

# The Home Bias and Capital Income Flows between Countries and Regions<sup>1</sup>

Michael J. Artis<sup>2</sup>      Mathias Hoffmann<sup>3</sup>

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<sup>2</sup>Dept. of Economics, European University Institute, Villa San Paolo, Via della Piazzuola 43, 50133 Florence, Italy E-Mail: artis@iue.it

<sup>3</sup>Corresponding author. Full address: Dept. of Economics, University of Dortmund, D-44221 Dortmund, Germany. E-Mail: M.Hoffmann@wiso.uni-dortmund.de

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## Abstract

This paper documents a marked increase in international consumption risk sharing throughout the recent globalization period. Unlike earlier studies that have found it difficult to document a consistent effect of financial globalization on international consumption comovements, we make use of the information implicit in the relative levels of consumption and output to measure long-run risk sharing among OECD countries and US federal states. We derive our empirical setup from a deliberately simplistic model in which countries can trade perpetual claims to each other's output (Shiller securities). This model allows us to identify the channels through which improvements in international risk sharing have come about. The model predicts cross-country and cross-regional income flows with considerable precision. Both international income flows as well as consumption risk sharing have increased since 1990, in line with the gradual removal of country portfolio home bias documented elsewhere. Still, the increase in international income flows falls short of explaining all of the consumption risk sharing we see in international data. We show that heterogeneity in countries' gross foreign asset positions is important in explaining this result. While countries with less portfolio home bias enjoy better consumption risk sharing, our findings also suggest that heterogeneity in country portfolios opens an separate channel for consumption risk sharing, possibly through asymmetric valuation effects that have been emphasized in the recent literature.

*Keywords:* Consumption Risk Sharing, International and regional business cycles, Capital flows, Home Bias, Non-stationary panel data

JEL classification: C23, E21, F36

# 1 Introduction

Financial market integration should lead to better international consumption risk sharing. Most of the extant literature on international risk sharing has, however, found it difficult to document a consistent effect of financial globalization on consumption.<sup>1</sup> Our first objective in this paper is to provide evidence that consumption risk sharing among OECD countries has indeed increased considerably during the recent globalization period, i.e. since 1980 but in particular after 1990. Our second objective is to investigate to what extent improvements in international consumption risk sharing have been associated with increases in international factor income flows and whether these improvements can eventually be linked to the dramatic increase in international cross-holdings of financial assets that has been documented in the recent literature.

In line with most of the empirical consumption risk sharing literature we base our empirical analysis on a key implication of complete financial markets: fluctuations in relative (i.e. idiosyncratic) marginal utility growth should be independent of idiosyncratic risk (as measured by relative output growth rates). Therefore, the coefficient of a regression of relative consumption growth on relative output growth should be zero.<sup>2</sup> If financial markets are incomplete, the size of this coefficient can be directly interpreted as a measure of the deviation from the complete markets outcome. Most of the empirical literature has estimated such risk sharing regressions based on data that has been rendered stationary through first differencing. One novelty of our approach is to use the information implicit in the levels of relative consumption and output by running (panel) risk sharing regressions in relative log levels rather than relative growth rates. The advantage of the level specification is that it enables us to pick up longer-term trends in consumption risk sharing that seem to remain blurred in the specifications that have so far been used in the literature. Based on such a level specification, we document that consumption risk sharing has indeed increased since 1990.

We motivate our econometric approach from a simple model that allows us to interpret the coefficient in the risk sharing regression as the share of the average country's or region's wealth held in claims to domestic output – the coefficient is a measure of portfolio 'home bias'. Our framework, while consistent with virtually all theoretical models of consumption behaviour, is sufficiently simple to allow us to address the second objective of this paper:

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<sup>1</sup>In Artis and Hoffmann (2004) we explore why this is the case

<sup>2</sup>Similar regressions were first proposed by Mace (1991), Cochrane (1991) and Townsend (1991) as tests of the null of market completeness. In the macroeconomic literature, they were popularized by Asdrubali, Sørensen and Yosha (1996), Crucini (1999) and others.

once we have estimated the degree of home bias based on consumption and output data, we can use the model to generate income data (defined as output plus net capital income flows) that we then compare to real-world GNP and state level income data.

Our empirical analysis is based on two data sets: the first is an international (OECD) data set and ranges from 1960 to 2000, whereas the second is the data set for U.S. federal states employed in the seminal paper by Asdrubali, Sørensen and Yosha (1996). This data set ranges from 1960-90. Our findings can be summarized as follows:

The lack of international consumption risk sharing that is so widely documented in the literature is considerably less pronounced in what we refer to as the globalization period, i.e. after 1990. We also provide evidence that these improvements in international consumption risk sharing are associated with increases in international capital income flows.

From the literature inspired by the seminal papers by Asdrubali, Sørensen and Yosha (1996) and Sørensen and Yosha (1998) we know that capital income flows derived from cross-holdings of claims to productive capital are a much more important channel of risk sharing among regions or federal states than among countries. Indeed, the fact that this channel is virtually absent in international data can account for almost all of the lack of consumption risk sharing at the international level. In this paper, we use our simple model – estimated from consumption and output data alone – to predict income flows. In spite of its simplicity, our model matches the pattern of income flows between U.S. federal states very well. For the globalization period, the model also predicts increases in international income flows that are in line with those observed in the data. But in international data, the degree of consumption risk sharing estimated from the model over the entire sample period remains hard to reconcile with the still very limited degree of international capital income flows.

As a solution to this puzzle, we explore the role of heterogeneity in country portfolios: first, the very notion of portfolio home bias implies that countries' asset portfolios are very heterogenous. But even as portfolio home bias is decreasing, important differences in the size and composition of country portfolios persist. This point is prominently documented in Lane and Milesi-Ferretti (2003). Secondly, if country portfolios are very different, fluctuations in asset prices can induce asymmetric wealth effects across countries and these wealth effects may serve as a hedge against idiosyncratic fluctuations in output. Indeed, we find that accounting for some heterogeneity in country portfolios goes a long way in explaining why income flows are less important as a channel of risk sharing among countries than among regions and why accounting for international capital income flows alone will tend to

underestimate the effective degree of international consumption risk sharing.

Recent contributions to which our paper is related are Lane and Milesi-Ferretti(2001, 2003), Gourinchas and Rey (2004)and Sørensen , Yosha, Wu and Zu (2004). Lane and Milesi-Ferretti document the virtual explosion in international asset cross-holdings during the 1990s along with the persistence of considerable heterogeneity in country portfolio holdings and returns. Gourinchas and Rey use a log-linearized intertemporal budget constraint to show that the U.S. current account forecasts exchange rate changes and changes in relative stock market valuations rather than future current account surpluses. Therefore, price adjustments rather than capital flows seem to restore intertemporal budget balance for the United States. Our paper is perhaps most closely related to Sørensen et al. (2004) who show that countries with higher shares of foreign assets in their net wealth tend to enjoy better income smoothing through higher international factor income flows. Therefore, the equity home bias and the lack of international consumption risk sharing appear as 'twin puzzles separated at birth'. Our theoretical framework captures this idea.

The remainder of this paper is structured as follows: in the next section we introduce our theoretical framework and use it to motivate the level risk sharing regression. In section three we present our data and obtain the country portfolio weights by estimating our levels risk sharing regressions. In section four we relate the estimated portfolio weights to international income flows and we explore the role of portfolio heterogeneity at the international level. Section five summarizes and concludes.

## **2 Income flows and consumption risk sharing: an integrated framework**

This section presents a general framework that allows us to study the link between consumption risk sharing and net capital income flows. In the first instance, we will use this framework to motivate an alternative way of measuring consumption risk sharing: our approach is based on panel regressions of relative log-levels of consumption on relative log levels of output. As we will argue, this approach is more likely to pick up the effects of financial globalization over time than are conventional approaches that have either used consumption correlations or regressions of consumption growth on output growth.

In a second step, we then ask if the pattern of interregional and international capital income flows is consistent with the predictions of the model

and with the degree of international risk sharing that we have estimated.

Our framework nests virtually all current theories of consumption: the only assumption we make is that each period the representative inhabitant of country or region  $k$  consumes a fraction  $\mu_t^k$  of her income

$$C_t^k = \mu_t^k INC_t^k \quad (1)$$

where  $C$  and  $INC$  denote per capita values of consumption and income. For example, this formulation is consistent with permanent income models, where  $\mu_t^k$  captures the effect of discounting and uncertainty on consumption, given today's income. We will discuss the interpretation of  $\mu_t^k$  in more detail below.

Now recall the definition of income from the national accounts: a country's income equals its output plus net claims to output produced in the rest of the world.

$$INC_t^k = Y_t^k + NFI_t^k$$

where  $NFI_t^k$  is net factor income from abroad, i.e. the country's net claims on flows of foreign output.

Recent work by Sørensen et al. (2004) demonstrates that the degree to which net factor income flows contribute to smoothing national income varies positively with the share of foreign assets in country wealth. They argue that the lack of international consumption risk sharing and the equity home bias are 'twin puzzles separated at birth'. We formalize this idea in our framework here that builds on Crucini (1999). In order to link international income flows to the structure of countries' asset portfolios in a tractable manner, we assume that countries trade perpetual claims to their respective output streams. Such assets have first been suggested by Shiller (1993) and we therefore refer to them as Shiller-securities. Each country allocates its wealth into either a claim to domestic assets or into a world mutual fund of foreign Shiller securities. Since income constitutes the dividend from wealth, per capita income must be the weighted average of dividends paid on domestic and foreign assets. The dividends of Shiller securities are just foreign and domestic output, so that per capita income in country  $k$  is

$$INC_t^k = \lambda Y_t^* + (1 - \lambda) Y_t^k \quad (2)$$

where  $\lambda$  is the (*ex ante* value weighted) share of foreign assets in the country's wealth portfolio. Here,  $Y_t^k$  denotes country  $k$  per capita output and  $Y_t^*$  is the average of per capita outputs across all countries. Note that under these assumptions, net factor income flows are given by

$$NFI_t^k = Y_t^k - INC_t^k = \lambda(Y_t^* - Y_t^k)$$

which captures the idea that countries with higher portfolio shares of foreign assets will achieve more risk sharing through income smoothing, as discussed by Sørensen et al. (2004).<sup>3</sup>

Perpetual claims to a country's entire output are not currently traded in world financial markets. But while our model is very stylized, we note that it is also quite general because existing assets – in particular equity – may at least in part allow countries and regions to replicate the pay-off structure of a portfolio of Shiller securities. Clearly, in frictionless markets, countries would want to diversify completely, which amounts to selling their national output to the world mutual fund. Hence, under complete diversification, we will have  $\lambda = 1$ . But claims to a country's entire output would also comprise claims to labour income and other non-tradeable output components. Furthermore, we will expect that frictions in financial and goods markets will drive  $\lambda$  away from unity. The parameter  $\lambda$  is therefore a metric of how close observed income flows are to the income flows we would observe if countries or regions could completely diversify any idiosyncratic risk by investing all their wealth into a world portfolio of Shiller securities. We think of  $\lambda$  as the effective degree of diversification of the average country and we refer to it as the ‘Shiller portfolio weight’ or as ‘home bias’: the parameter  $\lambda$  tells us, what share of a country's income is effectively derived from home and foreign sources and we turn to estimating  $\lambda$  from the data. Plugging into (1), we obtain

$$C_t^k = \mu_t^k INC_t^k = \mu_t^k [\lambda Y_t^* + (1 - \lambda)Y_t^k] \quad (3)$$

Note that this implies that countries will generally be able to decouple income and consumption through savings and dissavings. We can think of  $\mu_t^k$  as capturing an array of country-specific effects such as the rates of return on the country's or region's wealth. For example, in the context of the permanent income hypothesis (PIH), consumption should equal the permanent component of income defined as

$$INC_t^{kP} = \frac{r_k}{1 + r_k} \mathbf{E}_t \left\{ \sum_{l=0}^{\infty} \left[ \frac{1}{1 + r_k} \right]^l [INC_{t+l}^k] \right\}$$

where  $r_k$  is the country's real interest rate and  $\mathbf{E}_t$  is the expectations operator. Then, according to the PIH,  $C_t^k = INC_t^{kP}$ . Assume for expository purposes that income follows a stationary AR(1) with autoregressive coefficient  $\rho$ ,  $0 < \rho < 1$ . Then

$$C_t^k = \frac{r_k}{1 + r_k - \rho} INC_t^k \quad (4)$$

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<sup>3</sup>We start by assuming that  $\lambda$  is the same across countries. We explore the implications of variation in  $\lambda$  across countries and over time below.

so that in this simple case,  $\mu_t^k = r_k(1 + r_k - \rho)^{-1}$  is a country-specific constant reflecting the country's return on wealth and the persistence of its income process. Clearly, we could also let  $r$  vary over time, so that we could think of variation in  $\mu_t^k$  as reflecting time-variation in expected rate of returns on country wealth.

In the next subsection, we are now going to use equation (3) to develop a simple estimation equation for the portfolio weights  $\lambda$  that is based on consumption and output data alone. The road map for the empirical part of the paper is then as follows: we first estimate values of  $\lambda$ . We then use these values to generate artificial income data according to (2) above. The properties of these artificial income data are then compared to actual GNP and personal state income data along different dimensions. Finally, we also explore the impact of international differences in foreign asset positions on the size and volatility of international income flows.

## 2.1 A risk sharing regression in levels

We first re-write equation (3) by dividing by world income. For the link between world consumption and world income, we make an analogous assumption as for the home country, so that  $C_t^* = \mu_t^* INC_t^*$ . Then using that world per capita income is world per capita output, we obtain:

$$\frac{C_t^k}{C_t^*} = \frac{\mu_t^k}{\mu_t^*} \left[ \lambda + (1 - \lambda) \frac{Y_t^k}{Y_t^*} \right] \quad (5)$$

Equation (5) will not let us estimate  $1 - \lambda$  directly from a linear regression. We therefore base our estimation on a log-linear specification of (5). In addition, this offers the advantage that it is in keeping with most of the risk sharing regressions in the literature that are also largely based on log-linear specifications and keeping with this tradition facilitates highlighting parallels and differences in our approach. Secondly, specifications involving logarithmic levels rather than levels of macroeconomic variables are generally known to have normal residuals and would therefore – *a priori* – appear more robust.

We now make explicit the assumptions we make in log-linearizing (5). We apply logarithms on both sides of (5). Denoting  $\phi_t^k = \log \mu_t^k - \log \mu_t^*$ , we get

$$\log \left( \frac{C_t^k}{C_t^*} \right) = \phi_t^k + \log \left[ \lambda + (1 - \lambda) \frac{Y_t^k}{Y_t^*} \right] \quad (6)$$

Next, we expand the logarithmic term on the right hand side around  $\frac{Y_t^{kP}}{Y_t^{*P}} = 1$ .



This yields

$$\begin{aligned} \log \left[ \lambda + (1 - \lambda) \frac{Y_t^{kP}}{Y_t^{*P}} \right] &\approx \log [\lambda + (1 - \lambda)] + \frac{(1 - \lambda)}{\lambda + (1 - \lambda)} \left[ \frac{Y_t^k}{Y_t^*} - 1 \right] \\ &= (1 - \lambda) \left[ \frac{Y_t^k - Y_t^*}{Y_t^*} \right] \end{aligned}$$

Finally, approximating

$$\log \left( \frac{Y_t^k}{Y_t^*} \right) \approx \frac{Y_t^k - Y_t^*}{Y_t^*}$$

and plugging back into the previous equation, we obtain the levels risk sharing regression that is the focus of the empirical analysis in this paper:

$$\log \left( \frac{C_t^k}{C_t^*} \right) = \phi_t^k + (1 - \lambda_k) \log \left( \frac{Y_t^k}{Y_t^*} \right) \quad (7)$$

Having lower-case letters denote logarithms, we can write

$$c_t^k - c_t^* = (1 - \lambda) [y_t^k - y_t^*] + \phi_t^k \quad (8)$$

This equation is reminiscent of the equations estimated in Mace (1991), Asdrubali, Sørensen and Yosha (1996), Cochrane (1991) or Crucini (1999). It relates relative consumption to relative output. Under full risk sharing, the coefficient on relative (permanent) output should be zero. The decisive difference vis-à-vis the earlier literature is that equation (8) relates relative log-levels whereas earlier implementations were formulated in differences.

In our derivation, we have assumed  $\lambda$  to be the same across countries and in our empirical analysis we estimate (8) as a non-stationary panel relation in the sense of Phillips and Moon (1999). This will allow us to estimate the degree of home bias  $-(1 - \lambda)$  for the average country. Note that this setup, while quite similar in spirit to the literature that has estimated such regressions in first differences, estimating a non-stationary panel relation such as (8) allows for a high degree of unobserved heterogeneity across regions and countries through the time-varying, country-specific term  $\phi_t^k$ .<sup>4</sup> As we have discussed,  $\phi_t^k$  can account for differences in discount rates across countries, for international differences in the persistence of a country's or region's output, wealth effects from changes in a country's relative asset position and so forth. Note that (8) defines a cointegrating relationship if  $\phi_t^k$  is stationary. But this

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<sup>4</sup>In our empirical implementation, we decompose  $\phi_t^k = \phi_k + u_t^k$ , where  $\phi_k$  is a country-specific fixed effect and  $u_t^k$  is a residual. Clearly, besides  $\phi_k$  additional deterministic but time varying country-specific terms (such as linear trends) could also be considered.

is not an assumption we wish to make. The country-specific term  $\phi_t^k$  could even be non-stationary, still a well-defined long-run panel relation between consumption and output in the sense of Phillips and Moon(1999) can exist and can be estimated using standard methods. We discuss this issue below.

As our results will show, the coefficient from the levels regression has been declining since 1990 at the latest, suggesting that the international diversification of consumption risk has indeed increased. In Artis and Hoffmann (2004) we have explored explanations for why risk sharing regressions formulated in first differences have not generally detected this increase in risk sharing: if consumption is forward-looking as for example in a permanent income model and if risk sharing is incomplete, so that home output has some impact on home consumption, then expected future changes in output will influence current consumption decisions. Consider two countries, one in which (relative) output shocks are i.i.d. and one in which they are positively autocorrelated. Suppose both countries are diversified so that  $\lambda = 1/2$ . Then a positive shock in (relative) output today will lead to a one half percentage point increase in consumption in the country in which output shocks is i.i.d. But in the country where the shock is serially correlated, consumption will react more strongly because high output today forebodes higher output tomorrow and consumption reacts to the permanent level of output. In a regression that is based on first differences, the country with the serially correlated output shock will therefore have a coefficient higher than  $1/2$ , suggesting that the country shares less risk than the country with i.i.d. shocks. In our non-stationary setting here, differences in the persistence of country-specific shocks will only affect  $\phi_t^k$ , though, and *not* the estimate of the diversification measure  $\lambda$ . In an analogous way, the non-stationary risk sharing regression that we advocate in this paper is likely to be more robust to changes over time in the structure of countries' or regions' business cycles. Again, such changes will find their reflection in time variation in  $\phi_t^k$ , but not in the estimate of  $\lambda$ , while these very changes may blur – and can possibly offset – the effect of globalization on the coefficient in more traditional, differenced risk sharing regressions.

### 3 Empirical Implementation

#### 3.1 Data

We apply our approach to two data sets: one for U.S. states and one for a group of 23 OECD countries. All data are annual.

The US-data set is the one also used by Asdrubali, Sørensen and Yosha<sup>5</sup> and is based on gross-state product and income data from the Bureau of Economic Analysis (BEA). Since consumption data at the state level are not available, it is common practice<sup>6</sup> to use retail sales data by state. These retail sales data are re-scaled by the share of retail sales in aggregate (US-wide) consumption to obtain measures of state level consumption data. All data are deflated by the US-wide consumption price index. The US-data range from 1960 to 1990.

Country-level data are from the Penn World Table, release 6.1 (PWT 6.1.) by Heston, Summers and Aten (2002) and range from 1960 to 2000. All data are in constant (1996) international prices. The countries included in our estimation are:

1. Canada,
2. the United States,
3. Japan,
4. Austria,
5. Belgium,
6. Denmark,
7. Finland,
8. France,
9. Germany (West),
10. Greece,
11. Iceland,
12. Ireland,
13. Italy,
14. Luxemburg,
15. Netherlands,
16. Norway,
17. Portugal,
18. Spain,
19. Sweden,
20. Switzerland,
21. United Kingdom,
22. Australia,
23. New Zealand.

Most of these countries are OECD countries and we will refer to them under this label. As regards the US, we follow the general practice in the US regional business cycle literature and include all states except Washington D.C.

We express all data in per capita terms. Rest of the World (RoW) aggregates are the US- or OECD-wide average per capita values. Population data are from the BEA and PWT respectively.

Over the sample period covered by our international data set, international financial markets have become increasingly liberalized. To take account of this change, we will report results obtained for two subperiods: the first covers the period 1960-1990, the second covers 1990-2000. The results we obtain from the first sub period can be compared directly to others in the literature (the studies by Sørensen and Yosha (1998) and Crucini (1999) cover the same period), while the results from the second sub period should provide insights into the effects of the dramatic increase in net international asset positions that took place in particular in the 1990s (compare e.g. the data in Lane (2000), Lane and Milesi-Ferretti (2001) and Kraay, Loayza, Serven and Ventura (2001)).

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<sup>5</sup>The data base is available at Oved Yosha's web page <http://econ.tau.ac.il/research/riskshare/channels/channels.htm>

<sup>6</sup>Asdrubali, Sørensen and Yosha (1996), Hess and Shin (1998) and DelNegro(2002) all follow this approach.

## 3.2 Estimating portfolio shares

We now turn to estimating the Shiller portfolio weights based on the level risk sharing regression (8). This regression (8) constitutes a long-run panel relation in the sense of Phillips and Moon (1999) and can, in principle, be estimated consistently by OLS. However, OLS may suffer from second-order bias due to potential simultaneity and due to serial correlation of the errors. Phillips and Moon (1999) therefore advocate a panel version of the fully modified least squares method. Since, the FM-OLS estimator is semiparametric, it may, however, be imperfectly suited for relatively small samples. Kao and Chang (1999) have shown that the panel dynamic OLS estimator suggested by Mark and Sul (2002) may be preferable in this case. Also, Mark and Sul (2002) have forcefully argued for the dynamic panel OLS estimator on grounds of its simplicity. We therefore conducted all our analyses based on the panel OLS and the panel dynamic OLS estimator.

The panel dynamic OLS estimator accounts for serial correlation and potential simultaneity by including leads and lags of the differences of the RHS variables. We experimented with various leads and lags, but found our results to be very consistent across specifications. All results were also very similar to those obtained from plain OLS estimates. The parameter estimates in table 2 are based on the panel dynamic OLS procedure with one lead and lag which is sufficient to capture serial dependence in annual data.

The PDOLS procedure is robust to cross-sectional heteroskedasticity in the errors of the individual units of the panel. In fact, cross-sectional heterogeneity in the short-run dynamics and the disturbance terms purges the limiting distribution of the PDOLS estimator of nuisance parameters and reduces the asymptotic variance of the parameter estimates (see Kao and Chian (1999)). Some of the PDOLS estimates of  $(1 - \lambda)$  in table (2) would appear to be only marginally significant in international data. However, the reported standard errors are conservative since they do *not* allow for cross-sectional heterogeneity, whereas residual variances that vary across countries and regions are indeed likely to be a feature of our data set.<sup>7</sup>

One important issue in this context concerns the treatment of country-specific fixed effects or even trends in the data. As argued in Sørensen, Yosha et al. (2004) panel regressions in which country-specific effects are not controlled for can be thought of as capturing some notion of long-run risk

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<sup>7</sup>We explored an alternative possibility to account for cross-sectional heterogeneity: we first estimated all regressions country by country and state by state. We then weighted the data for each country with the standard deviation of the residuals and then redid the panel analysis. The results did however not turn out to be substantially different from our earlier specifications and are therefore not reported here.

sharing. In our setting, the level specification already is meant to capture long-run risk sharing. Still, country heterogeneity can have an impact on how much risk sharing we detect. As we have argued, the very notion of home bias implies that country portfolios are heterogeneous. For example, relative changes in asset prices can only affect a country's wealth in an asymmetric way if the size or composition of the country's portfolio is different from that of other countries. In this paper, we are interested in studying the impact of this kind of heterogeneity on our measure of consumption risk sharing. We therefore report our results with and without fixed effects.

We present our results in table 1. Our findings carry a clear message:

For US federal states, we find a home bias of around 50 percent, almost irrespective of whether we control for fixed effects or not. In international data, not controlling for fixed effects, we detect a home bias between 85 and 90 percent in the 1960-90 period. For the later (i.e. the globalization) period, estimates of  $(1 - \lambda)$  are just below 0.8. While this is considerably lower than in the 1960-90 period, the difference does not generally appear to be significant. However, once we control for country-heterogeneity by removing fixed effects, the increase in international risk sharing in the post-1990 period comes out much more strongly: for the 1960-90 period we now estimate  $(1 - \lambda)$  to be between 0.96 and 0.98, whereas for the globalization period the corresponding value is around 0.65(!). Note that the choice of estimation method (OLS vs. PDOLS) has virtually no effect on the results.

We interpret these findings as follows:

First, controlling for heterogeneity virtually does not matter for the amount of risk sharing we find among U.S. federal states. But it does matter for the size of the home bias detected among OECD countries and – in particular – it seems to have a strong effect on how strong the increase in risk sharing during the globalization period is found to be. The increase in international risk sharing that we document is in line with the evidence reported by researchers who have examined international portfolio holdings directly (Lane (2000), Lane and Milesi-Ferretti (2001), Kraay et al. (2000)) and who report a considerable increase in the net foreign asset positions of OECD countries over the last two decades.

Secondly, the estimates in table 1 suggest that there is a lack of risk sharing in international data in both subperiods, but even at the regional level we find that U.S. citizens own a disproportionate share of the claims to output of the federal state in which they live. This result provides a perspective on the relative size of intra- and international home bias: by measuring the effective degree of financial integration, we take account of those components of a nation's or region's output risk that are not traded in financial markets: the equity of small firms or companies is most likely

not traded across countries or regions nor are claims to the labour share of national or regional outputs. Our estimates reflect this. Against this background, even a modest estimate in table 1 of the increase in international risk sharing in the 1990s – a drop of  $1-\lambda$  from 0.9 to 0.8 when no country-fixed effects are controlled for – amounts to a dramatic increase in international risk sharing: if our empirical measure of home bias among U.S. states ( $\sim 0.5$ ) is taken as a benchmark, then around 30 percent  $((0.89 - 0.77) / (0.9 - 0.5) = 0.3)$  of the lack of international risk sharing (relative to regional risk sharing) has vanished in the ten years after 1990 alone.

Some of the point estimates in panel a) are not significantly different between subperiods, while those in panel b) – the fixed effect regressions – generally are. This underscores our point that a more detailed modelling of international differences in country-characteristics and their change over time is likely to be important in order to gauge the impact of financial globalization on consumption risk sharing. Our results below provide strong empirical indications that a drop in  $1 - \lambda$  of between 0.1 and 0.2 is indeed the empirically plausible order of magnitude for the increase in risk sharing. In a separate subsection we also attempt to time the exact onset of this increase in international diversification and we identify the late 1980s as the break-point. Before we return to these issues, we use the Shiller portfolio weights estimated in table 1 to generate income data.

## 4 Income flows and equity home bias

In this section, we examine to what extent we can use the model from section two to replicate the dynamics of international income flows from the estimated portfolio weights. We first demonstrate that the model – in spite of its simplicity – does a very good job in characterizing income flows among U.S. federal states. However, actual income flows fall short of predicted income flows in international data.

### 4.1 Risk sharing and income flows

We use the estimates of the international portfolio weights  $\lambda$  to generate income data according to

$$INC_t^k = \lambda Y_t^* + (1 - \lambda) Y_t^k \quad (9)$$

using actual values of GDP for  $Y^*$  and  $Y^k$ . In table 3 we present the correlations between the actual and artificial income growth rates for the

individual countries in the two subperiods. To save on space, we also present the average correlation for U.S. federal states. For the average U.S. state the correlation between actual and fitted income growth is 0.61, based on an estimate of  $1 - \lambda = 0.48$ . We note that we assumed that  $\lambda$  does not vary across states. At the international level, the model performs better in terms of income correlations, generating an average correlation of 0.71 in the 1960-90 period and of well above 0.9 in 1990-2000.

To assess the relative volatility of actual and artificial income data, we find it useful to employ the variance decomposition suggested by Asdrubali, Sørensen and Yosha (1996). These were the first authors to explore empirically to what extent consumption insurance is achieved through income smoothing (*ex-ante* insurance) or rather through *ex-post* consumption smoothing.<sup>8</sup> While ASY report that more than 40 percent of relative income variability gets smoothed *ex-ante* in state level US data, Sørensen and Yosha (1998) report that this channel is virtually inactive in international data. The contribution of *ex-post* smoothing, is, however, comparable in both international and national data. Can our artificial income data reproduce this evidence? To assess this issue, we run regressions of the type suggested by ASY (1996):

$$\Delta [y_t^k - y_t^*] - \Delta [inc_t^k - inc_t^*] = \beta_K \Delta [y_t^k - y_t^*] + u_t \quad (10)$$

where ‘*inc*’ denotes the logarithm of income constructed according to (2). Asdrubali, Sorensen and Yosha refer to  $\beta_K$  as a measure of the extent of risk sharing through net factor income flows (income smoothing). In analogy, the regression coefficient  $\beta_C$  in

$$\Delta [inc_t^k - inc_t^*] - \Delta [c_t^k - c_t^*] = \beta_C \Delta [y_t^k - y_t^*] + v_t \quad (11)$$

measures the extent through which the sale and purchase of assets contributes to risk sharing through consumption smoothing.

ASY also consider a fiscal transfer channel. There is no role for such a channel on our simple theoretical setup. However, we note that most fiscal transfers are not discretionary but based on rules or laws that have been set *ex-ante*. We would therefore argue that fiscal transfers mainly provide *ex ante* insurance through income smoothing .

We now estimate equations (10) and (11) based on our data sets, both the artificial and the actual ones. Table (3) contains the results and juxtaposes them to the findings obtained in ASY(1996) and Sørensen and Yosha (1998).

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<sup>8</sup>Since we will make frequent reference to this paper throughout this section, we will refer to it under the acronym ‘ASY’.

Our model does well in replicating the evidence on the relative importance of income and consumption smoothing, in U.S. data. Our point estimates for the artificial data are virtually the same as the ones obtained in ASY (1996) (if one includes fiscal transfers in the income smoothing channel) and Sørensen and Yosha (1998). Relative to our own estimates from the actual data, the model somewhat underpredicts income smoothing and overpredicts consumption smoothing. But we note that these deviations are benign relative to the overall extent of income risk sharing predicted by the model. They are also very much in line with the estimates in the literature, in particular with the ones obtained by ASY themselves.

In OECD data, however, the model does not allow us to generate GDP-GNP differentials that can approximate the stylized fact identified by Sørensen and Yosha and that is replicated in the table: the virtual shut-off of the income smoothing channel in international data. Our estimates of risk sharing through income flows based on artificial income data predict that about 13 percent of output risk are shared through income smoothing in the 1960-90 period and even 24 percent during the globalization period.

But note that we detect an increase in income risk sharing during the globalization period also in actual data, so that there seems to be an almost constant gap of around 15 percent between the amount of income risk sharing predicted by the model and the income risk sharing we find in the data.

We summarize our findings here as follows: in spite of its simplicity, our model replicates salient features of income flows among U.S. federal states. It also succeeds in rationalizing the increase in international risk sharing during the globalization period: indeed, increases in international risk sharing during the globalization period seem to be associated with increases in international income flows. However, in particular in international data, our model would somewhat overpredict the contribution of income flows to risk sharing in both the 60-90 and the globalization periods.

We explore these issues in turn: in the next subsection, we provide evidence based on recursive cross-sectional regressions to document that the increase in consumption risk sharing is indeed associated with increases in income flows. In final subsection we return to the role of country-heterogeneity emphasized in the discussion surrounding table 1. Specifically, we explore how heterogeneity in countries' international portfolio positions opens an additional channel for international risk sharing through capital gains and valuation effects. In this way, small net factor income flows for the average country can be reconciled with relatively high levels of consumption risk sharing.



## 4.2 The increase in international risk sharing and income flows since 1980

We provide further evidence that the increase in international risk sharing is associated with an increase in income flows. We run a sequence of cross-sectional versions of our level risk sharing regression:

$$c_{kt} - c_t^* = (1 - \lambda_t) [y_t^k - y_t^*] + u_{kt}$$

where  $(1 - \lambda)$  now varies with time and  $t$  indexes years from 1980 to 2000. This period covers the last ten years of our first subperiod as well as the globalization period itself and we should therefore be able to pick up any marked changes between periods.

To gauge how income risk sharing has increased over the same period, we also run a sequence of cross-sectional regressions of the form

$$[y_t^k - y_t^*] - [inc_t^k - inc_t^*] = \gamma_{Kt} [y_t^k - y_t^*] + u_{kt}$$

This regression is almost the same as the ASY income smoothing regression in (10) above, except that all variables are now expressed in levels. Running this risk sharing regression in levels rather than in differences, avoids a lot of cyclical variation in the coefficient estimate. For example, Agronin (2004) has shown that income risk sharing decreases in booms and increases in recessions. Sørensen, Yosha et al. (2004) run cross-sectional income risk sharing regressions in differences and have to smooth their estimates by taking moving averages to obtain plausible results. The levels-regression here emphasizes longer-term risk sharing and we will therefore expect  $\gamma_{Kt}$  to capture the trend of an increase in income risk sharing.

In figure (1), we plot OLS estimates of  $(1 - \lambda_t)$  and  $\gamma_{Kt}$ . Our earlier finding that consumption risk sharing has increased during the globalization period finds a wholesale confirmation. The home bias measure  $(1 - \lambda_t)$  starts to decline around 1990, exactly at the same time as  $\gamma_{Kt}$  starts to increase.

We note that the average of the coefficients  $1 - \lambda_t$  over the entire 1980-2000 period is 0.83. The cross-sectional regressions reported here include a constant, which accounts for the time-specific fixed effect, but clearly there is no way in which we could remove the country-specific mean in a pure cross-sectional regression. The average of 0.83 will therefore correspond to a panel regression in which country-specific means have not been controlled for. Once we control for country-specific effects by removing country-means for the entire 1980-2000 period before running the cross-sectional regressions, the parameter values fluctuate around a mean of 0.67. This would seem to be in keeping with the fixed effect panel estimates reported in table 1, where we

have found a value for  $1 - \lambda$  of 0.62. But note that removing the mean over the entire sample period also removes the clear breakpoint around 1990 in the sequence  $1 - \lambda_t$ . Rather,  $\lambda_t$  now appears unstable over the entire sample period.

We draw two conclusions from this finding: first, the home bias has started to decline in particular after 1990 and this decline amounts to an increase in  $\lambda_t$  of around 0.1-0.15. At the same time, income risk sharing has increased from virtually nil to around 8 percent, suggesting that the increase in income risk sharing falls somewhat short of explaining the increase in international risk sharing .

Secondly, in order to identify a precise starting point for the increase in international risk sharing in our data set, we need to rely on estimates that preserve country-heterogeneity by not removing country-specific fixed effects. This, in line with our results in table 1, suggests that country-heterogeneity itself plays an important role in understanding risk sharing among countries and in explaining why our model predicts income flows that are too big.

One important way in which heterogeneity in country characteristics could play a role in helping countries to share consumption risk is through differences in international asset positions. Note that the variance decomposition of ASY implies that  $\lambda_t - \gamma_{Kt}$  is equal to the coefficient  $\gamma_{Ct}$  in the regression

$$[inc_{kt} - c_{kt}] - [inc_t^* - c_t^*] = \gamma_{Ct} [y_t^k - y_t^*] + u_{kt}$$

where  $\gamma_{Ct}$  constitutes a levels counterpart of the ex-post (consumption smoothing) coefficient  $\beta_C$  above. Clearly, if increases in  $\gamma_{Kt}$  do not offset the decline in  $\lambda_t$ , then  $\gamma_{Ct}$  must have increased. However, note also that the interpretation of  $\gamma_{Ct}$  is slightly less straightforward than that of  $\beta_C$  : while  $\beta_C$  measures consumption smoothing at the business cycle frequency,  $\gamma_{Ct}$  measures long run consumption smoothing. Therefore, a positive value for  $\gamma_{Ct}$  would suggest that variation in savings – as measured by the difference between income and consumption – can help the *average* country in our sample to avoid consumption variability *in the long run*. This can only be the case if the average country has a buffer stock of foreign assets that can generate capital gains (losses) that allow (require) the country to save (dissave) in the long run.

But capital gains can only play a role in shielding relative consumption levels from idiosyncratic fluctuations in output levels, if countries hold different portfolios of assets. Indeed, the substantial heterogeneity in country portfolios, both in terms of the size of relative positions as well as in their composition is now extensively documented in the literature (see the papers by Lane and Milesi-Ferretti). Lane and Milesi-Ferretti (2003) also show that

industrialized countries have realized very different rates of return on their international portfolios.

### 4.3 Heterogeneity in country portfolios

We therefore now relax the assumption that  $\lambda$  is the same across countries. Our level risk sharing equation<sup>9</sup> now becomes

$$c_t^k - c_t^* = (1 - \lambda_k)[y_t^k - y_t^*] + \varepsilon_t^k \quad (12)$$

We expect that portfolio heterogeneity can have an impact on  $\lambda_k$  along two dimensions: first, countries with higher shares of foreign assets in their wealth portfolio should enjoy more risk sharing. This mechanism has recently been explored by Sørensen, Yosha et al. (2004). In this section we build on their empirical framework.

Secondly, we expect the composition of a country's portfolio to have a bearing on how much risk sharing is effectively achieved. Several recent papers have emphasized the differential role of bonds and equities in the international allocation of risk: Miller, Castrén and Zhang (2004) argue that the early millenium stockmarket bust had only a modest effect on U.S. consumption mainly because the previous stock market boom was financed through foreign equity inflows rather than through borrowing by U.S. investors. Becker and Hoffmann (2003) show that the lack of international risk sharing is even more pronounced over longer horizons than it is at business cycle frequencies. The main reason for this is that U.S. federal states generate income flows from equity cross-holdings which provide insurance against permanent idiosyncratic fluctuations in output. Since most OECD countries hold relatively little foreign equity, this channel appears much more muted at the international level.

Even though the average degree of risk sharing through income flows may (still) be low, we would still expect that countries that have engaged strongly in international asset trade will be more successful in decoupling their national incomes from their output. To capture the impact of foreign assets and the composition of the country portfolio on our measure of home bias, we postulate that  $\lambda_k$  is given by

$$1 - \lambda_k = \kappa'(\mathbf{z}_k - \bar{\mathbf{z}})$$

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<sup>9</sup>It would seem that this level risk sharing equation could be estimated country by country, very much as the levels risk sharing in the previous subsection. But note that unlike in (13) above, we are now dealing with non-stationary time series regressions which would be spurious unless relative consumption is cointegrated with relative output. In our data set, time series cointegration tests reject the null of no cointegration in only about half of the 23 countries in our cross-section.

where  $z_k$  is a vector of country characteristics and  $\bar{z}$  the vector of cross-country means of  $z_k$ . Plugging this relation into (12) then allows us to obtain a panel regression from which the coefficient vector  $\kappa$  can be estimated. Our vector of country characteristics  $z_k$  includes a measure two separate measure of international asset cross-holdings,: the first, that we abbreviate with  $cat$  is a measure of country  $k$ 's cumulative *asset trade* relative to its total financial wealth. The second, called  $ceqt_k$  is an indicator of the role of *cumulated equity trade*, again relative to net wealth.<sup>10</sup> We also control for the exchange rate regime by including a dummy for those countries that were eventually to become EMU members. Hence, we parametrize  $1 - \lambda_k$  as follows

$$1 - \lambda_k = \overline{(1 - \lambda)} + \kappa_1 (cat_k - \overline{cat}) + \kappa_2 (ceqt_k - \overline{ceqt}) + \kappa_3 (EMU_k - \overline{EMU}) \quad (13)$$

Here,  $EMU_k$  is the EMU dummy variable and bars again denote the mean across countries of the respective variable, so that in particular,  $\overline{(1 - \lambda)}$  is the cross-sectional average of  $1 - \lambda_k$ .

We note that our international diversification measures are constructed to emphasize the role of asset and in particular equity cross-holdings rather than net positions. Also, unlike other studies, we normalize these cross-holdings by the country's entire wealth rather than by GDP. This is in keeping with the interpretation of  $\lambda$  in our simple theoretical model:  $\lambda$  is the *ex ante* share of a country's or region's entire wealth that is invested abroad, but it is also the share of claims to its own output that the country sells to the world mutual fund of Shiller securities. Therefore, in the model, claims to domestic output are swapped for claims to rest-of-the-world output and the *ex ante* net asset position is zero.<sup>11</sup>

To implement (12) and (13), we obtain data on net foreign asset positions from Kraay and Ventura (2000) and take the average over each country's asset positions over the respective subperiod.<sup>12</sup> While richer data sets on

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<sup>10</sup>Specifically, we construct  $cat$  as  $cat_k = \frac{A_k + L_k}{W_k}$  and  $ceqt$  as  $ceqt_k = \frac{A_k^{eq} + L_k^{eq}}{W_k}$ , where  $W_k$  is country  $k$  net wealth,  $A_k$  and  $L_k$  are total gross foreign assets and gross liabilities respectively and  $A_k^{eq}$  and  $L_k^{eq}$  are gross foreign equity assets and liabilities.

<sup>11</sup>Our approach is can also justified based on Obstfeld's (2004) recent argument that cross-holdings, i.e. the sum of assets and liabilities measure the cumulated effect of asset trade on diversification, whereas net asset positions reflect intertemporal trade in assets. He refers to the former as diversification asset trade and to the later as development asset trade. Our interest here clearly is in diversification asset trade, so that we construct both  $cat$  and  $ceqt$  as functions of cross-holdings.

<sup>12</sup>The Kraay and Ventura data set only stretches till 1997, and for the globalization period we therefore take the mean over 1990-97 only. This is unlikely to affect our results since relative net foreign asset positions display a considerable degree of persistence.

international asset positions are by now available (see in particular the data set by Gian Maria Milesi-Ferretti and Philip Lane (2001)), one advantage of the Kraay and Ventura data set for our purposes here is that it also contains estimates of countries' domestic wealth, which in view of our discussion in the previous paragraph is important for the normalization of the diversification measures.

Again, we estimate the parameters in (13) for the two subperiods. Note that we deliberately do not control for country-fixed effects in this exercise. It is through the cross-sectional variation in  $\lambda$  that we mean to capture the heterogeneity that would otherwise show up in the country fixed effects. Our results, obtained by OLS, are given in table 4. Columns I and III give the regression results based on the full set of regressors, i.e.  $cat$ ,  $ceqt$ , and the EMU dummy. Note first that the estimated values for  $(1 - \lambda)$  in both subperiods are very close to the panel estimates for  $(1 - \lambda)$  obtained from the fixed effects panel regression in table 1, panel b. This is a very reassuring outcome since it strongly suggests that our explicit modelling of the cross-country- variation in  $\lambda_k$  properly captures the effect of country heterogeneity on our estimate of the home bias.

As is also apparent from these regressions, both the cumulative asset trade variable,  $cat$ , as well as the EMU dummy are significant in the 1960-90, pre-globalization period, while the trade in equity variable,  $ceqt$ , is not. After 1990, however, only the equity trade measure is significant. We further explore this result by restricting the regressions to include only those variables that proved significant in columns I and III. These regressions, reported in columns II and IV, strongly confirm the results from the unrestricted regressions.

Note that in both sets of regressions, the significant variables have the correct sign: countries with above average cumulative asset trade, and those eventually to become EMU members tend to have lower home bias. The same holds true during the globalization period, where countries with more internationally diversified equity positions appear to display lower home bias. But the three variables seem to have played different roles in the different subperiods. During the pre-globalization period, the composition of asset trade (equity vs. debt) appears less important than it does in the more recent period. Our interpretation is that in a world in which international diversification is still low, countries are most likely to differ significantly by the degree to which they engage in asset trade at all. The same logic may help explain the changing role of the EMU dummy: restrictions on international capital flows and international cross-ownership of assets prevailed during most of the period from 1960-90. In such an environment, the economic and financial integration that the prospective EMU members had already embarked on by

the time is likely to have made a significant difference for the degree to which those countries will have been able to share idiosyncratic risks. However, as financial globalization has proceeded, making access to international financial markets and the control of overseas assets easier for all countries in our sample, the role of EU and (eventual) EMU-membership in explaining the cross-sectional heterogeneity in the data is likely to have declined.

During the 1990s, countries' cumulative equity trade becomes the key variable in explaining international differences in consumption risk sharing. This result provides strong support for the conjecture by Sørensen, Yosha et al. (2004) that risk sharing and equity home bias are in fact 'twin puzzles separated at birth'. Our results here add an important element to this idea: while Sørensen, Yosha et al. show that countries with higher foreign asset positions tend to achieve better risk sharing through income flows, our results here emphasize the importance of equity cross-holdings in explaining cross-country differences in the degree of long-run risk sharing.

As we have argued, however, the increase in international consumption risk sharing that we have documented seems to exceed what can be explained by increased international income flows alone. The very heterogeneity of countries' equity portfolios in itself could explain why the increase in income flows seems to have remained quite moderate, possibly because valuation effects have allowed countries to insure against idiosyncratic risk. To explore this possibility, we generate the values of  $(1 - \lambda_k)$  implied by the restricted regressions in table 4. Again, we then use the estimates of  $\lambda_k$  to generate income flows according to

$$INC_t^k = (1 - \lambda_k)Y_t^* + \lambda_k Y_t^k$$

Table (5), panel a) displays the results of the ASY variance decomposition of output based on these income data. In both subperiods, the model now explains the lack of international income flows: for the 1960-90 period, we now obtain an estimate of  $\beta_K$ , i.e. of income risk sharing of  $-0.01$  almost identical to the value obtained from actual data. For the 1990-2000 period our estimate of  $\beta_K$  now becomes  $0.08$ , again virtually identical to that estimated from real data. The artificial income data continue to be highly correlated with actual income growth: the last column provides the average correlations between predicted and actual income growth rates. While the average correlation between actual and generated income flow data is just below  $0.7$  in the 1960-90 period, it is even higher after 1990, attaining a value of  $0.9$ .

Our point of departure for this subsection was that a simple model with no cross-regional variation in  $\lambda$  replicates US inter-state with considerable

precision, but that it predicts too much risk sharing through income flows at the international level, in particular during the recent globalization period. The exercise in this subsection has shown that controlling for differences in the degree to which individual countries' asset portfolios and in particular their equity portfolios are diversified goes a considerable way in reconciling observed international income flows with substantially increased levels of effective macroeconomic diversification (i.e. consumption risk sharing). We turn to a further discussion of this result in our concluding section.

## 5 Discussion and Conclusion

A key finding of our paper is that the consumption risk among OECD countries has improved dramatically over the last decade. This finding is what one should expect in world where the barriers to international capital flows have virtually been removed and it ties in with the bulk of empirical evidence that suggests that international cross-holdings of claims to capital have grown considerably. Still, the literature so far has found it difficult to document that higher capital mobility actually does find its reflection in better international consumption risk sharing. Our framework, based on non-stationary panel regressions, has allowed us to document that countries' consumption risks are indeed a lot more diversified now than they were in the past. This improved risk sharing, does, however, seem to be rather a longer-term phenomenon and that is why it is revealed by our level risk sharing regressions and not by the standard differenced version.

Our estimates suggest that international consumption risk sharing has increased considerably during the recent globalization period. There has also been a marked increase the role of international income flows for risk sharing among countries, but this increase falls short of explaining all of the consumption risk sharing we see in international data. Rather, at the international level, consumption smoothing through saving and dissaving seems important, even in response to permanent asymmetric output shocks. In the long run, it would seem that this is only possible if countries systematically realise capital gains as a way of insuring against output risk – a channel of insurance that seems entirely absent in regional (U.S. state level) data.

The role of capital gains for the dynamics of international asset positions has been emphasized in a number of influential recent studies, notably Lane (2001), Lane and Milesi-Ferretti (2003) and Rey and Gourinchas (2004). One precondition for such valuation effects to work as a channel that allows countries to share idiosyncratic consumption risk is that country portfolios must be heterogenous. Clearly, the very notion of portfolio home bias means

that countries' portfolios *are* heterogeneous. But even as the share of foreign assets in most countries' portfolios is increasing, substantial heterogeneity in terms of the composition of country portfolios persists in the data.<sup>13</sup>

We therefore examine to what extent heterogeneity in country portfolios can account for our finding that only a relatively modest share of total consumption insurance actually takes place through capital income flows. Our results confirm the intuition that countries with more diversified international asset – and in particular equity – positions generally enjoy better consumption risk sharing through larger capital income flows. But they also suggest that the heterogeneity in country portfolios has played an important role in keeping international capital income flows at a relatively modest level for the average country. Taken together, these results support the notion that valuation effects also play an important role in explaining the recent increase in international consumption risk sharing.

One interesting question that arises from these findings is *why* such valuation effects seem important for consumption risk sharing at the international level, while cross-regional income flows are the main channel of risk sharing between U.S. federal states. One potential explanation is that exchange rate adjustments can be an important source of valuation effects and thus, at least to the extent that they act as shock absorbers, a channel of consumption insurance. This would allow countries to substitute exchange rate flexibility for better international portfolio diversification. We leave this issue for future research.

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<sup>13</sup>Lane and Milesi-Feretti (2005) demonstrate that the dispersion of cross-holdings has actually been increasing in recent years.



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**Table 1: Estimates of the home bias  $(1 - \lambda)$**

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**Panel a: Regressions without fixed effects**

$$(c_t^k - c_t^*) = const + (1 - \lambda)(y_t^k - y_t^*) + u_t^k$$

	United States (1960-90)	OECD 1960-90	OECD 1990-2000
OLS	0.48 (0.01)	0.89 (0.01)	0.78 (0.02)
Panel Dynamic OLS	0.52 (0.08)	0.87 (0.09)	0.80 (0.19)

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**Panel b: Regressions controlling for fixed effects**

$$(c_t^k - c_t^*) = const + \phi^k + (1 - \lambda)(y_t^k - y_t^*) + u_t^k$$

	United States (1960-90)	OECD 1960-90	OECD 1990-2000
OLS	0.50 (0.02)	0.96 (0.02)	0.62 (0.06)
Panel Dynamic OLS	0.48 (0.13)	0.98 (0.23)	0.65 (0.19)

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NOTES: The results reported for the panel dynamic OLS estimation are based on estimating equations of the form  $c_{kt} - c_{kt}^* = (\widehat{1 - \lambda})x_{kt} + \sum_{l=-p}^p \delta_{kl} \Delta x_{t-l} + v_{kt}$  where  $x_{kt} = (y_{kt} - y_{kt}^*)$ . Standard errors are given in parentheses. Those for the PDOLS estimates are corrected for serial correlation in  $\Delta x$  and for its endogeneity based on the results in Kao and Chiang (1999). The reported OLS standard errors are valid only for a stationary regression. Since the OLS and the PDOLS have the same asymptotic variance, the corresponding standard errors for the OLS-procedure if  $c - c^*$  and  $x$  are non-stationary are the same as those provided for the PDOLS estimates. Constant estimates are not reported.

**Table 2**  
**Correlations between fitted and actual income growth**

Country	1960-90	1990-2000
Canada	—	0.98
USA	0.69	0.96
Japan	0.72	0.99
Austria	0.60	0.89
Belgium	0.56	0.77
Denmark	—	0.91
Finland	0.73	0.99
France	0.61	0.95
Germany	—	0.99
Greece	0.79	0.97
Iceland	0.90	0.99
Ireland	0.84	0.86
Italy	0.72	0.92
Luxemburg	0.65	0.71
Netherlands	0.64	0.68
Norway	0.83	0.96
Portugal	0.76	0.98
Spain	0.77	0.99
Sweden	0.72	0.97
Switzerland	0.74	0.82
United Kingdom	—	0.91
Australia	0.78	0.98
New Zealand	—	0.89
OECD average	<b>0.73</b>	<b>0.92</b>
US state average	<b>0.61</b>	—

fitted data generated with the portfolio shares estimated from the  
OLS regression with plain levels and without fixed effects. (table 1)

**Table 3: Ex-ante and ex-post risk sharing in fitted and actual GNP data**

Data	United States		1960-90		OECD	
	$1 - \lambda = 0.48$		$1 - \lambda = 0.89$		$1 - \lambda = 0.78$	
	<i>ex-ante</i>	<i>ex-post</i>	<i>ex-ante</i>	<i>ex-post</i>	<i>ex-ante</i>	<i>ex-post</i>
fitted	0.47 (0.01)	0.36 (0.03)	0.13 (0.01)	0.09 (0.05)	0.24 (0.01)	-0.03 (0.12)
actual	0.58 (0.01)	0.25 (0.03)	-0.01 (0.04)	0.23 (0.06)	0.08 (0.03)	0.13 (0.12)
Literature	<u>ASY (1996)</u>		<u>SY98 (1960-90)</u>		—	—
	0.52	0.30	0.03	0.25		

NOTES: regression coefficients from equations (10) (*ex-ante*) and (11) (ex post), based on actual and artificial ('fitted') data. Fitted data generated according to equation (2) with the portfolio shares  $\lambda$  given at the top of the column. Regressions without country-specific fixed effects.

**Table 4**  
**impact of foreign portfolio holdings on risk sharing**  
 OECD countries  
 1960-90                      1990-2000

	I	II	III	IV
$\overline{1 - \lambda}$	<b>0.93</b> (63.84)	<b>0.93</b> (64.83)	<b>0.70</b> (20.77)	<b>0.70</b> (22.99)
<i>cat</i>	<b>-0.53</b> (-4.71)	<b>-0.41</b> (-5.80)	-0.1275 (-0.8736)	
<i>ceqt</i>	0.79 (1.37)		-2.0201 (-2.67)	<b>-2.15</b> (-4.27)
<i>EMU</i>	<b>-0.22</b> (-5.08)	<b>-0.25</b> (-7.15)	-0.1026 (-1.53)	

Notes: coefficients estimated by OLS from eqs. 13 and 12. t-statistics in parentheses.

**Table 5: Ex-ante and ex-post risk sharing with portfolio heterogeneity**

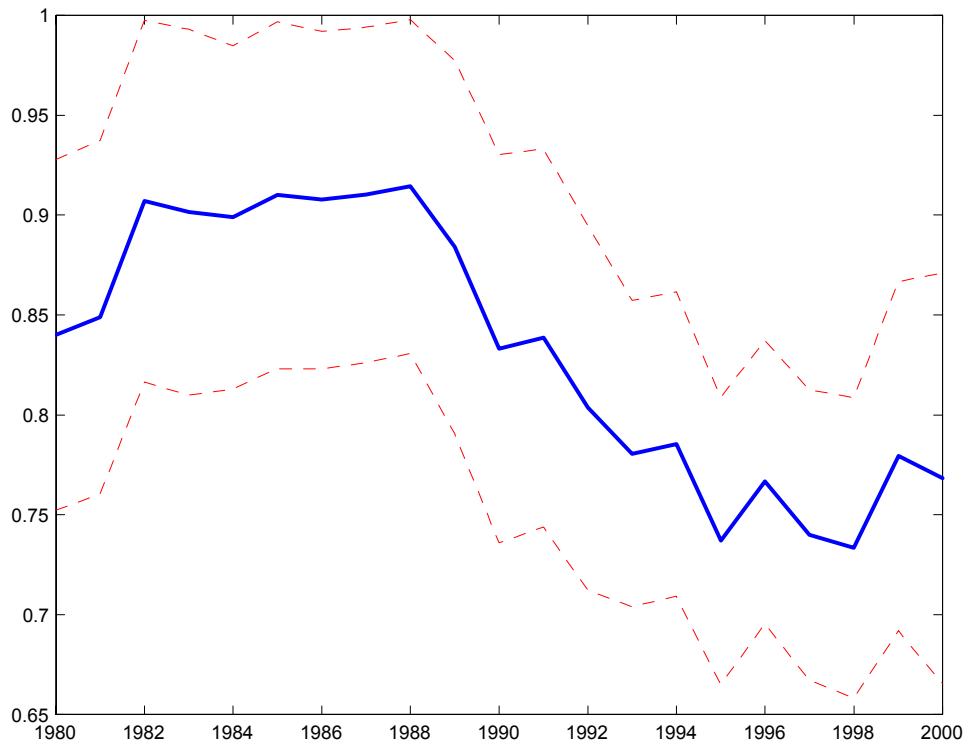
Regression	OECD					
	1960-90			1990-2000		
Data	<i>ex-ante</i>	<i>ex-post</i>	$\bar{\rho}$	<i>ex-ante</i>	<i>ex-post</i>	$\bar{\rho}$
fitted	-0.01 (0.01)	0.23 (0.05)	0.69	0.08 (0.01)	0.14 (0.11)	0.90
actual	-0.01 (0.04)	0.23 (0.06)	—	0.08 (0.03)	0.13 (0.12)	—

NOTES: the fitted data were generated based on the values for  $\lambda_k$  implied by the representation  $1 - \lambda_k = \boldsymbol{\kappa}'(\mathbf{z}_k - \bar{\mathbf{z}})$ , where the coefficients from the restricted models (columns II and IV) in table 4 have been used for the respective subperiod. The columns headed ' $\bar{\rho}$ ' give the mean (across countries) of the correlation between actual and fitted (relative) income growth data.



**Figure 1: The increase in consumption risk sharing 1980-2000.**

a) Recursive estimate of  $1 - \lambda_t$



b) Recursive estimate of  $\gamma_{Kt}$

