendix I.

5 Empirical Results

The theoretical part of the paper yields four testable predictions about international return differentials: (1) bonds issued in the currencies of larger countries should pay lower expected returns (Propositions 1 and 3); (2) the introduction of a currency union should lower expected returns on bonds within the union (Corollary 1a); (3) stocks in the non-traded sector of larger countries should pay lower expected returns than those of smaller countries (Propositions 2 and 3); and (4) the introduction of a currency union should lower expected returns on stocks in the non-traded sector of participating countries (Corollary 1b). This section presents tests each of these predictions in turn.

5.1 Country Size and Bond Returns (Prediction 1)

In this section, I investigate the empirical relationship between country size and international bond returns. The basic econometric model can be written as

$$\hat{\rho}^j_{d,t} = \kappa + \delta_t + \beta \hat{\theta}^{j,US}_t + X'_{jt}\varsigma + \epsilon_{j,t}, \tag{33}$$

where $\hat{\rho}^j_{d,t}$ are the realized real excess returns to maturity to a US investor on bonds of country j and maturity d as defined in (32), κ is a constant term, δ_t is a complete set of time fixed effects, which are constrained to sum to zero over time, $\hat{\theta}^{j,US}_t = \hat{\theta}^j_t - \bar{\theta}^{US}$ is country j's GDP Share normalized with the average US GDP Share over the sample period, and X'_{jt} is a vector of controls. The error term $\epsilon_{j,t}$ captures all omitted influences. Since the United States is the largest economy in the world it is of special interest how well the model fits the experience of the base-country. In this sense, the coefficient κ can be interpreted as a measure of how far the US real interest rate is off the regression line. In some specifications I also impose $\kappa = 0$, which is equivalent to forcing the specification to perfectly fit the US experience. However, the main coefficient of interest is β, which captures the relationship between country size and excess returns to a US investor.

Table 2 gives results for $d = 3$ *months*. The specifications in columns 1-3 do not contain time fixed effects but cluster standard errors by time. The specifications in all other columns contain time fixed effects and report robust standard errors. Column 1 gives the raw correlation in the data between excess returns and GDP Share. The estimated coefficient is -0.346 (s.e.=0.076) suggesting a negative significant relationship between the two variables, which is illustrated graphically in figure 3. The (adjusted) R^2 of this regression is quite low, at 0.6%, which is common in applications in which the dependent variable is a function of exchange rate movements.

The specification in column 2 controls for the variance of the bilateral exchange rate with the US dollar. In line with the predictions of the model, US investors seem to be earning significantly *lower* excess returns in countries which have a volatile exchange rate with the US Dollar. The model rationalizes this relationship as it predicts a link between countries variance-adjusted size and excess returns. In column 3, I add controls for two likely alternate divers of cross-country return differentials: a country's credit rating and the liquidity of its national currency. Since a number of countries did not obtain credit ratings until the early 1990s, this specification also contains a fixed effect for unrated observations.[20] The added explanatory power of these variables is relatively low. They raise R^2 by 0.2 percentage points, whereas $\hat{\theta}_t^{j,US}$ contributes about 0.5 percentage points to the R^2 of this specification.[21] Throughout, the coefficient of interest is almost unchanged at -0.353 (s.e.=0.074).

The specification in column 4 adds time fixed effects. For the remainder of the paper, I take this specification as the *standard specification*: The coefficient on GDP Share drops only slightly to -0.298 (s.e.=0.069). It points to an economically large effect which suggests that US investors tend to earn 2.98 percentage points less on bonds in a country that produces 10% of OECD output (such as Germany) than they earn in a country that has almost no economic mass (such as New Zealand). Moreover, an increase in a country's credit rating by one grade (e.g. from AA to AA+) is associated with a decrease in excess returns by 0.8 percentage points. The coefficient on the Unrated Dummy suggests that observations which do not have a credit rating tend to be treated by the market as if they had a rating of AA. Appendix table 2 replicates the same results for different estimators and uses alternative methods of computing standard errors.

[20] I have experimented with extrapolating ratings to the beginning of the sample in various different ways. None of these made much difference for the results.

[21] Dropping $\hat{\theta}_t^{j,US}$ from this specification reduces the adjusted R^2 to 0.4%.

In columns 5 and 6, I include GDP per Capita and Variance of Inflation respectively. Neither of the two variables change the coefficient of interest significantly. In column 7, I impose $\kappa = 0$ and the estimated coefficient almost halves to -0.123. However, the standard error also halves to 0.032 and the coefficient remains highly significant. The quantitative implications of these estimates thus depend crucially on whether we force the specification to fit the US data. The econometric reason for this is simple: Although the United States tend to have low interest rates, Japan, which is significantly smaller in terms of GDP, tends to have even lower interest rates during the sample period. If we force the regression line to fit the US, Japan plays little role in identifying β. I return to this issue below.

The coefficient β has a structural interpretation in terms of the model for the case in which the variances of both endowment and monetary shocks are identical across countries (see appendix F for analytical details). To give an idea of the quantitative implications of the model, we can calculate the level of relative risk aversion, γ, implied by the estimates in this table for a given set of parameters. As a numerical example, consider the case in which $\tau = 0.3$, $\varepsilon_\alpha = 1$, $\sigma = 0.05$, and $\tilde{\sigma}$ and ϕ are chosen to match the average standard deviation of the nominal and real exchange rates with the US Dollar in the data (these are 0.1145 and 0.1170, respectively).[22] Under these parameters; the estimate of β from the standard specification in column 4 of table 2 corresponds to $\gamma = 14.19$, whilst the lowest estimate in table 2 corresponds to $\gamma = 3.5$. The model can thus replicate the spreads observed in the data within a range of reasonable parameters.

5.1.1 Alternative Specifications

In Panel A of table 3, I explore a number of alternative specifications which use the differences in the variances of shocks experienced by countries for identification, rather than just controlling for these differences. Throughout, all specifications contain a full set of time fixed effects and all of the controls included in the standard specification (Variance of Exchange Rate; Country Credit Rating; Unrated Dummy; and Bid-Ask Spread on Currency). In column 1, GDP Share is interacted with variance of exchange rate. Interestingly, this interaction yields a highly significant coefficient of -26.905, while the coefficient on Variance of Exchange Rate loses significance. The specification in column 2 includes the interaction as well as GDP Share un-interacted. This specification has a structural interpretation in terms of the model, which can be derived under the assumption that the ratio of the variance of real and nominal shocks is identical across all countries, $\sigma_i^2/\tilde{\sigma}_i^2 = const$. For this case the model predicts a negative sign for the coefficient on the interaction and a positive sign for the coefficient on GDP Share. Indeed, the data support exactly this prediction. However, this specification is clearly plagued with

[22] Burstein, Neves, and Rebelo (2001) and Goldberg and Campa (2008) emphasize that a large share of consumption is non-tradable, since a significant proportion of the price of tradables accrues to non-tradable retail services. I therefore pick a relatively low value of $\tau = 0.3$ in this numerical example.

a high degree of colinearity between the two variables of interest, with the coefficient on the interaction shooting up to -151.883 (s.e.=32.690). The specifications in columns 3 and 4 take a slightly different approach by interacting GDP Share with the variance of real GDP growth and variance of inflation (as measured by CPI), respectively. The implicit assumption in the former case is that the variance of GDP growth accurately captures the variance of endowment shocks in the non-traded sector, and both specifications can be interpreted structurally if $\sigma_i^2 = \tilde{\sigma}_i^2$.

While the interaction between the variance of shocks and country size seems to add a moderate amount of explanatory power; I nevertheless continue to focus on the simpler standard specification, which is considerably easier to interpret. Panel B of table 3 explores which aspect of the data is driving the identification on β. In column 1, I re-run the standard specification, but with only the interest rate differential on the left hand side of the regression. This specification yields a coefficient of -0.213 (s.e.=0.016). In column 2, I drop the constant term and get a coefficient of -0.096 (s.e.=0.007). In both cases, these coefficients are only marginally lower than their counterparts in table 2. The driving force behind the identification of β thus seems to arise from interest rate differentials between countries rather than from systematic trends in exchange rates. In columns 3 and 4, I switch back to excess returns as the dependent variable but collapse the dataset into decade averages (1980-1990, 1991-1998, and 1999-2007). Again, the coefficients are very similar to those in table 2 suggesting that practically all of the identification is coming from the cross-section. We may thus conclude that the of the identification of β comes from persistent interest rate differentials between countries.

5.1.2 Robustness Checks

Tables 4 and 5 report additional robustness checks. Throughout, all specifications mirror the standard specification in table 2 column 4: they contain time fixed effects and control for the variance of the bilateral exchange rate to the US Dollar; default risk; and the bid-ask spread on the currency. In both tables 4 and 5, the specifications in Panel A contain a constant term and those in Panel B do not, where only the coefficients of interest are reported.

Table 4 reports results for bonds at different maturities, $d = 3$, 6, 24, 36, and 60 *months*. The sample drops to only 818 observations for two reasons. First, I have data for the entire yield curve of only 16 out of the 27 countries. Second, I use excess returns to maturity, which generates a maximum of a 5 year overlap. In all specifications in which there are overlapping observations I cluster standard errors by country.[23] Column 1 of Panel A re-runs the standard specification for this subsample and yields an estimate for β of -0.192 (s.e.=0.102). This coefficient remains significant and remarkably stable throughout the yield curve, with estimates ranging from -0.169 at the 2-year horizon to -0.194 at the 5-year horizon. If I force a perfect fit for the base-country by setting $\kappa = 0$, the coefficient drops (albeit to a lesser degree than the drop we saw in table 2), but also remains stable in a range from -0.091 at the 5-year horizon to

[23] See Petersen (2005) and Thompson (2006) for a discussion of the econometric issues involved.

-0.157 at the 3-month horizon. It thus seems to matter very little at which point of the yield curve we test the model.

Table 5 returns to bonds at the quarterly horizon and explores the sensitivity of the results with respect to dropping different countries and groups of countries from the sample. Column 1 replicates the standard specification for comparison. Column 2 drops the largest economy in the sample, the Euro Area post 1998. While the coefficient in Panel A changes -0.477 (s.e.=0.102), the coefficient in Panel B barely responds as the United States is of a similar size to the Euro Area and the specification is constrained to perfectly fit the United States with $\kappa = 0$. Column 3 instead drops Japan, in which case the coefficient is -0.088 (s.e.=0.053) and -0.082 (s.e.=0.031) in the two panels respectively. This convergence of the two estimates confirms our earlier conjecture that dropping the constant from the regression mainly affects the way in which Japan bears on the results. The specification in column 4 drops both large economies, the Euro Area and Japan simultaneously. The result is quite surprising: the coefficients are -0.259 (s.e.=0.109) and -0.084 (s.e.=0.032), and therefore very similar to the coefficients obtained from the full sample. This means that the cloud of smaller countries ranging from Germany to Iceland in figure 3 has almost the same slope as the full sample including the large economies. While the Euro Area and Japan individually have large bearing on the results, their joint influence on the estimates is far smaller than one might have expected. Column 5 drops all EMU member countries pre and post introduction of the Euro, column 6 drops all countries joining the OECD post 1980, and column 7 drops highly resource dependent countries (Australia; Canada; and Norway). In each case, the coefficients remain negative and significant. The conclusion from table 5 is that no single country or group of countries seem to be driving the results, but that a negative relationship between country size and excess returns exists throughout the subsamples of countries.

5.2 Currency Areas and Bond Returns (Prediction 2)

Until now the empirical investigation has focused on the link between excess returns on bonds and country size (Propositions 1 and 3); however, the model also predicts that excess returns on bonds should fall after the introduction of a currency union (Corollary 1a). This section tests this prediction for the case of European Monetary integration, which occurred in 1999 (Greece joined in 2001). To this end I now keep Euro Area member countries in the sample after 1999 (and Greece after 2001), assign them their national GDP Share, but the M1 Share of the Euro Area. Since data on short-term interest rates are not available for individual member countries of the EMU after 1998, I switch to government bonds (specifically 5-year government bonds for which data is most widely available) in calculating excess returns. The main specification is

$$\hat{\rho}^{j}_{5year,t} = \kappa + \delta_t + \beta\hat{\theta}^{j,US}_t + \upsilon Euro \times \left(\hat{M}^{j,US}_t - \hat{\theta}^{j,US}_t\right) + X'_{jt}\varsigma + \epsilon_{j,t}, \qquad (34)$$

where $Euro$ is a fixed effect for EMU member countries post 1998, $\hat{M}_t^{j,US} = \hat{M}_t^j - \bar{M}_t^{US}$ stands for country j's share of total OECD M1 money balances normalized with the average US M1 Share throughout the sample, $\bar{M}_t^{US}$. The model predicts that $\beta < 0$ and $\upsilon < 0$.

Two caveats are in order before we proceed to the results. First, a strict interpretation of the model would demand performing this regression with excess returns on bonds that are indexed to national consumer price indices on the left hand side, since there are no exchange rates between EMU member countries. However, internationally comparable data on such bonds is not available (they either do not exist or are indexed to Euro-Area wide inflation indices). We should therefore not interpret this specification structurally but simply as a reduced-form test of whether excess returns to US investors on EMU member bonds fell after monetary integration. Second, since the introduction of the Euro is the only formation of a currency union in my sample I am necessarily making an empirical statement about this concrete historical event rather than about currency unions in general.

Column 1 of table 6 begins by introducing the $Euro$ fixed effect into the standard specification with excess returns on 5 year government bonds on the left hand side. β is estimated as -0.249 (s.e.=0.061) and the coefficient on the fixed effect is negative and significant, indicating that excess returns to US investors from investing in government bonds of EMU members on average fell by 1.5 percentage points after the introduction of the Euro. Note that all specifications continue to control for country credit ratings; variance of exchange rates; and bid-ask spread; such that any change in these variables due to accession to the Euro is already accounted for. Column 2 interacts the $Euro$ fixed effect with the difference in M1 and GDP Shares as in (34). The estimate of υ is -0.03 (s.e.=0.014), which suggests a negative and significant effect as predicted by the model. Column 3 furthermore allows for countries outside the EMU to have currency areas that are larger or smaller than their national GDP Shares by introducing the term $(1 - Euro) \times \left(\hat{M}_t^{j,US} - \hat{\theta}_t^{j,US}\right)$. The coefficients on both interactions are negative and significant at -0.168 and -0.301, while β is now estimated at -0.037 and insignificant. Column 4 drops the interactions and instead includes the difference between M1 Share and GDP Share, regardless of whether or not the country is an EMU member. The coefficient on this variable is -0.079 (s.e.=0.028) and β is estimated at -0.192 (s.e.=0.052). Finally, column 5 drops the constant term, where both coefficients remain negative and significant.

The conclusion from table 6 is that the evidence supports the prediction that excess returns to US investors on EMU member bonds fell after 1998. Moreover, the data supports the view that countries generally seem to pay lower excess returns on their foreign lending if their currency area as measured by their M1 Share exceeds the size of their economy as measured by their GDP Share.

5.3 Country Size, Currency Areas, and Stock Returns (Predictions 3 & 4)

This section focuses on the link between country size, the size of currency areas, and stock returns. The model predicts that under reasonable assumptions; stocks in a larger country's non-traded sector pay lower expected returns (Propositions 2 and 3) and that the introduction of a currency union lowers expected returns in the non-tradable, but not in the traded sector of participating countries (Corollary 1b). While we can test the first prediction with cross-country data, the second prediction has implications for both the variation across countries and for the variation within countries: After the introduction of the Euro, domestic returns in the non-traded sector should have fallen relative to domestic returns in the traded sector within the participating countries. Both predictions are to my knowledge new to the literature and can therefore be seen as a good test of the model.

5.3.1 Cross-Country Return Differentials

I first focus on the cross-country variation by mirroring specification (34), but with the excess returns of a US investor from investing in the non-traded sector of country j, $\hat{\rho}^j_{N,t}$, as dependent variable:

$$\hat{\rho}^j_{N,t} = \kappa_N + \delta_t + \beta_N \hat{\theta}^{j,US}_t + \upsilon_N Euro \times \left(\hat{M}^{j,US}_t - \hat{\theta}^{j,US}_t\right) + X'_{jt}\varsigma + \epsilon^N_{j,t}, \tag{35}$$

where the vector X'_{jt} continues to contain all of the controls for default risk; the bid-ask spread; and the variance of the bilateral exchange rate with the US Dollar. While the latter two variables are as relevant for investors in international stocks as they are for investors in international bonds; I retain the control for default risk in the regression solely for the sake of comparison. Moreover, all specifications control for the (domestic) variance of returns in the non-traded sector.

The specification in column 1 of table 7 returns an estimate for β_N of -0.745. This coefficient is economically large indicating that stocks in the non-traded sector of a country that contributes 10% of OECD GDP tend to pay 7.45 percentage points lower returns on an annual basis than stocks in the non-traded sector of countries with almost no economic mass. However, this coefficient is also relatively imprecisely estimated with a standard error of 0.240. Column 2 shows that excess returns in the non-traded sector fell in EMU member countries by an average of 4.3 percentage points after the introduction of the Euro, while the estimate of β_N remains almost unchanged at -0.749 (s.e.=0.240). Column 3 introduces the interaction with $\left(\hat{M}^{j,US}_t - \hat{\theta}^{j,US}_t\right)$ suggested by the model, which gives an estimate for υ_N of -0.079 (s.e.=0.038). When I add the interaction for non-EMU members in column 4, both coefficients change sign and become statistically indistinguishable from zero. However, the specification in column 5 which drops the interactions and estimates a unified effect of the difference in M1 Share and GDP Share again returns a negative coefficient of -0.125 (s.e.=0.067). Finally, column 6 replicates this specification but drops the constant term. In this case, the estimate for β_N is -0.102 but statistically insignificant with a standard error of 0.097; however, the coefficient on the difference between M1 Share and GDP Share remains significant at -0.200 (s.e.=0.068).

While the results for stocks in the non-traded sector are less strong than those for bonds, the data is nevertheless consistent with both the prediction that stocks in the non-traded sector of larger countries pay lower excess returns, and the prediction that the introduction of the Euro would lower returns in the non-traded sector of participating countries. Appendix table 2 replicates all specifications of table 7, but with excess returns in the traded sector as the left hand side variable. Interestingly, none of the coefficients of interest are statistically distinguishable from zero in this case.

5.3.2 Within Country Return Differentials

In table 8, I focus on the following econometric model:

$$dr^j_{N,t} - dr^j_{T,t} = \kappa_\Delta + \upsilon_\Delta Euro \times \left(\hat{M}^{j,US}_t - \hat{\theta}^{j,US}_t\right) + \beta_\Delta \hat{\theta}^{j,US}_t + X^{\Delta\prime}_{jt}\varsigma_\Delta + \epsilon^\Delta_{j,t}, \tag{36}$$

It is derived by differencing specification (35) for excess returns in the non-traded and traded sectors, $\hat{\rho}^j_{N,t} - \hat{\rho}^j_{T,t}$. The new left hand side variable, $dr^j_{N,t} - dr^j_{T,t}$ is the domestic return differential between the portfolios of stock return indices in the traded-and non-traded sectors. The vector of controls $X^{\Delta\prime}_{jt}$ contains only the domestic variances of the returns on the portfolios in the two sectors as all other controls, like the time fixed effects, difference out of the equation. The coefficient of interest is υ_Δ; the differential impact of European monetary integration on returns in the two sectors. The model predicts $\upsilon_\Delta < 0$. Note, however, that the model has no implications for β_Δ, as the spread on international stocks in the traded sector is indeterminate.

Column 1 of table 7 shows a regression of the domestic return differential on the *Euro* fixed effect and a constant. The estimated coefficient on the fixed effect is -0.016 (s.e.=0.005). Domestic returns in the non-traded sector of EMU member countries thus tended to fall by 1.6 percentage points relative to those in the traded sector after the introduction of the Euro. In column 2 the *Euro* fixed effect is interacted with $\left(\hat{M}^{j,US}_t - \hat{\theta}^{j,US}_t\right)$, yielding a negative significant coefficient. Column 3 estimates the full model (36). The estimate for υ_Δ is -0.059 (s.e.=0.015), which suggests a negative significant effect as predicted by the model. The estimate of β_Δ is -0.078, but statistically indistinguishable from zero with a standard error of 0.050. Columns 4 and 5 allow for a general relationship between the size of currency areas and the domestic return differential. In column 5, the estimated coefficient is -0.061 (s.e.=0.016), which suggests that stocks in the non-traded sector of a hypothetical country which has a currency area that contributes 10% to the OECD money balances, but has no economic mass, would on average pay 0.6 percentage points lower returns than stocks in the same countries traded sector. Finally, column 6 re-estimates the same equation while including the US in the sample. The coefficient remains almost unchanged at -0.055 (s.e.=0.015).

The conclusion of table 8 is that European monetary integration seems to have indeed lowered domestic returns in the non-traded sector relative to returns in the traded sector of participating countries.

6 Conclusion

This paper has argued that differences in the economic size of countries have important implications for international return differentials. It has presented a standard international asset pricing model with complete markets and non-traded goods in which larger countries have lower real interest rates, because their bonds provide insurance against shocks that affect a larger fraction of the world market. Under reasonable restrictions on the parameter space, the same model predicts that stocks in the non-traded sector of larger countries should pay lower expected returns. These predicted international return differentials are a compensation for consumption risk. Moreover, if asset markets are segmented, the introduction of a currency union lowers real interest rates and returns on stocks in the non-traded sector of participating countries. The empirical part of the paper has shown that differences in country size indeed go a long way towards explaining the observed return differentials on international stocks and bonds.

The focus of this paper has been on static risk premia. In particular, the paper has provided an explanation for *static* violations of uncovered interest parity in the data; leaving at least two interesting avenues for future research: First, a truly dynamic version of the model in which countries' shares of world output endogenously fluctuate over time may offer interesting insights into *dynamic* violations of uncovered interest parity, which have been the main focus of the debate on the forward premium puzzle. Second, the empirical part of this paper leaves open the question of whether exchange rates actually correlate with the consumption risk borne by investors in the way predicted by the model. The main challenge in answering this question would of course be to find a reasonable proxy for investors' marginal utility of tradable consumption.

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Appendix

A Proof of Lemma 1

Consider an arbitrary asset with a stochastic payout of X units of tradables in period 2 and a period 1 price of V_X. Summing up the prices of state-contingent securities from the households' first order conditions (10) yields

$$V_X = e^{-\delta} E\left[\frac{\Lambda_{T2}}{\Lambda_{T1}} X\right].$$

Taking logs on both sides gives

$$v_X = -\delta + \log E\left[\Lambda_{T2} X\right] - \lambda_{T1}$$

Asset returns and marginal utilities are approximately log-normal

$$v_X \approx -\delta + E\lambda_2 + Ex + \frac{1}{2} var\left(\lambda_2\right) + \frac{1}{2} var\left(x\right) + cov\left(\lambda_2, x\right) - \lambda_1$$

Any other asset with payout Z:

$$v_Z \approx -\delta + E\lambda_2 + Ez + \frac{1}{2} var\left(\lambda_2\right) + \frac{1}{2} var\left(z\right) + cov\left(\lambda_2, z\right) - \lambda_1$$

Differencing and re-arranging yields

$$\left(\log ER_X - \log ER_Z\right) \approx cov\left(\lambda_2, z\right) - cov\left(\lambda_2, x\right).$$

B Proof of Lemma 2

The traded goods firm chooses a quantity of inputs $\left\{I_T\left(j\right)\right\}_j$ to solve

$$\max_{\left\{I_T(j)\right\}_j} \left[\int_0^1 I_T\left(j\right)^{\xi} dj\right]^{\frac{1}{\xi}} - \int_0^1 P_T\left(j\right) I_T\left(j\right) dj$$

The first order conditions associated with this problem state that the price of each tradable variety must equal its marginal product in the production of the traded good:

$$\left[\int_0^1 I_T\left(j\right)^{\xi} dj\right]^{\frac{1}{\xi}-1} I_T\left(j\right)^{\xi-1} = P_T\left(j\right) \quad \forall j \tag{37}$$

Combining the first order conditions (37), with the market clearing conditions for tradable varieties (7) we get that all intermediate varieties originating within one country fetch the same real price on the world market.

Moreover, solving the households' problem (maximizing (2) subject to (6)) Euler equations (10) as well as the following condition of optimality governing governing the ratio of tradable to non-tradable consumption:

$$P_{Nt} = \frac{(1-\tau)\, C_{Nt}\,(i)^{\alpha-1}}{\tau C_{Tt}\,(i)^{\alpha-1}}, \quad t = 1, 2. \tag{38}$$

It follows that the optimal behavior of all active households within a given country is characterized by the same first order conditions as well as identical budget constraints. We can therefore write

$$C_{T2}\,(\omega, i) = C_{T2}^{n}\,(\omega) \quad \forall i \in \Phi^{n},\ n = 1, ...N$$

and

$$C_{N2}\,(\omega, i) = C_{N2}^{n}\,(\omega) \quad \forall i \in \Phi^{n},\ n = 1, ...N.$$

C Details on the Social Planner's Problem

Applying 2 to the economy's resource constraints (7), (8), and (9), yields the following simplified expressions:

$$\theta^{n} C_{N}^{n} = \theta^{n} Y_{N}^{n} \quad \forall n,$$

$$\left[\sum_{n=1}^{N} \theta^{n} C_{T}^{n}\right] = \left[\sum_{n=1}^{N} \theta^{n}\,(Y_{T}^{n})^{\xi}\right]^{\frac{1}{\xi}}.$$

Maximization of (12) subject to these constraints yields $3n$ first order conditions which characterize the equilibrium allocation.

$$\left[\tau\,(C_{T}^{n})^{\alpha} + (1-\tau)\,(C_{N}^{n})^{\alpha}\right]^{\frac{1-\gamma}{\alpha}-1} (1-\tau)\,(C_{N}^{n})^{\alpha-1} = \Lambda_{N}^{n} \quad \forall n,$$

$$\left[\tau\,(C_{T}^{n})^{\alpha} + (1-\tau)\,(C_{N}^{n})^{\alpha}\right]^{\frac{1-\gamma}{\alpha}-1} \tau\,(C_{T}^{n})^{\alpha-1} = \Lambda_{T} \quad \forall n,$$

$$\Lambda_{T}\left[\sum_{n=1}^{N} \theta^{n}\,(I_{T})^{\xi}\, dj\right]^{\frac{1}{\xi}-1} (I_{T})^{\xi-1} = \Lambda_{T}^{n} \quad \forall n$$

where Λ_{N}^{n}, Λ_{T}^{n}, and Λ_{T}, are Lagrange multipliers associated with the corresponding constraints.

D Proof of Lemma 3

For the first part of the statement, note that the problem of the traded goods firm remains unchanged. We can thus apply the first step of the proof of lemma 2 to find that all tradable varieties originating within one country continue to fetch the same real and nominal price on the world market. It follows that all households (both active and inactive) within a given country enter the second period with the same amount of cash.

$$\tilde{M}_1^n(i) = \tilde{P}_{T1}^n \left(P_{T1}^n Y_{T1}^n + P_{N1}^n Y_{N1}^n\right) \equiv \tilde{M}_1^n \; ; \; \forall i \in \Theta^n, n = 1, ...N \tag{39}$$

It immediately follows that active households within each country consume identical bundles. Moreover, note that the condition ruling out that inactive households save by holding cash between the first and second period is sufficient to ensure that active households never do so, because active households can also save by purchasing state-contingent bonds in the first period. Then, a trading individual's problem is to maximize (2) subject to (22) and (24), yielding the conditions of optimality (10) and (38). Proof of the first part of the statement thus follows from the fact that the optimal behavior of all active households within a given country is characterized by the same first order conditions under identical constraints. It thus follows immediately that

$$C_{T2}(\omega, i) = C_{T2}^n(\omega) \quad \forall i \in \Phi^n, \; n = 1, ...N$$

$$C_{N2}(\omega, i) = C_{N2}^n(\omega) \quad \forall i \in \Phi^n, \; n = 1, ...N$$

For the second part of the lemma, I first show that the condition $\mu > \delta/(\gamma - 1)$ is sufficient to ensure that inactive households do not carry over cash from the first to the second period. We can re-write inactive households' problem in the following way:

$$\max U(i) = \frac{1}{1-\gamma} C_1(i)^{1-\gamma} + e^{-\delta} \frac{1}{1-\gamma} E\left[C_2(i)^{1-\gamma}\right]$$

subject to

$$C_1(i) = \frac{\tilde{M}_0^n(i) - H(i)}{P_1^n \tilde{P}_{T1}^n} \text{ and } C_2(i) = \frac{\tilde{M}_1^n(i) + H(i)}{P_2^n \tilde{P}_{T2}^n},$$

where $H(i) \geq 0$ are the savings in cash carried over from the first to the second period. Maximization of the problem yields

$$\left(\frac{\tilde{M}_0^n(i) - H(i)}{P_1^n \tilde{p}_{T1}^n}\right)^{-\gamma} \frac{1}{P_1^n \tilde{P}_{T1}^n} = e^{-\delta} E\left[\left(\frac{\tilde{M}_1^n(i) + H(i)}{P_2^n \tilde{P}_{T2}^n}\right)^{-\gamma} \frac{1}{P_2^n \tilde{P}_{T2}^n}\right],$$

where households choose not carry over cash between the two periods if

$$\left(\frac{M_0^n(i)}{P_1^n\tilde{p}_{T1}^n}\right)^{-\gamma}\frac{1}{P_1^n\tilde{P}_{T1}^n} > e^{-\delta}E\left[\left(\frac{M_1^n(i)}{P_2^n\tilde{P}_{T2}^n}\right)^{-\gamma}\frac{1}{P_2^n\tilde{P}_{T2}^n}\right]$$

Given that $[y_{T,1}, y_{N,1}, \tilde{\mu}_1] = 1$ and (1), this expression collapses to

$$\mu > \frac{\delta}{(\gamma-1)}.$$

Under this condition, inactive households thus face a stationary problem. This can be written as

$$\max \frac{1}{1-\gamma}\left[\tau\left(C_{T,t}(i)\right)^{\alpha} + (1-\tau)\left(C_{N,t}(i)\right)^{\alpha}\right]^{\frac{1-\gamma}{\alpha}}$$

subject to (23). Maximization of this problem yields (38) as the single condition of optimality. Since (39) applies to the cash holdings of both active and inactive households, it immediately follows that all inactive households within a given country must consume identical bundles $\left(\hat{C}_{T,t}^n, \hat{C}_{N,t}^n\right)$.

From (23) and (38), this bundle is given as

$$\hat{C}_{T,t}^n = \frac{\tilde{M}_{t-1}^n}{\tilde{P}_{T,t}^n\left(1+\left(P_{N,t}^n\right)^{\frac{-\alpha}{1-\alpha}}\left(\frac{1-\tau}{\tau}\right)^{\frac{1}{1-\alpha}}\right)},\ \hat{C}_{N,t}^n = \frac{\tilde{M}_{t-1}^n}{\tilde{P}_{T,t}^n P_{N,t}^n\left(\left(\frac{1-\tau}{\tau}\right)^{\frac{-1}{1-\alpha}}\left(P_{N,t}^n\right)^{\frac{\alpha}{1-\alpha}}+1\right)} \tag{40}$$

The money market clearing condition (38) implies

$$\tilde{P}_{T,t}^n = \frac{\bar{M}_t^n}{\theta^n\left(P_{T,t}^n Y_{T,t}^n + P_{N,t}^n Y_{N,t}^n\right)} = \frac{\tilde{M}_t^n}{\left(P_{T,t}^n Y_{T,t}^n + P_{N,t}^n Y_{N,t}^n\right)}$$

Monetary policy aims to stabilize the price level, such that

$$\frac{\tilde{P}_{T,t}^n}{\tilde{P}_{T,t-1}^n} = \frac{\bar{M}_t^n}{\bar{M}_{t-1}^n}\frac{P_{T,t-1}^n Y_{T,t-1}^n + P_{N,t-1}^n Y_{N,t-1}^n}{P_{T,t}^n Y_{T,t}^n + P_{N,t}^n Y_{N,t}^n} = \exp\left(\tilde{\mu}_t\right).$$

Combining these two conditions yields

$$\frac{\tilde{M}_{t-1}^n}{\tilde{P}_{T,t}^n} = \left(P_{T,t-1}^n Y_{T,t-1}^n + P_{N,t-1}^n Y_{N,t-1}^n\right)\exp\left(-\tilde{\mu}_t\right).$$

Plugging in the endowments in the first period and combining this expression with (40) yields

(26) and concludes the proof of the lemma.

E Social Planner's Problem and Log-linearization

E.1 Details on the Social Planner's Problem under Segmented Markets

Applying lemma 3 to the economy's resource constraints (7), (8), and (9), yields the following simplified expressions:

$$\theta^n \left(\phi C_N^n + (1-\phi)\,\hat{C}_N^n\right) = \theta^n Y_N^n \quad \forall n,$$

$$\phi \left[\sum_{n=1}^{N} \theta^n C_T^n\right] + (1-\phi)\left[\sum_{n=1}^{N} \theta^n \hat{C}_T^n\right] = \left[\sum_{n=1}^{N} \theta^n \left(I_T^n\right)^{\xi} dj\right]^{\frac{1}{\xi}},$$

and $Y_T^n = I_T^n$. The associated Lagrangian is

$$\begin{aligned} L \;=\; & \phi \sum_{n=1}^{N} \theta^n \frac{1}{1-\gamma}\left[\tau\left(C_T^n\right)^{\alpha} + (1-\tau)\left(C_N^n\right)^{\alpha}\right]^{\frac{1-\gamma}{\alpha}} \\ & -\Lambda_T \left(\phi \left[\sum_{n=1}^{N} \theta^n C_T^n\right] + (1-\phi)\left[\sum_{n=1}^{N} \theta^n \hat{C}_T^n\right] - \left[\sum_{n=1}^{N} \theta^n \left(I_T^n\right)^{\xi} dj\right]^{\frac{1}{\xi}}\right) \\ & -\sum_{n=1}^{N} \theta^n \Lambda_N^n \left(\phi C_N^n + (1-\phi)\,\hat{C}_N^n - Y_N^n\right) - \sum_{n=1}^{N} \theta^n \Lambda_T^n \left(I_T - Y_T^n\right) \end{aligned}$$

which yields $3n$ first order conditions

$$\left[\tau\left(C_T^n\right)^{\alpha} + (1-\tau)\left(C_N^n\right)^{\alpha}\right]^{\frac{1-\gamma}{\alpha}-1} \tau\left(C_T^n\right)^{\alpha-1} = \Lambda_T \quad \forall n,$$

$$\left[\tau\left(C_T^n\right)^{\alpha} + (1-\tau)\left(C_N^n\right)^{\alpha}\right]^{\frac{1-\gamma}{\alpha}-1} (1-\tau)\left(C_N^n\right)^{\alpha-1} = \Lambda_N^n \quad \forall n,$$

and

$$\Lambda_T \left[\sum_{n=1}^{N} \theta^n \left(I_T^n\right)^{\xi} dj\right]^{\frac{1}{\xi}-1} \left(I_T^n\right)^{\xi-1} = \Lambda_T^n \quad \forall n.$$

E.2 System of Log-Linearized Equations

Log-linearizing the first order conditions and resource constraints around the point at which $[y_T, y_N, \tilde{\mu}]' = 0$ yields

$$(1-\gamma-\alpha)\left(\tau c_T^n + (1-\tau)\, c_N^n\right) + \log\tau + (\alpha-1)\, c_T^n = \lambda_T \quad \forall n,$$

$$(1-\gamma-\alpha)\left(\tau c_T^n+(1-\tau)\, c_N^n\right)+\log(1-\tau)+(\alpha-1)\, c_N^n=\lambda_N^n \quad \forall n,$$

$$\lambda_T+(1-\xi)\left(\sum_{n=1}^{N}\theta^n y_T^n\right)+(\xi-1)\, y_T^n=\lambda_T^n \quad \forall n,$$

$$\phi c_N^n+(1-\phi)\left(-\tilde{\mu}^n-\tau\left(\frac{1}{1-\alpha}+\frac{1-\tau}{\tau}\right)\left(p_N^n-\log\left(\frac{1-\tau}{\tau}\right)\right)\right)=y_N^n \quad \forall n,$$

and

$$\phi\sum_{n=1}^{N}\theta^n c_T^n+(1-\phi)\sum_{n=1}^{N}\theta^n\left(-\tilde{\mu}^n-\frac{\alpha}{1-\alpha}(1-\tau)\left(p_N^n-\log\left(\frac{1-\tau}{\tau}\right)\right)\right)=\sum_{n=1}^{N}\theta^n y_T^n.$$

The equivalent expressions for the model with complete asset markets can be obtained by setting $\phi=1$ in the expressions above.

F Full Analytical Results under Market Segmentation

This section lists full solutions for the case in which markets are segmented and the economy experiences both real and monetary shocks. The relative price of non-traded goods in an arbitrary country h is given as

$$\begin{aligned} p_N^h &= \varepsilon_\alpha^{-1}\sum_{n=1}^{N}\theta^n y_T^h-\frac{\gamma y_N^h}{(1-(1-\varepsilon_\alpha)\tau)\gamma-(\gamma-1)(1-\tau)\phi} \\ &\quad+\frac{(1-\tau)\left[\gamma-\gamma\varepsilon_\alpha^{-1}(1-\phi)-\varepsilon_\alpha^{-1}\phi\right]}{(1-(1-\varepsilon_\alpha)\tau)\gamma-(\gamma-1)(1-\tau)\phi}\sum_{n=1}^{N}\theta^n y_n^n-\frac{\gamma(1-\phi)}{(1-(1-\varepsilon_\alpha)\tau)\gamma-(\gamma-1)(1-\tau)\phi}\tilde{\mu}^h \\ &\quad+\sum_{n=1}^{N}\frac{\gamma v^n(1-\phi)}{(1-(1-\varepsilon_\alpha)\tau)\gamma-(\gamma-1)(1-\tau)\phi}\tilde{\mu}^n-\log\left(\frac{\tau}{1-\tau}\right). \end{aligned}$$

Marginal utility of active households from tradable consumption is

$$\begin{aligned} \lambda_T &= -\left((1-\tau)\varepsilon_\alpha^{-1}+\frac{\tau\gamma}{\phi}+(1-\tau)\gamma\varepsilon_\alpha^{-1}\frac{1-\phi}{\phi}\right)\sum_{n=1}^{N}\theta^n y_T^n \\ &\quad-(1-\tau)\left[\frac{\gamma}{\phi}-\varepsilon_\alpha^{-1}-\gamma\varepsilon_\alpha^{-1}\frac{1-\phi}{\phi}\right]\sum_{n=1}^{N}\theta^n y_N^n-\frac{1-\phi}{\phi}\gamma\sum_{n=1}^{N}\theta^n\tilde{\mu}^n+\log(\tau), \end{aligned}$$

the real exchange rate is given as

$$s^{h,f}=\frac{\gamma(1-\tau)}{(1-(1-\varepsilon_\alpha)\tau)\gamma-(\gamma-1)(1-\tau)\phi}\left[(1-\phi)\left(\tilde{\mu}^h-\tilde{\mu}^f\right)+y_N^h-y_N^f\right],$$

and the nominal exchange rate becomes

$$\begin{aligned}\tilde{s}^{h,f} &= \left(\frac{\gamma(1-\tau)}{((1-(1-\varepsilon_\alpha)\tau)\gamma-(1-\tau)(\gamma-1)\phi)}(1-\phi)-1\right)\left(\tilde{\mu}^h-\tilde{\mu}^f\right) \\ &\quad+\frac{\gamma(1-\tau)}{((1-(1-\varepsilon_\alpha)\tau)\gamma-(1-\tau)(\gamma-1)\phi)}\left(y_N^h-y_N^f\right).\end{aligned}$$

International spreads on stocks in the traded sector, on stocks in the non-traded sector, and on risk-free bonds are

$$\rho_T^{h,f}=((1-\tau)\phi\varepsilon_\alpha^{-1}+(1-\phi)\gamma(1-\tau)\varepsilon_\alpha^{-1}+\gamma\tau)(\varepsilon_\xi^{-1}-1)/\phi\left(\sigma_h^2\theta^h-\sigma_f^2\theta^f\right),$$

$$\begin{aligned}\rho_N^{h,f} &= \frac{\gamma^2(\phi-1)^2}{((1-(1-\varepsilon_\alpha)\tau)\gamma-(\gamma-1)(1-\tau)\phi)\phi}\left(\tilde{\sigma}_h^2\theta^h-\tilde{\sigma}_f^2\theta^f\right) \\ &\quad+\frac{[(\gamma-1)\phi+(\varepsilon_\alpha-1)\gamma](1-\tau)[(1-\tau)(\gamma-1)\phi-\tau\gamma(\varepsilon_\alpha-1)]}{((1-(1-\varepsilon_\alpha)\tau)\gamma-(\gamma-1)(1-\tau)\phi)\phi\varepsilon_\alpha}\left(\sigma_h^2\theta^h-\sigma_f^2\theta^f\right),\end{aligned}$$

and

$$\begin{aligned}\rho^{h,f} &= (1-\tau)\frac{\gamma^2(\phi-1)^2}{((1-(1-\varepsilon_\alpha)\tau)\gamma-(\gamma-1)(1-\tau)\phi)\phi}\left(\tilde{\sigma}_h^2\theta^h-\tilde{\sigma}_f^2\theta^f\right) \\ &\quad+(1-\tau)\frac{(1-(1-\varepsilon_\alpha)\tau)\gamma-(1-\tau)(\gamma-1)\phi-\gamma\varepsilon_\alpha}{(1-(1-\varepsilon_\alpha)\tau)\gamma-(1-\tau)(\gamma-1)\phi}\frac{\gamma}{\varepsilon_\alpha\phi}\left(\sigma_h^2\theta^h-\sigma_f^2\theta^f\right)\end{aligned}$$

respectively. Conditions 1 and 3 are

$$\gamma>\frac{\phi}{\varepsilon_\alpha-(1-\phi)}$$

and

$$\gamma>\frac{\phi(1-\tau)}{(\phi+((1-\phi)-\varepsilon_\alpha)\tau)}.$$

The calculations for the numerical example in section 5.1 are based on the following calculations. First, the predicted spread on nominal bonds is

$$\begin{aligned}\rho_{\text{nominal}}^{h,f} &= \frac{\gamma\varepsilon_\alpha-(1-(1-\varepsilon_\alpha)\tau)\gamma+(1-\tau)(\gamma-1)\phi}{(1-(1-\varepsilon_\alpha)\tau)\gamma-(1-\tau)(\gamma-1)\phi}\frac{\gamma(1-\tau)}{\varepsilon_\alpha\phi}\left(\sigma_h^2\theta^h-\sigma_f^2\theta^f\right) \\ &\quad+\frac{(1-\tau)\gamma^2(1-\phi)^2+\gamma(1-\phi)[(\gamma-1)(1-\tau)(1-\phi)+(1-\tau+\tau\gamma\varepsilon_\alpha)]}{((1-(1-\varepsilon_\alpha)\tau)\gamma-(\gamma-1)(1-\tau)\phi)\phi}\left(\tilde{\sigma}_h^2\theta^h-\tilde{\sigma}_f^2\theta^f\right)\end{aligned} \tag{41}$$

Under the assumption the variance of endowment and monetary shocks is identical across countries, the variance of the real exchange rate is

$$var\left(\Delta s\right)=2\frac{\left(g\left(1-\tau\right)\right)^{2}}{\left(\left(1-\left(1-\varepsilon_{\alpha}\right)t\right)g-\left(g-1\right)\left(1-t\right)\phi\right)^{2}}\left[(1-\phi)^{2}\tilde{\sigma}^{2}+\sigma^{2}\right] \tag{42}$$

and the variance of the nominal exchange rate is given as

$$\begin{aligned} var\left(\Delta\tilde{s}\right) &= 2\left(\frac{g\left(1-\tau\right)}{\left(\left(1-\left(1-\varepsilon_{\alpha}\right)t\right)g-\left(1-t\right)\left(g-1\right)\phi\right)}\left(1-\phi\right)-1\right)^{2}\tilde{\sigma}^{2} \\ &\quad +2\left(\frac{g\left(1-\tau\right)}{\left(\left(1-\left(1-\varepsilon_{\alpha}\right)t\right)g-\left(1-t\right)\left(g-1\right)\phi\right)}\right)^{2}\sigma^{2}. \end{aligned} \tag{43}$$

Substitute $\tilde{\sigma}_h = \tilde{\sigma}_f$ and ϕ out of (41) with (42) and (43) and plug in the values for the remaining parameters given in the text to obtain the implied estimates of γ.

G Within-Country Correlations

Proposition 4 *Given conditions 2 and 1, the difference in log expected returns between larger and smaller countries' risk-free and nominal bonds increases monotonically with the within-country covariance between endowments and monetary shocks, as well as with the within-country covariance between endowments in the traded and non-traded sectors.*
Given conditions 2, 1, and 3 the same is true for the difference in log expected returns between larger and smaller countries' stocks in the non-traded sector.

Proof. The difference in log expected returns between two countries risk-free bonds is given as

$$\begin{aligned} \rho^{h,f} &= \left(1-\tau\right)\frac{\gamma^{2}(\phi-1)^{2}}{\left(\left(1-\left(1-\varepsilon_{\alpha}\right)\tau\right)\gamma-\left(\gamma-1\right)\left(1-\tau\right)\phi\right)\phi}\left(\tilde{\sigma}_{h}^{2}\theta^{h}-\tilde{\sigma}_{f}^{2}\theta^{f}\right) \\ &\quad +\left(1-\tau\right)\frac{\left(1-\left(1-\varepsilon_{\alpha}\right)\tau\right)\gamma-\left(1-\tau\right)\left(\gamma-1\right)\phi-\gamma\varepsilon_{\alpha}}{\left(1-\left(1-\varepsilon_{\alpha}\right)\tau\right)\gamma-\left(1-\tau\right)\left(\gamma-1\right)\phi}\frac{\gamma}{\varepsilon_{\alpha}\phi}\left(\sigma_{h}^{2}\theta^{h}-\sigma_{f}^{2}\theta^{f}\right) \\ &\quad +\left(1-t\right)\varepsilon_{\alpha}^{-1}g\frac{\left(1-\phi\right)}{\phi}corr\left(\tilde{\mu},y_{T}\right)\left(\tilde{\sigma}_{h}\sigma_{h}\theta^{h}-\tilde{\sigma}_{f}\sigma_{f}\theta^{f}\right) \\ &\quad +\left(1-t\right)\varepsilon_{\alpha}^{-1}g\frac{\left(1-\phi\right)}{\phi}\frac{\left(\left(2-t\right)\varepsilon_{\alpha}g-\left[\left(1-\phi\right)g+\phi\right]\left(1-t\right)\right)}{\left(\left(1-t\left(1-\varepsilon_{\alpha}\right)\right)g-\left(1-t\right)\phi\left(g-1\right)\right)}corr\left(\tilde{\mu},y_{N}\right)\left(\tilde{\sigma}_{h}\sigma_{h}\theta^{h}-\tilde{\sigma}_{f}\sigma_{f}\theta^{f}\right) \\ &\quad +(1-t)\varepsilon_{\alpha}^{-1}g\frac{1}{\phi}corr\left(y_{T},y_{N}\right)\left(\sigma_{h}^{2}\theta^{h}-\sigma_{f}^{2}\theta^{f}\right). \end{aligned}$$

Proof of the first part of the statement thus amounts to observing that 2 and 1 are sufficient to ensure that the sign of each term is the sign of $\left(\theta^{h}-\theta^{f}\right)$.
The difference in log expected returns between two countries stocks in the non-traded sector

is given as

$$
\begin{aligned}
\rho_N^{h,f} \quad = \quad & \frac{\gamma^2 (\phi-1)^2}{((1-(1-\varepsilon_\alpha)\tau)\gamma-(\gamma-1)(1-\tau)\phi)\phi}\left(\tilde{\sigma}_h^2\theta^h-\tilde{\sigma}_f^2\theta^f\right) \\
& +\frac{[(\gamma-1)\phi+(\varepsilon_\alpha-1)\gamma](1-\tau)[(1-\tau)(\gamma-1)\phi-\tau\gamma(\varepsilon_\alpha-1)]}{((1-(1-\varepsilon_\alpha)\tau)\gamma-(\gamma-1)(1-\tau)\phi)\phi\varepsilon_\alpha}\left(\sigma_h^2\theta^h-\sigma_f^2\theta^f\right) \\
& +\varepsilon_\alpha^{-1} g\frac{(1-\phi)}{\phi} corr(\tilde{\mu}, y_T)\left(\tilde{\sigma}_h^2\theta^h-\tilde{\sigma}_f^2\theta^f\right) \\
& +g\frac{(1-\phi)}{\phi}\left[\varepsilon_\alpha^{-1}\frac{((2-t)\varepsilon_\alpha g-[(1-\phi)g+\phi](1-t))}{((1-t(1-\varepsilon_\alpha))g-(1-t)\phi(g-1))}-1\right] corr(\tilde{\mu}, y_N)\left(\tilde{\sigma}_h^2\theta^h-\tilde{\sigma}_f^2\theta^f\right) \\
& +\varepsilon_\alpha^{-1}\frac{(\phi(1-t)(g-1)-(\varepsilon_\alpha-1)gt)}{\phi} corr(y_N, y_T)\left(\sigma_h^2\theta^h-\sigma_f^2\theta^f\right),
\end{aligned}
$$

where again conditions 2, 1, and 3 are sufficient to ensure that each term has the same sign as $\left(\theta^h-\theta^f\right)$. The proof for nominal bonds is analogous. ■

H Numerical Solution

In the main part of the paper I employ two simplifying devices that enable me to provide closed-form analytical solutions: (1) I assume that active households receive transfers in the first period that de-centralize the allocation corresponding to the utilitarian welfare function, and (2) I log-linearize the model around the point at which $[y_T, y_N, \tilde{\mu}]' = 0$. This section gives a numerical solution to the model, demonstrating that neither of these two simplifying devices seem to matter for the results in any meaningful way.

The numerical algorithm used is a standard Gauss-Hermite quadrature (see Judd (1998)). I solve for the case in which the world economy consists of two countries, where the home country constitutes 55% of the world economy and the foreign country constitutes 45% of the world economy (i.e. $\theta^h - \theta^f = 0.1$). Moreover, I choose the same combination of parameters used for the calibrated numerical example in section 5.1: $\tau = 0.3$, $\varepsilon_\alpha = 1$, $\sigma = 0.05$, and $\tilde{\sigma}$ and ϕ are chosen to match the average standard deviation of the nominal and real exchange rates to the US Dollar in the data (these are 0.1145 and 0.1170, respectively). Finally, I set $e^{-\delta} = 0.95$ and choose μ such that the net present value of consumption is equalized between active and inactive households within each country. I choose 5 points approximating the log-normal distributions of each of the real and nominal shocks. The state-space thus consists of $5^6 = 15625$ possible combinations of these shocks.

I first quantify the inaccuracies stemming from the log-linearization. Column 1 of appendix table 3 list the international spreads on all four types of assets using the closed-form solutions derived in the main part of the paper. Column 2 gives the corresponding exact numerical solution. The log-approximation comes very close to the exact solutions in each case. For example, the log-approximated spread on nominal bonds is -0.0298 and the exact spread is

-0.0306. Generally, the log-approximation seems to underestimate the spreads slightly. Both the solution in column 1 and the solution in column 2 solve for the allocation corresponding to unit Pareto-Negishi weights. The transfer that de-centralizes this allocation is a payment of 0.1% of the total wealth of active households in the home country to those in the foreign country.

If no transfers are made, households initial wealth is a function of the first-period value of the claims to the endowments they receive in the second period. By numerically solving a fixed point problem between equilibrium spreads and the net present value of these endowments we can identify the Social Planner's problem that corresponds to this allocation. For the present numerical example this problem gives home households Pareto-Negishi weights that exceed those of foreign households by factor 1.008 in order to account for the endogenous differences in wealth between the residents of both countries. Column 3 of appendix table 3 gives the spreads on the four types of international assets for this allocation. The values in columns 2 and 3 are almost exactly identical.

The conclusion from this table is that while the log-approximation generates small quantitative inaccuracies, the assumption of first-period transfers that de-centralize the allocation corresponding to unit Pareto-Negishi weights seems to be almost completely innocuous.

I Data Appendix

This section gives details on the sources of the data series used.

I.1 Interest Rates

I use interbank interest rates at the short end of the yield curve as data on government bonds with maturity of under one year are not widely available. At maturities of over one year I use government bond yields. The data on interest rates at the 3-month, 6-month, and 5-year horizons are sourced from the Global Financial Data online database (GFD) and the rates at the 2-year and 3-year horizons are sourced from Thompson Financial Datastream (DS). In each case I picked the source with the widest coverage of OECD countries throughout the sample period. Yields on Government bonds of a particular maturity refer to the average yield on a basket of traded government bonds within a certain band around the desired maturity. See the data providers' websites for details on their respective methodologies. The series in detail are:

- **3 and 6-month interbank rates** (GFD): Series symbols are IB*ccg*3D and IB*ccg*3D. After 1998 interbank rates are not available for individual EMU member countries.
- **Yields on 5-year government bonds** (GFD): Series symbols are IG*ccg*5D.

- **Yields on 2 and 3 year government bonds** (DS): Series mnemonics are BM*ccd*02Y(RA) and BM*ccd*03Y(RA).

ccg and *ccd* refer to the country codes used by GFD and DS respectively. In each case, the data refers to the last trading day of the quarter.

I.2 Industry Stock Return Indices

The industry stock return indices are sourced from Thompson Financial Datastream (DS).The mnemonics of the series used for the construction of

- **stock returns in the non-traded sector** are mv/riFINAN*ccd*, mv/riCNSMS*ccd*, and mv/riHLTHC*ccd*,
- **stock returns in the traded sector** are mv/riINDUS*ccd*, mv/riCNSMG*ccd*, and mv/riBMATR*ccd*.

mv/ri =RI gives the mnemonic for the stock return index of the sector in question, mv/ri =MV gives the mnemonic for the total market valuation of the stocks in the index, and *ccd* refers to the country code used by DS. The domestic return in the non-traded sector used in the text is calculated as

$$dr^j_{N,t} = \log\left(\frac{\frac{RICNSMS^j_{t+1}}{RICNSMS^j_t}MVCNSMS_t + \frac{RIFINAN^j_{t+1}}{RIFINAN^j_t}MVFINAN_t + \frac{RIHLTHC^j_{t+1}}{RIHLTHC^j_t}MVHLTHC_t}{MVCNSMS_t + MVFINAN_t + MVHLTHC_t}\right)$$

and the domestic return in the traded sector is calculated as

$$dr^j_{T,t} = \log\left(\frac{\frac{RIINDUS^j_{t+1}}{RIINDUS^j_t}MVINDUS_t + \frac{RICNSMG^j_{t+1}}{RICNSMG^j_t}MVCNSMG_t + \frac{RIBMATR^j_{t+1}}{RIBMATR^j_t}MVBMATR_t}{MVINDUS_t + MVCNSMG_t + MVBMATR_t}\right),$$

where the variables in the formula refer directly to the mnemonic of the series.

I.3 Exchange Rates

The main data on exchange rates is the end of quarter nominal exchange rate to the US Dollar obtained from the International Financial Statistics online database (IFS). In the construction if bid-ask spreads I use the same series used by Burnside et al. (2006), which are from DS. I copy their procedure in using the difference between bid and ask interbank spot exchange rates in the London market against the British Pound, where the I take the UK bid-ask spread to be the British Pound against US Dollar spread. The series in detail are:

- **Nominal spot exchange rate to US Dollar** (IFS): Series symbols are *cci*..AE.ZF.

- **Bid and ask spot exchange rate to British Pound** (DS): Series symbols are UKDOLLR(Eb/o), AUSTDOL(Eb/o), AUSTSCH(Eb/o), BELGLUX(Eb/o), CNDOLLR(Eb/o), CZECHCM(Eb/o), DANISHK(Eb/o), ECURRSP(Eb/o), FINMARK(Eb/o), FRENFRA(Eb/o), DMARKER(Eb/o), GREDRAC(Eb/o), HUNFORT(Eb/o), ICEKRON(Eb/o), IPUNTER(Eb/o), ITALIRE(Eb/o), JAPAYEN(Eb/o), FINLUXF(Eb/o), GUILDER(Eb/o), NZDOLLR(Eb/o), NORKRON(Eb/o), POLZLOT(Eb/o), PORTESC(Eb/o), SLOVKOR(Eb/o), SPANPES(Eb/o), SWEKRON(Eb/o), SWISSFR(Eb/o), USDOLLR(Eb/o), KORSWON(Eb/o).

cci refers to the country codes in the IFS database. Bid rates are obtained with mnemonics in which b/o =B and ask rates are obtained with mnemonics in which b/o =O.

I.4 Macroeconmic Data

Quarterly GDP data in terms of US Dollars, consumer price indices, and are from Global Financial Data. The series in detail are

- **GDP** (GFD): Series symbols are GDP*ccg*M, where the data for Japan, Italy, and South Korea are given in billions rather than millions.
- **Population** (GFD): Series symbols are POP*ccg*
- **Consumer Price Indices** (GFD): Series symbols are CP*ccg*M, where the series symbol for the UK and the Euro area are CPGBRCM.and CPEUR12 respectively.
- **M1 Money Balances** (IFS): Series symbols are *cci*59MA, where M1 for Australia, New Zealand, Slovak Republic, and Poland are listed in millions of the national currency, Japan is listed in trillions of Yen, and the data for all other countries are in billions of the national currency.

ccg refers to the country codes used by GFD.

I.5 Country Credit Ratings

The data on country credit ratings are the long-term government debt ratings from Moody's and Standard and Poor's obtained through Bloomberg Finance. I coded the data off the screen as these series do not seem to be downloadable. The coded ratings are on a scale of 0 to 20, where 0 corresponds to no rating and 20 corresponds to AAA/Aaa, AA+/Aa1 corresponds to a rating of 19, AA/Aa2 to 17, etc. I did not code positive or negative indications when credit ratings came under review. Since there is no rating available for the European Union I assigned it a score of 20.

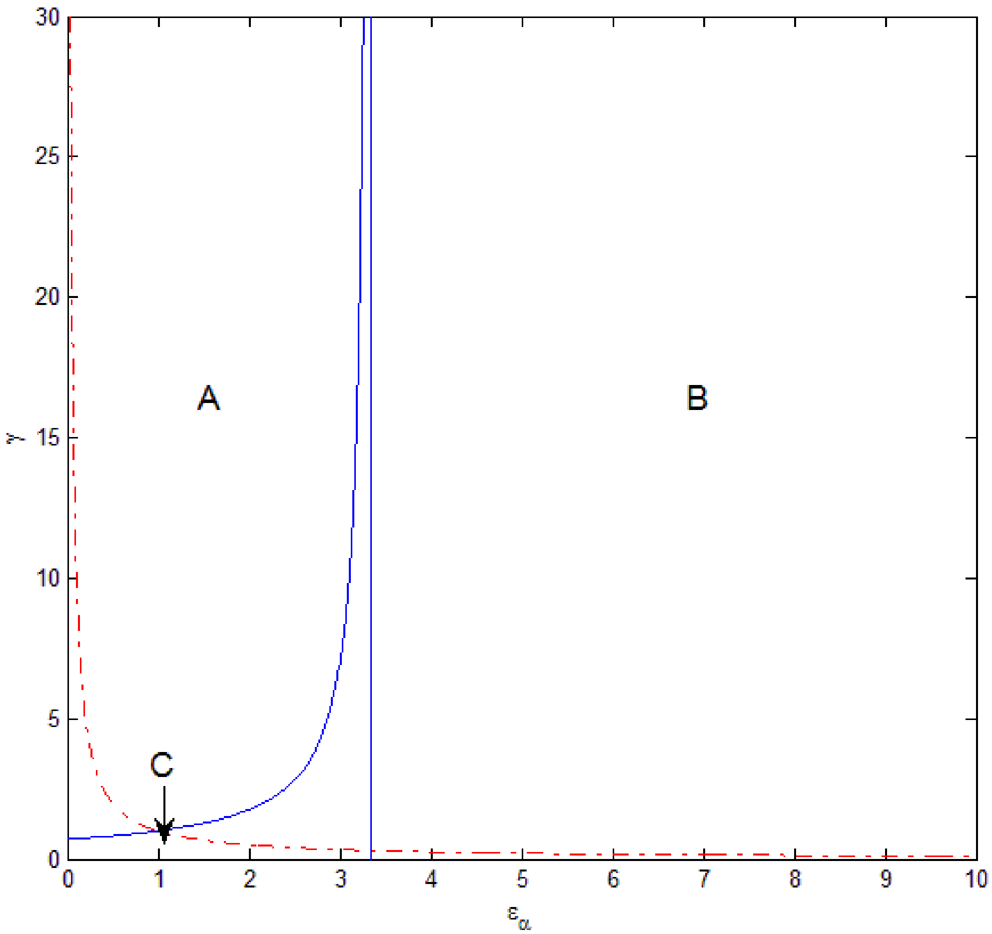

Figure 1: This figure plots the restrictions on the parameter space required in propositions 1 and 2 for $\tau = 0.3$: All combinations north-east of the broken line satisfy condition 1 which is required for both propositions 1 and 2. The combinations above the solid line satisfy condition 3 which is required only by proposition 2.

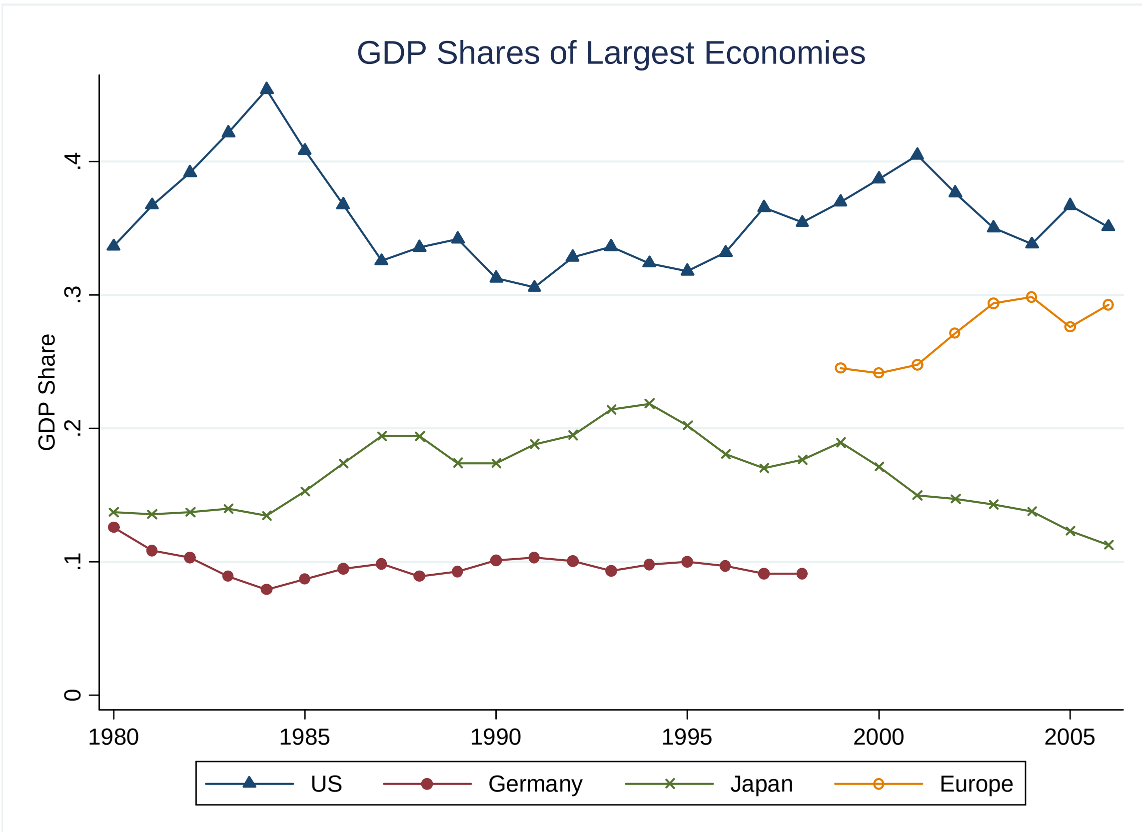

Figure 2: Shares of OECD GDP 1980-2007 for United States, Germany, Japan and the Euro Area (after 1998) at annual frequency.

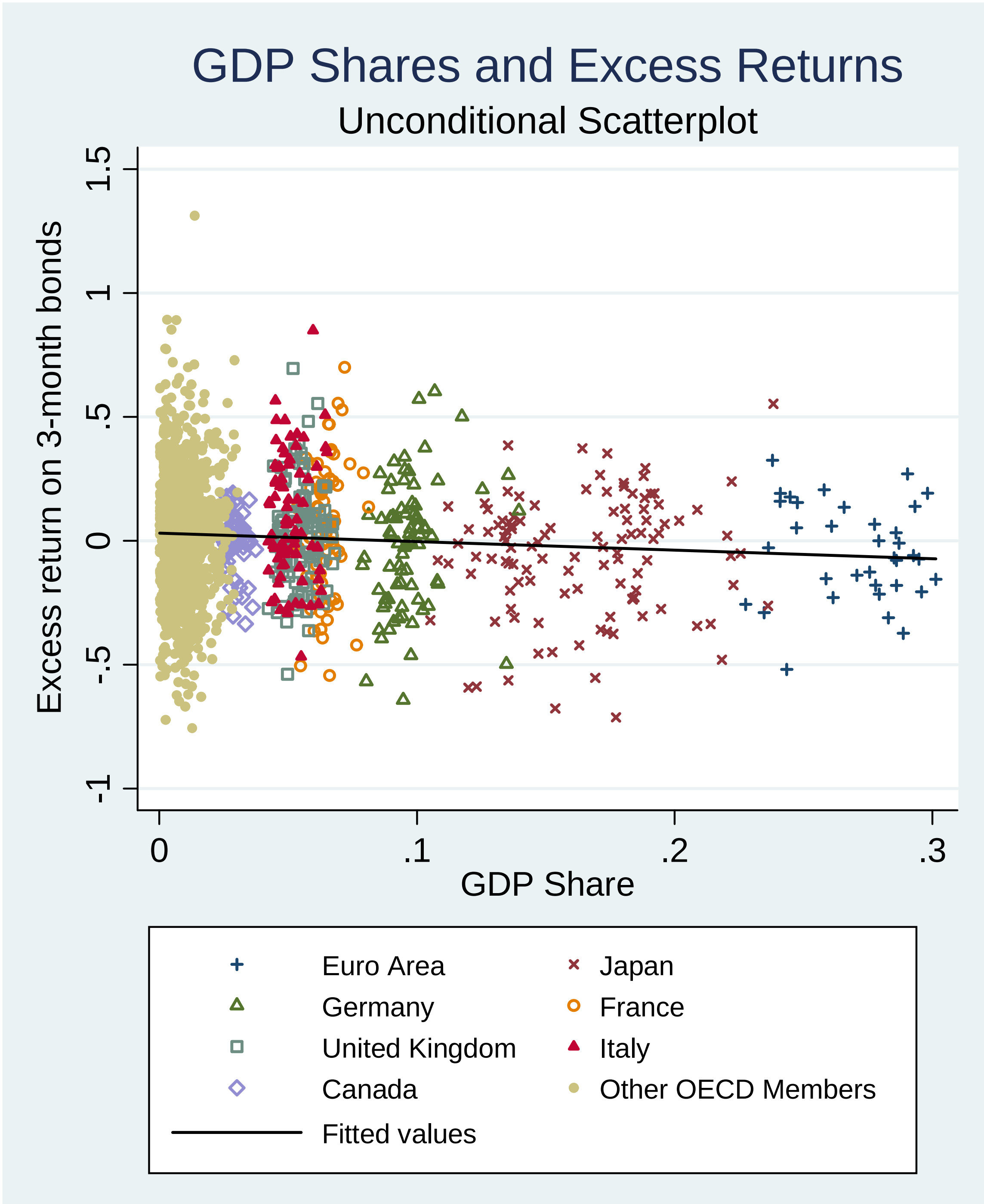

Figure 3: Unconditional scatterplot relating log real excess returns to maturity to a US investor on 3-month bonds (interbank rates) of different OECD countries to the GDP share of the country in question. The slope on the fitted values (-0.346, s.e.=0.076) corresponds to the specification in table 2, column 1. The sample consists of quarterly data for OECD countries 1980-2007, excluding Mexico and Turkey. After 1998 countries that joined the European Monetary Union are dropped from the sample and replaced by a single observation for the Euro Area. See table 2 for details.

Table 1
Descriptive Statistics

	(1)	(2)	(3)	(4)	(5)
	Obs.	*Mean*	*Std.Dev.*	*Min*	*Max*
GDP Share	1885	0.055	(0.095)	0.000	0.458
M1 Share	1358	0.080	(0.118)	0.001	0.492
Annualized Yield on 3-Month Bond (interbank rates)	1885	0.081	(0.050)	0.000	0.344
Annualized Yield on 5-Year Bond (gov. debt)	1568	0.074	(0.036)	0.002	0.213
Qtrly Domestic Rtrn on Portfolio of 'Traded' Industries	1548	0.030	(0.130)	-0.674	0.509
Qtrly Domestic Rtrn on Portfolio of 'Non-Traded' Industries	1588	0.035	(0.111)	-0.631	0.476
Qtrly Growth in Nominal Exchange Rate to US-Dollar	1885	0.000	(0.056)	-0.186	0.286
Quarterly Inflation	1876	0.010	(0.012)	-0.018	0.087
Bid Ask Spread on Currency	1885	0.002	(0.002)	0.000	0.020
Country Credit Rating	1105	18.956	(1.834)	14	20
Variance of Exchange Rate	1885	0.012	(0.005)	0.000	0.049
Domestic Variance of 'Traded' Portfolio Returns	1822	0.017	(0.006)	0.009	0.052
Domestic Variance of 'Non-traded' portfolio returns	1822	0.013	(0.007)	0.007	0.064

Note: The sample consists of quarterly data for OECD countries 1980-2007, excluding Mexico and Turkey. Countries enter the sample upon joining the OECD or when data becomes available. After 1998 countries that joined the European Monetary Union are dropped from the sample and replaced by a single observation for the Euro Area. GDP Share is countries' share in total OECD output at each point in time and M1 Share is countries' share in total OECD M1 money balances at each point in time. Both series are adjusted for fluctuations in the sample. Annualized Yield on 3-Month Bond is the annualized 3-month LIBOR (or national equivalent) interbank rate. Annualized Yield on 5-Year Bond is the annualized yield to maturity on government debt at the 5 year horizon. Qtrly Domestic Rtrn on Portfolio of 'Traded' ('Non-Traded') Industries is the quarterly domestic currency return on a value-weighted portfolio of industry return indices which are taken to produce mainly tradable (non-tradable) output; where the 'Basic Materials'; 'Consumer Goods'; and 'Industrials' industries are classified as producing mainly tradable output and the 'Health Care'; 'Consumer Services'; and 'Financials' industries are classified as producing mainly non-tradable output. Qtrly Growth in Nominal Exchange Rate to US Dollar is the quarterly growth in the price of one US Dollar in terms of the national currency. Quarterly Inflation is the quarterly growth of the national consumption price index. Bid-Ask Spread on Currency is the offer rate minus the bid rate on the national currency in the London market. Country Credit Rating is the average of Moody's and S&P country credit ratings converted to a scale of 0 to 20, where 20 represents a rating of AAA. Variance of Exchange Rate is the variance of the bilateral nominal exchange rate of the national currency with the US Dollar. Domestic Variance of 'Traded' ('Non-Traded') Portfolio Returns is the variance of the Qtrly Domestic Rtrn on Portfolio of 'Traded' ('Non-Traded') Industries variable. See data appendix for details.

Table 2
GDP Shares and Excess Returns (Prediction 1)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Excess return on 3-month bonds						
GDP Share	-0.346*	-0.353*	-0.349*	-0.298*	-0.284*	-0.234*	-0.123*
	(0.076)	(0.076)	(0.074)	(0.069)	(0.068)	(0.069)	(0.032)
Variance of Exchange Rate		-2.067*	-2.225*	-1.696*	-1.418+	-2.952*	-2.604*
		(0.818)	(0.898)	(0.801)	(0.791)	(0.854)	(0.778)
Country Credit Rating			0.001	-0.008*	-0.004	-0.010*	-0.009*
			(0.007)	(0.003)	(0.004)	(0.003)	(0.003)
Unrated Dummy			0.006	-0.152*	-0.073	-0.171*	-0.169*
			(0.120)	(0.054)	(0.076)	(0.053)	(0.053)
Bid-Ask Spread on Currency			7.243+	5.494*	5.281*	3.549+	5.271*
			(3.844)	(1.945)	(1.956)	(1.977)	(1.999)
GDP per Capita					-0.001		
					(0.000)		
Variance of Inflation						70.754*	
						(13.924)	
Constant	-0.094*	-0.070*	-0.074*	-0.067*	-0.069*	-0.039	
	(0.028)	(0.026)	(0.026)	(0.025)	(0.025)	(0.025)	
R^2	0.006	0.007	0.009	0.670	0.672	0.678	
N	1774	1774	1774	1774	1765	1774	1774
Time fixed effects	no	no	no	yes	yes	yes	yes
S.E. clustered by time	yes	yes	yes	no	no	no	no

Note: OLS regressions with robust standard errors in parentheses. In columns 1-3 standard errors are clustered by time. All other specifications contain time fixed effects, which are not reported and are constrained to sum to zero, $\sum_t \delta_t = 0$. Columns 1-6 contain a constant term, whereas the specification in column 7 does not. Dependent variable is the annualized log real excess return to maturity to a US investor on 3-month bonds (interbank rates). The sample consists of quarterly data for OECD countries 1980-2007, excluding Mexico and Turkey. Countries enter the sample upon joining the OECD or when data becomes available. After 1998 countries that joined the European Monetary Union are dropped from the sample and replaced by a single observation for the Euro Area. GDP Share is countries' share in total OECD output at each point in time, adjusted for fluctuations in the sample. Variance of Exchange Rate is the variance of the bilateral nominal exchange rate of the national currency with the US Dollar. Country Credit Rating is the average of Moody's and S&P country credit ratings converted to a scale of 0 to 20, where 20 represents a rating of AAA. For time periods before their initial rating countries receive a score of 0. Unrated Dummy is a fixed effect for these observations. Bid-Ask Spread on Currency is the offer rate minus the bid rate on the national currency. GDP per Capita is GDP per capita in US Dollars. Variance of Inflation is the variance of the national inflation rate as measured by the consumer price index. See data appendix for details. All independent variables are differenced with the US time average.

Table 3
Alternative Specifications (Prediction 1)

	(1)	(2)	(3)	(4)
Panel A	*Excess return on 3-month bonds*			
GDP Share * Variance Exchange Rate	-26.905*	-151.883*		
	(5.843)	(32.690)		
GDP Share * Variance GDP			-11.494*	
			(2.707)	
GDP Share * Variance Inflation				-12.200*
				(5.237)
GDP Share		1.587*		
		(0.369)		
Variance of GDP			0.950*	
			(0.194)	
Variance of Inflation				75.951*
				(13.863)
Variance of Exchange Rate	-1.115	1.650	-2.539*	-3.103*
	(0.802)	(1.076)	(0.850)	(0.870)
R^2	0.671	0.674	0.673	0.677
N	1774	1774	1774	1774
Time fixed effects	yes	yes	yes	yes
Constant term included	yes	yes	yes	yes
Panel B	*Interest rate differential*		*Excess return 3-mo. bonds*	
GDP Share	-0.213*	-0.096*	-0.291*	-0.183*
	(0.016)	(0.007)	(0.140)	(0.087)
R^2	0.364		0.332	
N	1774	1774	45	45
Time fixed effects	yes	yes	yes	yes
Constant term included	yes	no	yes	no

Note: OLS regressions with robust standard errors in parentheses. All specifications are analogous to the standard specification in column 4 of Table 2: They contain controls for Variance of Exchange Rate; Country Credit Rating; and Bid-Ask Spread on Currency; they also contain a complete set of time fixed effects, which are constrained to sum to zero, $\sum_t \delta_t = 0$ (see the caption of table 1 and the data appendix for details). All specifications except those in columns 2 and 4 of Panel B contain a constant term. Panel A of this table explores a number of specifications which control for differences in the variance of real and nominal shocks in a more structural manner. Dependent variable in Panel A and is the annualized log real excess return to maturity to a US investor on 3-month bonds. Column 1 of panel B re-estimates the standard specification with only the interest rate differential to the United States as dependent variable. Column 2 of panel B drops the constant term. Column 3 of Panel B re-estimates the standard specification with time averages over the periods 1980-1990, 1991-1998, and 1999-2007, and column 4 again drops the constant term. The sample consists of quarterly data for OECD countries 1980-2007, excluding Mexico and Turkey. Countries enter the sample upon joining the OECD or when data becomes available. After 1998 countries that joined the European Monetary Union are dropped from the sample and replaced by a single observation for the Euro Area. GDP Share is countries' share in total OECD output at each point in time, adjusted for fluctuations in the sample. Variance of Exchange Rate is the variance of the bilateral nominal exchange rate of the national currency with the US Dollar. Variance of GDP is the variance of real GDP growth, deflated with the national consumer price index. Variance of Inflation is the variance of the national inflation rate as measured by the consumer price index. All independent variables are differenced with the US time average.

Table 4
Yield Curve (Prediction 1)

	(1)	(2)	(3)	(4)	(5)
Panel A	*Excess return on bonds of different maturities*				
Maturity	*3mo*	*6mo*	*2y*	*3y*	*5y*
GDP Share	-0.192+	-0.182*	-0.169*	-0.179*	-0.194*
	(0.102)	(0.074)	(0.036)	(0.030)	(0.023)
Constant	-0.010	-0.014	-0.006	-0.011	-0.030*
	(0.039)	(0.028)	(0.014)	(0.011)	(0.009)
R^2	0.663	0.671	0.733	0.738	0.765
N	818	818	818	818	818
Panel B	*Excess return on bonds of different maturities*				
Maturity	*3mo*	*6mo*	*2y*	*3y*	*5y*
GDP Share	-0.157*	-0.143*	-0.136*	-0.127*	-0.091*
	(0.073)	(0.052)	(0.023)	(0.018)	(0.015)
R^2					
N	818	818	818	818	818
Time fixed effects	yes	yes	yes	yes	yes
S.E. clustered by country	no	yes	yes	yes	yes

Note: OLS regressions with robust standard errors in parentheses. In columns 2-5 standard errors are clustered by country. All specifications are analogous to the standard specification in column 4 of Table 2: They contain but do not report controls for Variance of Exchange Rate; Country Credit Rating; and Bid-Ask Spread on Currency (see the caption of table 1 and the data appendix for details). All specifications contain time fixed effects, which are constrained to sum to zero, $\sum_t \delta_t = 0$. The specifications in Panel A contain a constant term, whereas the specifications in Panel B do not. Dependent variable in both panels is the annualized log real excess return to maturity to a US investor on bonds of different maturities. Columns 1 and 2 use interbank rates, while columns 3-5 use government bonds. The sample consists of quarterly data for the 16 OECD countries 1980-2007 for which data at all maturities is available. Countries enter the sample upon joining the OECD or when data becomes available. After 1998 countries that joined the European Monetary Union are dropped from the sample and replaced by a single observation for the Euro Area. GDP Share, is countries' share in total OECD output at each point in time, adjusted for fluctuations in the sample. All independent variables are differenced with the US time average.

Table 5
Subsets of Countries (Prediction 1)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A				*Excess return on 3-month bonds*			
GDP Share	-0.298*	-0.477*	-0.088+	-0.259*	-0.321*	-0.330*	-0.315*
	(0.069)	(0.102)	(0.053)	(0.109)	(0.123)	(0.070)	(0.071)
Constant	-0.066*	-0.128*	0.001	-0.056	-0.091*	-0.059*	-0.058*
	(0.024)	(0.035)	(0.019)	(0.038)	(0.043)	(0.027)	(0.024)
R^2	0.670	0.669	0.697	0.694	0.554	0.688	0.717
N	1774	1739	1663	1628	1035	1601	1526
Panel B				*Excess return on 3-month bonds*			
GDP Share	-0.124*	-0.128*	-0.082*	-0.085*	-0.099*	-0.192*	-0.165*
	(0.032)	(0.033)	(0.031)	(0.032)	(0.033)	(0.045)	(0.038)
R^2							
N	1774	1739	1663	1628	1035	1601	1526
Time fixed effects	yes	yes	yes	yes	yes	yes	yes
Sample Excludes		Euro Area	Japan	Euro Area, Japan	Euro Area, EMU countries pre 1998	Countries joining OECD after 1980	Resource dependent countries

Note: OLS regressions with robust standard errors in parentheses. All specifications are analogous to the standard specification in column 4 of Table 2: They contain but do not report controls for Variance of Exchange Rate; Country Credit Rating; and Bid-Ask Spread on Currency (see the caption of table 1 and the data appendix for details). All specifications contain time fixed effects, which are constrained to sum to zero, $\sum_t \delta_t = 0$. The specifications in Panel A contain a constant term, whereas the specifications in Panel B do not. Dependent variable in both panels is the annualized log real excess return to maturity to a US investor on 3-month bonds (interbank rates). The sample consists of quarterly data for OECD countries 1980-2007, excluding Mexico and Turkey. Countries enter the sample upon joining the OECD or when data becomes available. After 1998 countries that joined the European Monetary Union are dropped from the sample and replaced by a single observation for the Euro Area. Column 1 uses the entire sample; Columns 2 and 3 drop the Euro Area and Japan respectively. Column 4 drops the Euro Area and Japan simultaneously. Column 5 drops all Euro Area countries pre and post the establishment of the currency union. Column 6 drops countries that join the OECD post 1980: Czech Republic; Hungary; South Korea; Poland; and the Slovak Republic. Column 7 drops highly resource dependent economies: Australia; Canada; and Norway. GDP Share is countries' share in total OECD output at each point in time, adjusted for fluctuations in the sample. All independent variables are differenced with the US time average.

Table 6
Currency Unions and Use of Currency Abroad (Prediction 2)

	(1)	(2)	(3)	(4)	(5)
	Excess return on 5-year government bonds				
GDP Share	-0.249*	-0.250*	-0.037	-0.192*	-0.113*
	(0.061)	(0.060)	(0.082)	(0.052)	(0.038)
Euro Area Dummy	-0.015*				
	(0.007)				
(M1 Share - GDP Share)*Euro Area		-0.030*	-0.168*		
		(0.014)	(0.042)		
(M1 Share - GDP Share)*Not Euro Area			-0.301*		
			(0.094)		
(M1 Share - GDP Share)				-0.079*	-0.073*
				(0.028)	(0.034)
R^2	0.756	0.756	0.771	0.762	
N	1081	1081	1081	1081	1081
Constant term included	yes	yes	yes	yes	no
Time fixed effects	yes	yes	yes	yes	yes
S.E. clustered by country	yes	yes	yes	yes	yes

Note: OLS regressions with robust standard errors in parentheses. All specifications are analogous to the standard specification in column 4 of Table 2: They contain but do not report controls for Variance of Exchange Rate; Country Credit Rating; and Bid-Ask Spread on Currency (see the caption of table 1 and the data appendix for details). All specifications contain time fixed effects, which are constrained to sum to zero, $\sum_t \delta_t = 0$. The specifications in columns 1-4 contain a constant term, whereas the specification in column 5 does not. Dependent variable is the annualized log real excess return to maturity to a US investor on 5-year government bonds. The sample consists of quarterly data for OECD countries 1980-2007, excluding Mexico and Turkey. Countries enter the sample upon joining the OECD or when data becomes available. Euro Area countries remain in the sample after 1998. They are assigned their national GDP Share and the M1 Share of the Euro. M1 Share is the national currency's share in total OECD money balances at each point in time, adjusted for fluctuations in the sample. M1 Share - GDP Share is the difference between countries' share in total OECD money balances and their share in total OECD GDP. Euro Area Dummy is a fixed effect for Euro Area countries after 1998; and Not Euro Area is a fixed effect for the complementary set of observations. All independent variables are differenced with the US.

Table 7
Stocks in 'Non-Traded' Industries (Predictions 3 & 4)

	(1)	(2)	(3)	(4)	(5)	(6)
	Excess return on portfolio of 'non-traded' industries					
GDP Share	-0.745*	-0.749*	-0.755*	-0.884*	-0.663*	-0.102
	(0.240)	(0.240)	(0.240)	(0.326)	(0.243)	(0.097)
Euro Area Dummy		-0.043*				
		(0.021)				
(M1 Share - GDP Share)*Euro Area			-0.079*	0.001		
			(0.038)	(0.151)		
(M1 Share - GDP Share)*Not Euro Area				0.178		
				(0.328)		
(M1 Share - GDP Share)					-0.125+	-0.200*
					(0.067)	(0.068)
Domestic Variance of 'Non-Trad.' Portfolio	5.096+	5.639*	5.652*	5.561*	5.647*	6.037*
	(2.618)	(2.630)	(2.633)	(2.639)	(2.638)	(2.636)
R^2	0.473	0.474	0.474	0.474	0.474	
N	1537	1537	1537	1537	1537	1537
Constant term included	yes	yes	yes	yes	yes	no
Time fixed effects	yes	yes	yes	yes	yes	yes

Note: OLS regressions with robust standard errors in parentheses. All specifications are analogous to the standard specification in column 4 of Table 2: They contain but do not report controls for Variance of Exchange Rate; Country Credit Rating; and Bid-Ask Spread on Currency (see the caption of table 1 and the data appendix for details). All specifications contain time fixed effects, which are constrained to sum to zero, $\sum_t \delta_t = 0$. The specifications in columns 1-5 contain a constant term, whereas the specification in column 6 does not. Dependent variable is the annualized log real excess return to a US investor of investing in a value-weighted portfolio of 3 industry stock return indices of other OECD countries versus the corresponding US portfolio of indices. These industries can broadly be interpreted as providing localized services and therefore the non-tradable sector: Health Care; Consumer Services; and Financials (Indices for the telecommunications industry and for utilities are also available for some countries but are not used do to their limited coverage). All indices are sourced from Thompson Financial Datastream. The sample consists of quarterly data for the 24 OECD countries that are covered by the Datastream indices, 1980-2007. Euro Area countries remain in the sample after 1998. They are assigned their national GDP Share and the M1 Share of the Euro. M1 Share is the national currency's share in total OECD money balances at each point in time, adjusted for fluctuations in the sample. M1 Share - GDP Share is the difference between countries' share in total OECD money balances and their share in total OECD GDP. Domestic Variance of Non-Trad. Portfolio is the local-currency variance of returns of the portfolio of indices. Euro Area Dummy is a fixed effect for Euro Area countries after 1998; and Not Euro Area is a fixed effect for the complementary set of observations. All independent variables are differenced with the US time average.

Table 8
Domestic Return Differential between Traded and Non-Traded Sectors (Prediction 4)

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A	*Domestic return differential, 'non-traded' - 'traded'*					
Euro Area Dummy	-0.016*					
	(0.005)					
(M1 Share - GDP Share)*Euro Area		-0.054*	-0.059*	-0.060*		
		(0.014)	(0.015)	(0.016)		
(M1 Share - GDP Share)*Not Euro Area				-0.049		
				(0.072)		
(M1 Share - GDP Share)					-0.061*	-0.055*
					(0.016)	(0.015)
GDP Share			-0.078	-0.038	-0.029	-0.019
			(0.050)	(0.069)	(0.050)	(0.019)
Domestic Variance of 'Trad.' Portfolio			-0.247	-0.236	-0.234	-0.181
			(0.604)	(0.604)	(0.605)	(0.573)
Domestic Variance of 'Non-Trad.' Portfolio			0.592	0.634	0.642	0.580
			(0.909)	(0.917)	(0.912)	(0.895)
R^2	0.007	0.007	0.007	0.007	0.007	0.006
N	1421	1421	1421	1421	1421	1532
USA included	no	no	no	no	no	yes

Note: OLS regressions with robust standard errors in parentheses. Dependent variable is the quarterly log return differential measured in local currency between a portfolio of industry stock return indices in the non-traded sector and a portfolio of industry stock return indices in the traded sector. The former is constructed from return indices for Health Care; Consumer Services; and Financials and the latter from return indices for Basic Materials; Consumer Goods; and Industrials. Both portfolios are value-weighted and all indices are sourced from Thompson Financial Datastream. The sample consists of quarterly data for the 24 OECD countries that are covered by the Datastream indices, 1980-2007. Euro Area countries remain in the sample after 1998. They are assigned their national GDP Share and the M1 Share of the Euro. M1 Share is the national currency's share in total OECD money balances at each point in time, adjusted for fluctuations in the sample. M1 Share - GDP Share is the difference between countries' share in total OECD money balances and their share in total OECD GDP. Variance of Industry Returns is the (domestic) variance of returns in a given country-industry pair. Euro Area Dummy is a fixed effect for Euro Area countries after 1998; and Not Euro Area is a fixed effect for the complementary set of observations. Domestic Variance of Trad. (Non-Trad.) Portfolio is the local-currency variance of log returns of the portfolio of indices in the traded (non-traded) sector.

Appendix Table 1
Alternative Standard Errors and Estimators

	(1)	(2)	(3)	(4)
Panel A	*Excess return on 3-month bonds*			
Estimator	*OLS/FE*	*OLS/FE*	*OLS*	*Fama-McB*
Standard Errors	*White*	*Roger*	*Thompson*	
GDP Share	-0.298*	-0.298+	-0.343*	-0.269*
	(0.069)	(0.171)	(0.106)	(0.082)
R^2	0.670	0.670	0.013	
N	1774	1774	1774	1774
Time fixed effects	yes	yes	no	-
S.E. clustered by time	no	no	yes	-
S.E. clustered by country	no	yes	yes	-

Note: This table re-estimates the standard specification in Table 2 column 4 using different estimators and standard errors. Column 1 replicates the standard specification for comparison. It reports (White) robust standard errors. Column 2 reports Roger standard errors clustered by country for the same specification. In Column 3, time fixed effects are dropped and standard errors are clustered by both time and country. Column 5 gives the Fama-MacBeth coefficients and standard errors. All specifications contain but do not report a constant and controls for Variance of Exchange Rate; Country Credit Rating; and Bid-Ask Spread on Currency (see the caption of table 1 and the data appendix for details).

Appendix Table 2
Stocks in 'Traded' Industries

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A	*Excess return on portfolio of 'traded' industries*					
GDP Share	-0.337	-0.348	-0.353	-0.359	-0.284	0.116
	(0.267)	(0.268)	(0.269)	(0.340)	(0.269)	(0.110)
Euro Area Dummy		-0.032				
		(0.027)				
(M1 Share - GDP Share)*Euro Area			-0.059	-0.056		
			(0.048)	(0.148)		
(M1 Share - GDP Share)*Not Euro Area				0.008		
				(0.305)		
(M1 Share - GDP Share)					-0.101	-0.137
					(0.085)	(0.085)
Domestic Variance of 'Trad.' Portfolio	1.830	1.953	1.943	1.944	1.913	2.951
	(1.993)	(2.005)	(2.003)	(2.007)	(2.000)	(1.886)
R^2	0.408	0.409	0.409	0.408	0.409	
N	1535	1535	1535	1535	1535	1535
Constant term included	yes	yes	yes	yes	yes	no
Time fixed effects	yes	yes	yes	yes	yes	yes

Note: OLS regressions with robust standard errors in parentheses. All specifications are analogous to the standard specification in column 4 of Table 2: They contain but do not report controls for Variance of Exchange Rate; Country Credit Rating; and Bid-Ask Spread on Currency (see the caption of table 1 and the data appendix for details). All specifications contain time fixed effects, which are constrained to sum to zero, $\sum_t \delta_t = 0$. The specifications in columns 1-5 contain a constant term, whereas the specification in column 6 does not. Dependent variable is the annualized log real excess return to a US investor of investing in a value-weighted portfolio of 3 industry stock return indices of other OECD countries versus the corresponding US portfolio of indices. These industries can broadly be interpreted as producing tradable output: Basic Materials; Consumer Goods; and Industrials (An index for the high technology sector is also available for some countries but is not used do to its limited coverage). All indices are sourced from Thompson Financial Datastream. The sample consists of quarterly data for the 24 OECD countries that are covered by the Datastream indices, 1980-2007. Euro Area countries remain in the sample after 1998. They are assigned their national GDP Share and the M1 Share of the Euro. M1 Share is the national currency's share in total OECD money balances (in terms of US Dollars) at each point in time, adjusted for fluctuations in the sample. M1 Share - GDP Share is the difference between countries' share in total OECD money balances and their share in total OECD GDP. Domestic Variance of Non-Trad. Portfolio is the local-currency variance of returns of the portfolio of indices. Euro Area Dummy is a fixed effect for Euro Area countries after 1998; and Not Euro Area is a fixed effect for the complementary set of observations. All independent variables are differenced with the US time average.

Appendix Table 3
Numerical Integration

	(1)	(2)	(3)
	Spreads Between Home and Foreign Assets		
	Utilitarian Weights		*Endogenous Weights*
	log-approximation	*exact solution*	*exact solution*
Risk-free bond	-0.0115	-0.0120	-0.0119
Nominal bond	-0.0298	-0.0306	-0.0306
Stock in non-traded sector	-0.0142	-0.0147	-0.0147
Stock in traded sector	0.0000	0.0000	0.0000

Note: This table compares the spreads computed using the log-approximated analytical solutions in the text with an exact numerical solution, and with the (exact) spreads corresponding to an allocation in which Pareto-Negishi weights are endogenous to the value of endowments received by households. In this numerical example, the world economy consists of two countries, where the home country is 10 percentage points larger than the foreign country. The values given in the table are log expected returns on home assets minus log expected returns on foreign assets. The parameters used for this numerical example are $\tau = 0.3$, $\epsilon_\alpha = 1$, $\sigma = 0.05$, and $e^{-\delta} = 0.95$. ϕ and $\tilde{\sigma}$ are chosen to match the average standard deviation of the nominal and real exchange rates to the US Dollar in the data, and μ is chosen such that the net present value of consumption is equalized between active and inactive households within each country.