

Trade Costs, Asset Market Frictions and Risk Sharing: A Joint Test*

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Abstract

Why does international consumption risk sharing fail? I propose a new test that uses data on bilateral imports to identify whether *both* trade costs *and* asset market frictions are necessary to explain this failure. I implement the test using a sample of 73 developed and developing countries, 1970-2000. The null hypothesis of no trade costs is overwhelmingly rejected for both developed and developing countries. Two versions of the test give contrasting results on the role of asset market frictions. The baseline test does not reject the null hypothesis of frictionless asset markets within developed countries, though it does reject between developed and developing countries. A variant on the baseline test finds that the marginal utility of wealth moves with current income for both developed and developing countries. But the sensitivity of the marginal utility of wealth to income in developed countries is 1/3 of what it is in developing countries, and is only marginally significantly different from zero.

Keywords: Risk sharing, trade costs, asset market frictions

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1 Introduction

In a world where there are no frictions in goods markets, and a full set of contingent claims can be traded, the growth rate of the marginal utility of consumption is perfectly correlated across countries. This prediction is strongly rejected by the data (Backus, Kehoe and Kydland [1992] and Lewis [1996]). A substantial literature has proposed different types of asset and goods market frictions as potential explanations for this rejection. A notable contribution is Obstfeld and Rogoff (2000), who suggest that trade costs alone may go a long way to resolving this as well as other puzzles in international macroeconomics. While asset market frictions reduce countries' ability to smooth their consumption, trade costs make smoothing costly, so it is optimal for the marginal utility of consumption to respond to changes in output. The main contribution of this paper is to present a test based on bilateral trade data that can identify whether *both* asset market frictions *and* goods market frictions (specifically, trade costs) are necessary to explain the failure of risk sharing. I implement the test using a sample of 73 developed and developing countries. For the sample as a whole, both frictions are found to be present. However, for a developed country subsample, the null hypothesis of no frictions in asset markets cannot be rejected using the baseline test. A modified version of the test rejects the no asset market frictions null for these developed countries, but at a marginal significance level.

The framework within which the test is developed is a multi-country DSGE model with Armington specialization, iceberg costs of shipping goods across countries and a very general asset market structure. The asset market structure is general enough to nest the cases usually considered in the literature on risk sharing: frictionless asset markets; financial autarky; an exogenously restricted set of assets, possibly with borrowing constraints and/ or limited enforceability of intertemporal contracts. There is a corresponding disadvantage of generality. Since I do not characterize the asset market structure, I cannot use the estimates I obtain to analyze the potential welfare gains from eliminating asset market frictions.

Identification requires me to place more structure on the nature of goods market frictions than on the asset market side. In focusing on trade costs, I follow Backus, Kehoe and Kydland [1992, 1995], Dumas [1992], Dumas and Uppal [2001], Heathcote and Perri [2004], Kose and Yi [2005], Mazzenga and Ravn [2004], as well as Obstfeld and Rogoff [2000]. By assuming multiple countries, complete specialization and country-pair specific iceberg trade costs, the

modeling approach closely follows the structural gravity literature (most recently, Anderson and van Wincoop [2003, 2004] and Eaton and Kortum [2002]) which aims to explain the full matrix of bilateral trade flows. This approach gives the model a chance to match facts about both intra-temporal and inter-temporal trade, while simultaneously allowing for potential risk sharing through the terms of trade as described in Cole and Obstfeld [1991].

Standard tests of the null hypothesis of frictionless asset markets (e.g. Townsend [1994], Lewis [1996]) are easily modified to take account of potential costs of trade by controlling for relative prices. But these tests do not have enough degrees of freedom to identify simultaneously the role of the two types of friction in impeding risk sharing. To identify the two frictions separately and simultaneously, I make use of the first order conditions governing demand for individual goods. Each country specializes in a distinct good. If there is consumption risk sharing, it must take place through flows of these goods. For each country, there are as many of these first order conditions as there are goods. The marginal utility of wealth appears in each first order condition, but is the same for all goods imported by a particular country, so it can be controlled for using time-varying country fixed effects. By placing restrictions on the behavior of these fixed effects, it is possible to test the null hypothesis of no frictions in asset markets. On the goods market side, estimating these multiple first order conditions amounts to estimating a gravity model of trade. This allows the role of trade costs to be identified, as the literature on structural gravity models has demonstrated.

I implement the test using bilateral import data for a sample of 73 developed and developing countries from 1970-2000. As a baseline, I test the hypothesis that the marginal utility of wealth is constant over time. Using this approach, I reject the null of frictionless financial markets between developing and developed countries, while not being able to reject the null of frictionless asset markets within developed countries. A stronger version of the test examines whether the marginal utility of wealth responds to current income. This test rejects the null of frictionless financial markets within developed countries as well as between developed and developing countries. However the estimated sensitivity of the marginal utility of wealth to current income in developed countries is significantly different from zero only at the 10% level and is 1/3 what it is in the full sample. The null hypothesis of zero trade costs is overwhelmingly rejected for both developed and developing countries. I find that trade costs are large and economically significant, though they fall substantially over the sample period. These results are robust to the modification of several features of the

empirical implementation.

While methodologically, the approach presented here is closest to the tests of consumption insurance in Townsend [1994] and Lewis [1996], it is also related to the literature on the relationship between consumption and real exchange rates (Backus and Smith [1993]; Kollmann [1995]; Ravn [2001]; Corsetti, Dedola and Leduc [2006]). The weak rejection of the null hypothesis of no asset market frictions for developed countries is at odds with the findings of that literature. The reason for this difference lies in the way that real exchange rates (and real consumption) are measured. The test presented here does not require CPI data or data on real consumption. It is implicitly based on relative prices that are consistent with observed trade flows being generated by a gravity model of trade. These relative prices behave quite differently from the real exchange rates constructed using CPI data, and imply more risk sharing than CPI-based real exchange rates.

The first section of the paper lays out the theoretical framework. The second section describes the tests for the role of frictions. The third section goes into more detail on the precise empirical strategy employed. The fourth section describes the data and results, presents some robustness tests, and discusses why the results are different from the previous literature. The final section concludes.

2 Theoretical framework

Summary

There are N countries in the world, indexed $i = 1, \dots, N$. Each country produces a distinct intermediate good (also indexed i) using capital and labor. Capital is accumulable. Productivity in the production of these intermediate goods is stochastic, and may differ across countries. The intermediate goods are tradeable (at some cost). They are combined using a CES aggregator, the same in all countries, to produce a non-tradeable aggregate good used for consumption and investment. Asset markets are complete and frictionless within countries, but there may be exogenous or endogenous limitations on the contracts that can be written across countries.

Uncertainty

In each period t , the economy experiences one event, $s_t \in S$. Denote by s^t the history of events from date 0 to date t . The probability of history s^t at date t is given by $\pi_t(s^t)$.

Preferences and technology

For simplicity, the problem is described as if country i had a single agent with expected utility given by:

$$U^i = \sum_{t=0}^{\infty} \sum_{s^t} \beta^t \pi_t(s^t) N_t^i u(C_t^i(s^t) / N_t^i) \quad (1)$$

where N_t^i is the population of country i and $C_t^i(s^t)$ is total consumption.

Country i produces intermediate good i by combining capital and labor using a constant returns to scale production function:

$$Y_t^i(s^t) = F(K_t^i(s^{t-1}), A_t^i(s^t) N_t^i) \quad (2)$$

where $A_t^i(s^t)$ is the realization of productivity, and $K_t^i(s^{t-1})$ is the (predetermined) capital stock available for use in production in country i at time t .

The production function for the aggregate non-traded good, X is:

$$X_t^i(s^t) = \left(\sum_{k=1}^N Z_t^i(k, s^t)^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}} \quad (3)$$

where $Z_t^i(k, s^t)$ is absorption in country i of intermediate good k at s^t . As $\eta \rightarrow \infty$, we are back in the case of a one-good world. The resource constraint for the aggregate good in i is:

$$X_t^i(s^t) = C_t^i(s^t) + I_t^i(s^t) \quad (4)$$

where $I_t^i(s^t)$ is investment in country i . Given the rate of depreciation δ , capital in country i accumulates according to:

$$K_{t+1}^i(s^t) = (1 - \delta) K_t^i(s^{t-1}) + I_t^i(s^t)$$

Resource costs of trade

Intermediate goods trade may be costly: in order for one unit of j 's good to arrive in i , τ_t^{ij} units must be shipped, with $\tau_t^{ii} = 1$, $\tau_t^{ij} \geq 1$ and $\tau_t^{ij} \tau_t^{jk} \geq \tau_t^{ik}$. It is not in general required that $\tau_t^{ij} = \tau_t^{ji}$. The intermediate goods resource constraints must take account of

the resource cost of trade:

$$Y_t^i(s^t) = \sum_{k=1}^N \tau_t^{ki} Z_t^k(i, s^t) \quad (5)$$

Goods markets

Producers of intermediate goods are assumed to be price takers. But due to trade costs, intermediate goods prices differ across countries:

$$Q_t^k(i, s^t) = \tau_t^{ki} Q_t^i(i, s^t) \quad (6)$$

where $Q_t^i(i, s^t)$ is the spot price of intermediate i in country i at s^t and $Q_t^k(i, s^t)$ is its spot price in country k . In what follows, $Q_t^i(i, s^t)$ is abbreviated to $Q_t(i, s^t)$.

Asset markets

At s^t , country i enters with a vector of asset holdings $\mathbf{B}_t^i(s^{t-1})$ that pays dividends with value given by $\mathbf{D}_t(s^t) \cdot \mathbf{B}_t^i(s^{t-1})$. The vector of asset prices, taken as given by each country, is $\mathbf{R}_t(s^t)$. The value of asset holdings is given by $\mathbf{R}_t(s^t) \cdot \mathbf{B}_t^i(s^{t-1})$. The country can choose to re-optimize its holdings by spending $\mathbf{R}_t(s^t) \cdot \mathbf{B}_{t+1}^i(s^t)$ to purchase a new vector with $\mathbf{B}_{t+1}^i(s^t) \in \mathcal{B}_i(s^t, \mathbf{K}_t(s^{t-1}), \mathbf{B}_t(s^{t-1}))$. Assets are distinguished by their dividend vectors, while the asset market structure determines $\mathcal{B}_i(s^t, \mathbf{K}_t(s^{t-1}), \mathbf{B}_t(s^{t-1}))$, the set of assets available to country i at s^t . Assets are defined such that they are in zero net supply:

$$\sum_{i=1}^N \mathbf{B}_t^i(s^t) = 0 \quad (7)$$

This setup is general enough to encompass frictionless asset markets, financial autarky, and a variety of different types of frictions that allow for partial risk sharing through asset markets.

Sequential competitive equilibrium

At each point in time, country i chooses $C_t^i(s^t)$, $\mathbf{Z}_t^i(s^t)$, $K_{t+1}^i(s^t)$ and $\mathbf{B}_{t+1}^i(s^t)$ to maximize expected utility (1) subject to its aggregate good resource constraint:

$$\left(\sum_{k=1}^N Z_t^i(k, s^t)^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}} = C_t^i(s^t) + K_{t+1}^i(s^t) - (1 - \delta) K_t^i(s^{t-1}) \quad (8)$$

and its (nominal) budget constraint:

$$\sum_{k=1}^N \tau_t^{ik} Q_t(k, s^t) Z_t^i(k, s^t) - Q_t(i, s^t) F(A_t^i(s^t), K_t^i(s^{t-1}), N_t^i) =$$

$$[\mathbf{D}_t(s^t) + \mathbf{R}_t(s^t)] \cdot \mathbf{B}_t^i(s^{t-1}) - \mathbf{R}_t(s^t) \cdot \mathbf{B}_{t+1}^i(s^t) \quad (9)$$

where $\mathbf{R}_t(s^t)$, $\mathbf{D}_t(s^t)$ and $\mathbf{Q}_t(s^t)$, are taken as given, and $\mathbf{B}_{t+1}^i(s^t) \in \mathcal{B}_i(s^t, \mathbf{K}_t(s^{t-1}), \mathbf{B}_t(s^{t-1}))$. A competitive equilibrium is a vector of prices $(\mathbf{Q}^*, \mathbf{R}^*)$ and a vector of quantities for each country $(\mathbf{C}^{i*}, \mathbf{Z}^{i*}, \mathbf{K}^{i*}, \mathbf{B}^{i*})$ such that each country solves the above problem at every realized state s^t and (5), (7) and (8) hold for all realized s^t (i.e. all markets clear).

First order conditions

Assume the existence of a competitive equilibrium. Then for any s^t and for given \mathbf{K}^* and \mathbf{B}^* , the first order conditions with respect to aggregate consumption and absorption of each intermediate are necessary and sufficient for competitive equilibrium (the problem of country i at s^t is convex).

The first order condition with respect to $C_t^i(s^t)$ is:

$$\lambda_t^i(s^t) u_c(C_t^i(s^t)/N_t^i) = P_t^i(s^t) \quad (10)$$

where $\lambda_t^i(s^t)$ is inverse of the marginal utility of current per capita nominal wealth for country i evaluated at s^t , u_c is the marginal utility of consumption per capita, and $P_t^i(s^t)$ is the nominal price of the consumption aggregate at s^t :

$$P_t^i(s^t) = \left[\sum_{k=1}^N (\tau_t^{ik} Q_t(k, s^t))^{1-\eta} \right]^{\frac{1}{1-\eta}} \quad (11)$$

The λ 's have an alternative interpretation as the (time-varying) per capita Pareto weights for each country in a series of intra-temporal planning problems. A useful normalization of the λ 's (and consequently, prices) suggested by this interpretation is $\sum_i \lambda_t^i(s^t) = 1$.

The first order condition with respect to $Z_t^i(k, s^t)$ is:

$$P_t^i(s^t) X_t^i(s^t)^{\frac{1}{\eta}} Z_t^i(k, s^t)^{-\frac{1}{\eta}} = \tau_t^{ik} Q_t(k, s^t) \quad (12)$$

Classic tests of international consumption risk sharing are based on (10). Before discussing these tests, and an alternative based on (12), I briefly review the correspondence between the marginal utility of wealth and the nature of frictions in asset markets.

2.1 Asset markets and the marginal utility of wealth

Frictionless asset markets

When asset markets are complete and frictionless, the sequential competitive equilibrium of this economy is Pareto optimal. The competitive equilibrium allocation can be recovered as the solution to a planning problem where for appropriate $\{\lambda^1, \dots, \lambda^N\}$ the planner chooses sequences of \mathbf{C} , \mathbf{Z} and \mathbf{K} to maximize the ex-ante weighted sum of expected utilities:

$$\sum_{i=1}^N \lambda^i U^i = \sum_{i=1}^N \sum_{t=0}^{\infty} \sum_{s^t} \beta^t \pi_t(s^t) \lambda^i N_t^i u(C_t^i(s^t) / N_t^i) \quad (13)$$

subject to (for all i and s^t) the resource constraints (5) and (8). The first order conditions for this problem are exactly (10) and (12), with constant λ^i . In particular, the relative marginal utility of nominal wealth does not depend on current income.

Asset markets with frictions

More generally, the relative marginal utility of nominal wealth varies across states and over time. Aiyagari [1994] and Krusell and Smith [1998] show that when agents can hold only one asset, and there is an exogenous borrowing limit, the sensitivity of $\lambda_t^i(s^t)$ to current income varies with the level of wealth. High wealth agents are approximately permanent income consumers, implying a low sensitivity idiosyncratic shocks to current income. Agents with low wealth are more likely to be constrained, and hence to have consumption and wealth that responds a lot to current income. When asset markets are complete, but there is limited enforcement, the marginal utility of wealth of one agent relative to another is constant if neither agent is tempted to default. For constrained agents, wealth and the marginal utility of wealth must change by an amount necessary to make them indifferent between default and remaining in the market (Kocherlakota [1996]; Kehoe and Perri [2002]). This implies that their marginal utility of wealth is sensitive to current income. In short, commonly assumed configurations of asset market frictions imply that $\lambda_t^i(s^t)$ may respond to current income, but the magnitude of that response varies across agents and over time.

3 Why does risk sharing fail?

Tests based on aggregate consumption and real exchange rates

From (10), relative marginal utility of consumption is given by:

$$\frac{u_c(C_t^i(s^t)/N_t^i)}{u_c(C_t^j(s^t)/N_t^j)} = \left[\frac{\lambda_t^i(s^t)}{\lambda_t^j(s^t)} \right]^{-1} \left[\frac{P_t^i(s^t)}{P_t^j(s^t)} \right] \quad (14)$$

In the presence of trade costs and frictions in asset markets, relative marginal utility of consumption can vary for two reasons. First, with frictions in asset markets, $\lambda_t^i(s^t)/\lambda_t^j(s^t)$ need not be constant. In particular, relative wealth may respond to current output, as sketched above. Second, in order for consumption risk sharing to take place, goods must be shipped internationally. If shipping is costly, agents will optimally choose not to smooth consumption perfectly. The effect of trade costs is perfectly captured by the real exchange rate, $P_t^i(s^t)/P_t^j(s^t)$, which varies with current output when trade is costly.

To see this second effect more clearly, rewrite (14) as:

$$\frac{u_c(C_t^i(s^t)/N_t^i)}{u_c(C_t^j(s^t)/N_t^j)} = \left[\frac{\lambda_t^i(s^t)}{\lambda_t^j(s^t)} \right]^{-1} \left[\frac{\sum_{k=1}^N \left[\frac{Y_t^k(s^t)}{\phi_t^k(s^t)(\tau_t^{ik})^\eta} \right]^{\frac{\eta-1}{\eta}}}{\sum_{k=1}^N \left[\frac{Y_k(s^t)}{\phi_t^k(s^t)(\tau_t^{jk})^\eta} \right]^{\frac{\eta-1}{\eta}}} \right]^{\frac{1}{(1-\eta)}} \quad (15)$$

with

$$\phi_t^k(s^t) = \sum_{h=1}^N \left(\frac{P_t^h(s^t)}{\tau_t^{hk}} \right)^{\eta-1} P_t^h(s^t) X_t^h(s^t) \quad (16)$$

The numerator in the second term in (15) is a weighted average of the output of all countries, where the weights are inversely proportional to the cost of shipping to country i . The denominator is a similar weighted average where the weights are inversely proportional to the cost of shipping to country j . Trade costs induce a correlation between consumption growth rates and output growth rates even in the absence of frictions in asset markets.

Tests of international consumption insurance that follow the approach of Townsend [1994] (such as those in Lewis [1996]) look at whether relative traded goods consumption growth rates are correlated with relative output growth rates. If traded goods prices differ across countries, these tests cannot distinguish between failures of risk sharing due to frictions in goods markets and failures of risk sharing due to frictions in asset markets. By contrast,

the literature on consumption-real exchange rate correlations (Backus and Smith [1993]; Kollmann [1995]; Ravn [2001]; recent contributions summarized in Corsetti, Dedola and Leduc [2006]) infers the presence of frictions in international asset markets from the low or negative correlation between relative consumption and real exchange rates, implicitly conditioning on (but not testing for) frictions in goods markets.

A test based on bilateral import flows

Based on the framework outlined above, I propose a new test that uses data on bilateral imports to identify simultaneously whether *both* trade costs *and* asset market frictions are necessary in order to explain the failure international consumption risk sharing. This test is based on the first order conditions for individual intermediate goods in addition to the first order condition for aggregate consumption which underlies the tests described above.

Combining the intermediate goods first order conditions with the intermediate good resource constraints yields the relationship (state-contingent notation is suppressed for the sake of brevity):

$$\frac{IM_t^{ik}}{EXP_t^i GDP_t^k} = \left(\frac{P_t^i \Pi_t^k}{\tau_t^{ik}} \right)^{\eta-1} \quad (17)$$

IM_t^{ik} is the value of imports into i from k ; EXP_t^i is the value of i 's expenditure on consumption and investment; GDP_t^k is the value of k 's output; P_t^i is the price of the aggregate good in i and Π_t^k is given by:

$$(\Pi_t^k)^{1-\eta} = \sum_{j=1}^N \left(P_t^j / \tau_t^{jk} \right)^{\eta-1} EXP_t^j \quad (18)$$

Equation (17) is a structural “gravity” equation (for recent contributions, see Anderson and van Wincoop [2003], [2004]). The value of bilateral imports is inversely proportional to bilateral trade costs, and proportional to the expenditure of the importer, the output of the exporter, and to time-varying importer and exporter “multilateral resistance” terms. These terms are functions of utility-consistent prices.

Now the first order condition for aggregate consumption tells us that:

$$P_t^i = \lambda_t^i u_c (C_t^i / N_t^i) \quad (19)$$

This implies that (17) can be rewritten:

$$\frac{IM_t^{ik}}{EXP_t^i GDP_t^k} = \left(\frac{\lambda_t^i u_c (C_t^i / N_t^i) \Pi_t^k}{\tau_t^{ik}} \right)^{\eta-1} \quad (20)$$

Equation (20) holds in the presence of trade costs ($\tau_t^{ik} \neq 1$) and frictions in goods markets ($\lambda_t^i \neq \lambda^i$). Standard “gravity” variables can be used to control for trade costs τ_t^{ik} . There are N equations for each importer country i at a given point in time (one for each good), and $P_t^i = \lambda_t^i u_c (C_t^i / N_t^i)$ appears in all of them. Similarly, for each good k , there are N equations at a point in time (one for each export destination), and Π_t^k appears in all of them. This implies that importer-year fixed effects and exporter-year fixed effects can be used to control for $\lambda_t^i u_c (C_t^i / N_t^i)$ and Π_t^k respectively.

It is straightforward to impose the null hypothesis of frictionless asset markets, i.e. $\lambda_t^i(s^t) = \lambda^i$ in this framework. If the marginal utility of aggregate consumption is controlled for, λ^i can be picked up by an importer fixed effect. The resulting expression is nested in (20), so the null of frictionless asset markets can be tested against the alternative of some asset market friction using a likelihood ratio test.

It is also straightforward to impose the joint hypothesis of financial autarky and symmetric trade costs. Under financial autarky, total imports must be equal to total exports for all countries, i.e. aggregate trade must be balanced. If in addition $\tau_t^{ik} = \tau_t^{ki} \forall i, k, t$, the symmetric structure of the model implies that bilateral trade must also be balanced, so we must have $P_t^i = \lambda_t^i u_c (C_t^i / N_t^i) = \Pi_t^i$. That is, symmetry must be imposed on the importer-year and exporter-year fixed effects. Again, the resulting expression is nested in (20), so the null of financial autarky can be tested against the alternative of some asset trade using a likelihood ratio test.

Finally, in the absence of trade costs, the composition of the expenditure basket is always identical across countries, irrespective of the nature of frictions in the asset market (these shift the size of the basket across periods and states, but not its composition). Prices are the same everywhere: $P_t^i = P_t^j = P_t$, and the right hand side of (20) reduces to the inverse of world GDP. The assumption of no trade costs can therefore be imposed by regressing the dependent variable on a time fixed effect alone. As before, this is nested in (20), so the null of no trade costs can be tested against the alternative of some trade costs using a likelihood ratio test.

To summarize, we have the following four models implied by different configurations of frictions, where model (a) nests models (b), (c) and (d):

Summary of Predictions

	Asset market	Trade costs	P_t^i	Π_t^k	τ_t^{ik}
(a)	General	Yes	$\lambda_t^i u_c^i(\cdot)$	$\left[\sum_{j=1}^N \left(P_t^j / \tau_t^{kj} \right)^{\eta-1} EX P_t^j \right]^{\frac{1}{1-\eta}}$	τ_t^{ik}
(b)	Autarky	Yes ¹	$\lambda_t^i u_c^i(\cdot)$	$\lambda_t^k u_c^k(\cdot)$	τ_t^{ik}
(c)	Frictionless	Yes	$\lambda^i u_c^i(\cdot)$	$\left[\sum_{j=1}^N \left(P_t^j / \tau_t^{kj} \right)^{\eta-1} EX P_t^j \right]^{\frac{1}{1-\eta}}$	τ_t^{ik}
(d)	General	No	1	$1 / \sum_{j=1}^N EX P_t^j$	1

The implementation of the test is described in the next section.

This approach to identifying why international risk sharing fails differs from the previous literature along three dimensions. First, it provides a common framework for identifying the role of trade costs and asset market frictions. This contrasts with Lewis [1996], who does not take account of the possibility of goods market frictions over and above non-traded goods. It contrasts with the literature on consumption-real exchange rate correlations, which controls for goods market frictions (if present) by conditioning on real exchange rates, but which does not directly identify the presence or nature of these frictions.

Second, the estimation of multiple first order conditions for each country makes it possible to test the hypothesis that the relative marginal utility of wealth is constant against the alternative that it varies over time, without making any assumptions about the relationship between λ_t^i and particular variables. As sketched above, the relationship between the relative marginal utility of wealth and current output is likely to differ across countries and over time. In addition, as Cochrane [1991] points out, correlated measurement error in consumption and output could lead tests based on the relationship between these two variables to reject the null of no asset market frictions incorrectly. However it is simple to nest the Townsend [1994] and Lewis [1996] approach within this framework by testing whether current output enters significantly on the right hand side in model (c).

Finally, as I elaborate below, using this test, it is not necessary to use CPI data or deflators to construct real exchange rates or recover real consumption. The test can be implemented using value data alone. Value data are less likely to be subject to measurement

¹Symmetric trade costs must also be assumed.

error than data on prices or quantities. In addition, this sidesteps the problem that measured price indexes may be poor proxies for the utility-consistent prices suggested by theory.

4 Empirical strategy

Functional form for marginal utility

Some assumptions must be made about the form of the marginal utility of consumption in order to implement the test. For expositional purposes, the possibility of a labor-leisure tradeoff has been suppressed until this point. In the empirical implementation, it is straightforward to allow for this tradeoff and potential non-separability between consumption and leisure. Suppose that $u(\cdot)$ takes the form:

$$u(C_t^i/N_t^i, L_t^i/N_t^i) = \frac{(C_t^i/N_t^i)^{1-\rho} (L_t^i/N_t^i)^\psi}{1-\rho} + v(L_t^i/N_t^i) \quad (21)$$

for some $v(\cdot)$ with the appropriate properties. The first order condition for aggregate consumption can be written:

$$\lambda_t^i u_c(\cdot, \cdot) = \lambda_t^i (C_t^i/N_t^i)^{-\rho} (L_t^i/N_t^i)^\psi = P_t^i \quad (22)$$

The labor-leisure tradeoff and potential non-separability of this form do not affect any of the expressions in the previous section beyond modifying the form of marginal utility.²

Value data on consumption

Given that the test implicitly involves estimating P_t^i , it is both convenient and internally consistent not to use any information on aggregate prices or real exchange rates in implementing it. The assumed form for the utility function allows the first order condition for aggregate consumption, (10), to be rewritten as a function of the value of consumption:

$$(\lambda_t^i)^{\frac{1}{1-\rho}} (P_t^i C_t^i/N_t^i)^{\frac{-\rho}{1-\rho}} (L_t^i/N_t^i)^{\frac{\psi}{1-\rho}} = P_t^i \quad (23)$$

Trade costs

²The additional intratemporal first order condition is not exploited in the test.

The standard assumption in the empirical gravity literature on the form of bilateral trade costs is (see Anderson and van Wincoop [2004]):

$$\left(\tau_t^{ik}\right)^{1-\eta} = \prod_{n=1}^J \left(G_n^{ik}\right)^{\gamma_n^i}, \quad G_n^{ik} = 1 \text{ if } i = k, G_n^{ik} \geq 1 \text{ otherwise} \quad (24)$$

Commonly used “gravity variables” (G_n^{ik}) include bilateral distance, dummies for common language, colonial heritage and legal origins. In general, the number of gravity variables $J \ll N^2$, where N^2 is the number of bilateral pairs included in the regressions. Ideally, bilateral barriers due to trade policy should also be controlled for. This would not require modifying the empirical approach; However constructing the required data is beyond the scope of this paper.

Implementation

Taking models (a) to (d) from the previous section, substituting in the expression for trade costs and taking logs yields four linear models. Let $w_t^{ik} = \ln(IM_t^{ik}/EXP_t^iGDP_t^k)$, $c_t^i = \ln(CONS_t^i/N_t^i)$, $l_t^i = \ln(L_t^i/N_t^i)$ and $g_n^{ik} = \ln G_n^{ik}$, where $CONS$ is the value of consumption. In addition, let θ_t^i be an importer-year fixed effect, ϕ_t^k an exporter-year fixed effect, θ^i an importer fixed effect and ϕ_t a time fixed effect. Then we have the following four estimating equations:

Estimating Equations³

	Asset market	Trade costs	Estimating equation
(a)	General	Yes	$w_t^{ik} = \theta_t^i + \phi_t^k + \sum_{n=1}^J \gamma_{nt} g_n^{ik} + \varepsilon_t^{ik}$
(b)	Autarky	Yes ⁴	$w_t^{ik} = \theta_t^i + \theta_t^k + \sum_{n=1}^J \gamma_{nt} g_n^{ik} + \varepsilon_t^{ik}$
(c)	Frictionless	Yes	$w_t^{ik} = \theta^i + \phi_t^k + \beta_c c_t^i + \beta_l l_t^i + \sum_{n=1}^J \gamma_{nt} g_n^{ik} + \varepsilon_t^{ik}$
(d)	General	No	$w_t^{ik} = \phi_t + \varepsilon_t^{ik}$

Given the large numbers of fixed effects, (a), (b) and (c) are estimated as two-way fixed effects models. Likelihood ratio tests are used to test (b), (c) and (d) against the alternative of (a).

An alternative test combines the Townsend [1994] approach with the strategy developed here. Let $gdp_t^i = \ln[(GDP_{it}/N_{it}) / (GDP_t^W/N_t^W)]$. Include this variable on the right hand

³The restrictions on the relationships between ϕ_t^k and the other variables in models (a), (b), and (c) cannot be imposed because data on the full universe of bilateral pairs would be required.

⁴Symmetric trade costs must also be assumed.

side in estimating (c):

$$w_t^{ik} = \theta^i + \phi_t^k + \beta_c c_t^i + \beta_l l_t^i + \beta_y \ln gdp_t^i + \sum_{n=1}^J \gamma_{nt} g_n^{ik} + \varepsilon_t^{ik} \quad (e)$$

Under the frictionless asset market null, the relative marginal utility of nominal wealth does not respond to current income, so β_y should not be significantly different from zero.

Remaining data issues

The data used is described in the next section. For roughly 1/3 of the country pairs in the sample, bilateral imports are recorded as zero. As standard in the gravity literature, to avoid dropping these observations from the bilateral tests, w_t^{ik} is constructed as $\ln [(1 + IM_t^{ik}) / EXP_t^i GDP_t^k]$. I test the robustness of the results to this choice.

The model presented above is of a world where gross output equals value added. The fact that this is not the case in the data is reflected in ratios of exports to GDP that exceed 1 for some countries in the sample. Since the dependent variable, w_t^{ik} , is a ratio of an output quantity to a value added quantity, this is of concern. It is straightforward to modify the model to allow gross output and value added to differ. Assume that the intermediate goods have a production function that takes the form:

$$Y_t^i(s^t) = M_t^i(s^t)^\sigma [F(A_t^i(s^t), K_t^i(s^{t-1}), N_t^i)]^{1-\sigma}$$

where $M_t^i(s^t)$ is the quantity of the aggregate good (materials) used in the production of intermediates. The value share of materials in gross output is equal to σ . The gravity equations on which the bilateral tests are based are unchanged, except that GDP is replaced by gross output and expenditure is replaced by expenditure gross of materials. Data on gross output is not generally available, but for a given value for σ , a model-consistent estimate is given by

$$OUT_t^i = \frac{1}{1-\sigma} GDP_t^i$$

A value of $\sigma = 0.5$ is assumed, consistent with the fact that the average ratio of gross output to GDP in the *OECD Intersectoral Database* is approximately equal to 2. A country's absorption of its own output is then calculated as gross output less exports. These observations (i.e. countries' imports from themselves) are included in the baseline analysis. Robustness

of the results to the construction of gross output is tested.

5 Data and results

All data is annual. Population, the current dollar value of GDP, the current dollar value of total expenditure, the current dollar value of total imports and the value share of private consumption expenditures in GDP are taken from the World Bank's *World Development Indicators* (WDI). The employment rate is taken from the *Penn World Tables*, version 6.1. Bilateral merchandise imports in current dollars from 1970 to 2000 are taken from the *NBER-United Nations Trade Data* (UN) prepared by Feenstra and Lipsey. Bilateral service trade flows are not available for the sample period. It is implicitly assumed that they follow the same pattern as bilateral merchandise flows. The dependent variable for the bilateral tests is constructed by applying the bilateral shares from the UN data to the National Accounts data from the WDI to make trade and National Accounts data consistent.

For the purpose of estimating the gravity equations, variables that are correlated with trade costs are required. The set of variables used here is standard. Bilateral distance in miles is calculated using the great circle distance algorithm provided by Gray [2001]. Dummy variables indicating common language, contiguity, a colonial relationship post-1945 and a common colonizer post-1945 are constructed based on the *CIA World Factbook*. A dummy variable indicating common legal origin (British, French, German, Scandinavian or Socialist) is constructed based on the categorization provided by la Porta et al [1999].

The largest possible sample given the requirement that all of the above variables be available for all years 1970-2000 consists of 73 developed and developing countries. These are listed in the Appendix.

5.1 Results

Baseline bilateral tests

Table 1 reports the results from estimating the four models described above using all bilateral pairs in the 73-country sample. In the baseline specification, the coefficients on the gravity variables are allowed to vary by 5-year period. The estimated coefficients on the gravity variables are fairly standard and stable across specifications. Based on equation (23), the coefficient on the value of consumption in the frictionless asset markets model is consistent

with the Backus-Smith observation of a positive unconditional correlation between prices and consumption. The share of the variance in the dependent variable explained by the frictionless financial markets model is approximately equal to that explained by the model that imposes financial autarky.

Table 2 reports the likelihood ratio test statistics and p-values for the three hypothesis tests, taking the trade cost-unspecified friction in asset markets model as the alternative hypothesis in each case. The null of no frictions in asset markets is rejected at all significance levels. The null of financial autarky is rejected at all significance levels. The null of no trade costs is rejected at all significance levels.

Do developed and developing countries face different frictions?

To test the hypothesis that asset market frictions are less salient between developed countries than developed and developing countries, I repeat the exercise just described using only observations on bilateral imports between 22 developed countries. The countries included in this subsample are listed in the Appendix. The estimation results are reported in Table 3. The magnitude of the coefficients on the gravity variables in the models with trade costs are different from those in the full sample, and the implied trade costs are substantially smaller. Overall, the models with trade costs explain a good deal more of the variation within this subsample than they do in the full sample of 73 countries.

Table 4 reports the likelihood ratio test statistics and associated p-values for the developed country sub-sample. The null hypothesis of no asset market frictions and costly trade *cannot* be rejected for this sample. The null of financial autarky is rejected at all levels of significance. The null of no trade costs is rejected at all levels of significance. However the coefficient on distance and the implied trade costs are smaller than in the pooled sample.⁵ Implementation of the same tests for sub-samples of 22 countries that contain both developed and developing countries indicate that the failure to reject the no asset market frictions null for developed countries is not due to the difference in sample size. The developed country subsample is closer to perfect risk sharing than the full sample, both because trade costs are lower, and because frictions in asset markets are less salient.

Are frictions declining in importance over time?

⁵This is driven by the presence of zeros in the larger sample, and the absence of zeros in the developed country subsample.

I split the sample and estimate the four models separately on the period 1970-1984 and the period 1985-2000. Table 5 reports the likelihood ratio test statistics and associated p-values for the two sub-samples. In both the earlier period and the later period, the null of no asset market frictions and costly goods trade is rejected against the alternative of frictions in both goods and asset markets, though the likelihood ratio statistic is much lower in the later period. Similarly, the null of financial autarky is rejected in favor of the alternative of some risk sharing through financial markets, and the null of no trade costs is strongly rejected in both periods. These results are mildly suggestive of some weakening in asset market frictions over time.

More about asset market frictions and trade costs

The estimated coefficients on the gravity variables from the unrestricted model (the first column of Table 1) can be used to construct fitted values of bilateral trade costs between all country pairs for the 6 five-year intervals covered by the sample. This requires a value for the elasticity of substitution, η . Following Anderson and van Wincoop [2004], a baseline value of 6 is used. The first panel of Table 7 reports summary statistics of the implied trade costs. Using this elasticity, and under the joint assumption of zero internal trade costs and no home bias, the predicted trade costs are very high, much higher than measured costs of trade for goods that are actually traded. This is typical of the trade costs estimated using gravity models. The estimated resistance to trade is such that implied trade costs are very high for plausible elasticities of substitution. The estimated trade costs are not sensitive to the assumed frictions in asset markets. Panel 2 of Table 7 reports the implied trade costs from the frictionless asset trade model. They are very similar to those in Panel 1.

One explanation for these high estimates is that trade costs are heterogeneous, and that only those goods with the lowest trade costs are actually traded in equilibrium. The costs estimated here can be interpreted as the uniform cost across all goods consistent with the observed volume of trade. Hence the comparison with observed trade costs is not very relevant. Another possible explanation is that there are in fact both fixed and per unit costs of trade. Helpman, Melitz and Rubinstein [2007] argue that failure to control for the extensive margin of trade in the presence of fixed costs may lead to an upward-bias in estimates of per unit trade costs. In sum, the evidence strongly suggests a much greater macroeconomic role for trade costs than usually presumed in the international real business cycle literature.

The estimates of the importer fixed-effects from the unrestricted model can be used to recover $\hat{\lambda}_t^i$, the implied inverse marginal utility of per capita wealth, or per capita Pareto weight, for each country. This requires some assumptions about the parameters ρ and ψ of the utility function, and the elasticity of substitution η . If $\psi = 0$ (utility separable between consumption and leisure), we have:

$$\hat{\lambda}_t^i = \frac{\left[\exp \hat{\theta}_t^i \right]^{\frac{1-\rho}{\eta-1}} \left[CONS_t^i / N_t^i \right]^\rho}{\sum_{j=1}^N \left[\exp \hat{\theta}_t^j \right]^{\frac{1-\rho}{\eta-1}} \left[CONS_t^j / N_t^j \right]^\rho}$$

Table 6 reports summary statistics for the distribution of the coefficient of variation of $\hat{\lambda}_t^i$ over the period 1970-2000 for both subsamples. Various different configurations of parameter values are considered. For all configurations of parameter values, relative weights are more variable for developing than developed countries. This is further illustrated in Figures 1 to 3, which plot the time-series of normalized $\hat{\lambda}_t^i$ for selected groups of countries under the assumption that $\rho = 1.5$ and $\eta = 6$. The test of the null hypothesis of no asset market frictions against the alternative of some friction amounts to asking whether the variation of each country's $\hat{\lambda}_t^i$ over time is crucial to explaining the variability in normalized bilateral imports. The greater variability of $\hat{\lambda}_t^i$ for developing than developed countries drives the failure to reject the no asset market frictions null for developed countries, while it is rejected for the sample as a whole.

Alternative test

As described in the previous section, it is possible to combine a test for the presence of frictions in asset markets that closely follows Townsend [1994] and Lewis [1996] with the bilateral import framework used here. Columns 2 and 4 of Table 8 report the results from estimating model (e) in the full sample and in the developed country sub-sample respectively (columns 1 and 3 repeat the estimates of the model that imposes no frictions in asset markets for comparison). In both cases, the coefficient on relative GDP per capita is positive and significantly different from zero. In the case of the full sample, it is significantly different from zero at the 5% level. In the case of the developed country subsample, the coefficient is less than 1/3 as big, and significantly different from zero only at the 10% level. This ranking is consistent with the results from the baseline test, though this test appears to have stronger

power against the no asset market frictions null.

5.2 Robustness

Full set of time interactions

Allowing trade costs to vary freely over time (i.e. allowing for the full set of time interactions with the gravity variables) improves the fit of the model. However none of the baseline results are affected. For the full sample, all restrictions on the general asset frictions-trade cost model are rejected in favor of the unrestricted model. For the developed country subsample, the null of trade costs but no asset market frictions cannot be rejected against the unrestricted alternative.

Unbalanced panel

Just over 40% of the 165,199 observations in the 73-country sample have zero recorded bilateral imports (For the developed country subsample, the number of zeros is negligible). These zeros can be interpreted as true zeros - due to fixed costs of trade - or as positive values censored by some rounding down or measurement error in the data collection process. A popular strategy for dealing with zeros in the estimation of log-linear gravity equations is to drop these observations. Helpman, Melitz and Rubinstein [2007] argue that with fixed costs of exporting and selection into exporting, this leads to a downward bias in the estimated costs of trade (this is distinct from the upward bias due to failure to control for the extensive margin referred to before). The estimation strategy I employ avoids dropping these observations by adding 1 to bilateral imports before normalizing by importer expenditure and exporter GDP to get the dependent variable. When the alternative strategy of dropping the zeros is employed, estimated per unit trade costs fall. However the results of the likelihood ratio tests are unchanged. All restrictions on the two-frictions model are rejected for the full 73-country sample, while the trade cost, no asset market frictions null cannot be rejected for the developed country sub-sample.

5-year aggregation of the data

It is possible that some of the zeros in bilateral imports are due to infrequent trade rather than no trade - zeros are more frequent in quarterly or monthly data. The model does not specify what is the length of a period. It is customary to use annual data to estimate gravity equations, but there is no reason why longer frequencies should not be used. When the

data is aggregated over 5-year periods, deflating nominal variables by the US consumer price index, the results are very similar to the baseline. The null of trade costs but frictionless asset markets is rejected for the sample as a whole, but cannot be rejected for the developed country subsample. In all other cases, the null is rejected in favor of the unrestricted 2-frictions model.

Exclusion of estimates of trade with self

The baseline sample includes observations on a country's estimated absorption of domestic output, constructed under the assumption that the ratio of gross output to value added is equal to 2 for all countries and all periods. These observations are not necessary for the test. When these observations are not included, and GDP is used in the test rather than the estimate of gross output, estimated trade costs are somewhat larger. But the results of the likelihood ratio tests are very similar. The null hypothesis of trade costs but frictionless asset markets is rejected for the sample as a whole, but cannot be rejected for the developed country subsample. In all other cases, the null is rejected in favor of the alternative.

5.3 Discussion

Why the results differ from the previous literature

The results of the tests I present are somewhat more favorable to the null hypothesis of no asset market frictions between developed countries than previous results in the literature. As explained in section 3, the test I use differs from the previous literature along three dimensions. The most important difference, as regards driving the difference in results, is the fact that I do not use measured CPI data to construct real exchange rates, real consumption, or indeed any variable. The test uses only data on values. The rich bilateral structure of the data, combined with strong functional form assumptions, is used to estimate implicitly the relative prices that are consistent with a gravity structure for bilateral trade. The ability of restricted versions of these estimates (and their comovement with the value of aggregate consumption) to explain the variation in bilateral trade is what drives the test results.

To understand how it is that these implicit relative price estimates give a different view of the nature of frictions in asset markets, it is useful to consider the correlation between them and more standard measures of bilateral real exchange rates. The following real exchange rate variable can be constructed using the importer-year fixed effects from the unrestricted

model:

$$(\eta - 1) \ln \widehat{rer}_t^{ij} = (\eta - 1) (\ln P_t^j - \ln P_t^i) = \hat{\theta}_t^j - \hat{\theta}_t^i$$

I compare this variable with a standard real exchange rate, calculated using end of year nominal exchange rates from the IMF's *International Financial Statistics*, and consumer price inflation from the *World Development Indicators*:

$$\ln rer_t^{ij} = \ln CPI_t^j + \ln E_t^{ij} - \ln CPI_t^i$$

I calculate the time-series correlation between these two measures, i.e.

$$\text{corr} \left((\eta - 1) \ln \widehat{rer}_t^{ij}, \ln rer_t^{ij} \right)$$

for all bilateral pairs in the sample. For the sample as a whole, the median correlation is -0.07. For pairs of OECD countries, the median correlation is -0.17.

Clearly, the variation in the implied real exchange rates on which the test in this paper is based is different from the variation in measured CPI real exchange rates. It is beyond the scope of this paper to investigate in detail why this is so. Suffice to say that, using models with multiple heterogeneous goods, Ghironi and Melitz [2005] and Corsetti, Martin and Pesenti [2007] also find that measured prices behave differently from what the models predict. They argue that the way the CPI is constructed is not consistent with a utility-based price index with heterogeneous goods.

Welfare consequences of frictions

The test for international consumption risk sharing presented here can identify a role for asset market frictions in impeding risk sharing for some groups of countries, but it does not pin down the exact nature of those frictions. Without knowing where we start from, we cannot calculate the benefits from moving from there to full risk sharing. Hence, a rigorous analysis of the welfare gains from reducing frictions in goods and asset markets is beyond the scope of this paper. However an extensive previous literature gives some idea of what the order of magnitude of the gains might be.

Attanasio and Davis [1996] find that for reasonable values of risk aversion, the welfare costs of imperfect insurance across agents within countries are moderate, about 1-2% of consumption. On the international side, estimates of the potential gains from greater risk

sharing through financial markets depend crucially on the specification of the environment, and the data used. But for low values of risk aversion, the implied gains are on the same order of magnitude as the welfare costs of business cycles in closed economies, i.e. about 1% (Lewis [2000]). Gourinchas and Jeanne [2006] estimate that welfare losses due to slower capital accumulation under financial autarky are about 1% of consumption - a small number when compared with the potential gains to convergence in TFP levels. All of these authors ignore frictions in goods markets, but it seems reasonable to assume that the presence of trade costs would not *increase* the scope for welfare gains from eliminating asset market frictions.⁶

On the trade cost side, a rigorous analysis must take into account the effect of changing trade costs on intertemporal trade as well as intratemporal trade, and hence requires taking a stand on asset market frictions. For example, Guibaud (2005) shows that when there is an enforcement friction in international asset markets, reducing trade costs relaxes borrowing constraints. However, as a first pass one can consider the following simple calculation. Assume that trade costs really are iceberg trade costs. Suppose we reduce all trade costs by 10% while holding the value of all trade flows fixed (Even with a very high value of the elasticity of substitution η , the estimates underlying Table 7 imply that average trade costs fell much more than 10% between 1970 and 2000). The dollar value of resources saved as a fraction of the nominal value of world output is approximately 10% of the total value of world trade divided by the value of world output. In 1970, the value of world trade was 13% of world GDP, so this amounts to recovering 1.3% of the value of world GDP. This number does not take into account welfare gains from increased variety due to the expansion of trade: While world trade was 13% of world GDP in 1970, it was 24% of world GDP in 2000. The welfare gain from variety depends on the elasticity of substitution between different goods. Broda and Weinstein (2006) estimate these elasticities for many goods, and find welfare gains of 2.6% of GDP due to expanding variety through trade for the US from 1972-2001. This implies that the potential welfare gains from reasonable reductions in goods market frictions may be more substantial than the welfare gains from greater risk sharing through financial markets.

⁶Dumas and Uppal [2001] find that trade costs do not affect the welfare gains from financial integration, though their one-good model may behave very differently from one where there is intratemporal trade.

6 Conclusion

Why does international consumption risk sharing fail? This paper develops a test that can identify whether both asset market frictions and trade costs are necessary to explain this failure. I implement this test using a sample of developed and developing countries. The null hypothesis of no trade costs is unambiguously rejected for both developed and developing countries. Trade costs, though falling over time, are found to be of much greater economic importance than is usually assumed in the international real business cycle literature. The null hypothesis of frictionless asset markets between developing and developed countries is rejected. However the baseline test does not reject the null of frictionless asset markets between developed countries. A variant on the baseline test does reject the null hypothesis of frictionless asset markets between developed countries, but at a marginal level of significance.

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Table 1: Estimation of competing models, 73 countries, 1970-2000

		(1)	(2)	(3)	(4)
Asset market		General friction	Autarky	No friction	.
Goods market		Trade costs	Trade costs	Trade costs	No trade costs
variable	interaction	coeff. s.e.	coeff. s.e.	coeff. s.e.	coeff. s.e.
ln(private cons.)	none	.	.	0.35 0.07 **	.
ln(emp. rate)	none	.	.	1.09 0.37 **	.
ln(1+dist)	1970-1974	-1.16 0.08 **	-1.16 0.08 **	-1.18 0.08 **	.
ln(1+dist)	1975-1979	-1.11 0.08 **	-1.11 0.08 **	-1.16 0.08 **	.
ln(1+dist)	1980-1984	-1.02 0.08 **	-1.02 0.08 **	-1.13 0.07 **	.
ln(1+dist)	1985-1989	-0.96 0.09 **	-0.96 0.09 **	-1.06 0.08 **	.
ln(1+dist)	1990-1994	-1.02 0.09 **	-1.02 0.09 **	-0.93 0.08 **	.
ln(1+dist)	1995-2000	-1.02 0.09 **	-1.02 0.09 **	-0.87 0.08 **	.
not contiguous	1970-1974	0.39 0.49	0.39 0.49	0.64 0.51	.
not contiguous	1975-1979	0.62 0.45	0.62 0.45	1.01 0.45 **	.
not contiguous	1980-1984	0.49 0.39	0.49 0.39	0.82 0.38 **	.
not contiguous	1985-1989	0.46 0.44	0.46 0.44	0.54 0.44	.
not contiguous	1990-1994	0.97 0.42 **	0.97 0.42 **	0.57 0.43	.
not contiguous	1995-2000	1.11 0.42 **	1.11 0.41 **	0.57 0.44	.
no common lang.	1970-1974	-2.74 0.17 **	-2.74 0.17 **	-2.99 0.17 **	.
no common lang.	1975-1979	-1.91 0.16 **	-1.91 0.16 **	-2.04 0.16 **	.
no common lang.	1980-1984	-1.54 0.17 **	-1.54 0.17 **	-1.48 0.17 **	.
no common lang.	1985-1989	-1.33 0.21 **	-1.33 0.21 **	-1.14 0.21 **	.
no common lang.	1990-1994	-1.65 0.21 **	-1.65 0.21 **	-1.58 0.21 **	.
no common lang.	1995-2000	-1.63 0.20 **	-1.63 0.20 **	-1.57 0.20 **	.
no colonial rel.	1970-1974	-0.36 0.40	-0.36 0.40	0.08 0.43	.
no colonial rel.	1975-1979	-1.77 0.40 **	-1.77 0.39 **	-1.59 0.41 **	.
no colonial rel.	1980-1984	-3.31 0.41 **	-3.31 0.41 **	-3.23 0.40 **	.
no colonial rel.	1985-1989	-4.33 0.47 **	-4.33 0.47 **	-4.43 0.44 **	.
no colonial rel.	1990-1994	-3.88 0.46 **	-3.88 0.45 **	-4.16 0.45 **	.
no colonial rel.	1995-2000	-3.54 0.46 **	-3.54 0.45 **	-3.82 0.46 **	.
no com. col. rel.	1970-1974	-2.03 0.27 **	-2.03 0.28 **	-2.44 0.28 **	.
no com. col. rel.	1975-1979	-1.47 0.26 **	-1.47 0.27 **	-1.69 0.26 **	.
no com. col. rel.	1980-1984	-0.59 0.24 **	-0.59 0.25 **	-0.44 0.25 *	.
no com. col. rel.	1985-1989	0.12 0.32	0.12 0.32	0.59 0.31 *	.
no com. col. rel.	1990-1994	0.32 0.31	0.32 0.32	0.44 0.32	.
no com. col. rel.	1995-2000	0.42 0.31	0.42 0.31	0.32 0.32	.
no com. legal hist.	1970-1974	0.50 0.13 **	0.50 0.14 **	0.36 0.13 **	.
no com. legal hist.	1975-1979	0.41 0.13 **	0.41 0.14 **	0.40 0.13 **	.
no com. legal hist.	1980-1984	0.21 0.13	0.21 0.14	0.27 0.13 *	.
no com. legal hist.	1985-1989	-0.12 0.16	-0.12 0.17	-0.03 0.15	.
no com. legal hist.	1990-1994	0.14 0.16	0.14 0.16	0.16 0.15	.
no com. legal hist.	1995-2000	0.20 0.15	0.20 0.15	0.19 0.15	.
importer fixed effects		no	no	yes	no
importer-year fixed effects		yes	no	no	no
exporter-year fixed effects		yes	no	yes	no
symmetric-year fixed effects		no	yes	no	no
year fixed effects		no	no	no	yes
R ²		0.54	0.51	0.51	0.03
N		165199	165199	165199	165199

Dependent variable is $\log(1+IM_{ij}/EXP_iGDP_j)$. * significant at 10%; ** significant at 5%

Standard errors clustered at the country-pair level

Table 2: Likelihood ratio tests for 73 countries, 1970-2000

Null	Alternative	LR	d.f.	N	p-value
Trade costs, no asset market friction	trade, asset friction	10907	2188	165199	1
Trade costs, financial autarky	trade, asset friction	9777	2263	165199	1
No trade costs	trade, asset friction	123271	4531	165199	1

LR test statistic is asymptotically distributed as chi-squared with d.f. as given

A p-value greater than 0.05 indicates rejection of the null at the 5% significance level

Table 3: Estimation of competing models, 22 developed countries, 1970-2000

		(1)		(2)		(3)		(4)	
		General friction		Autarky		No friction			
		Trade costs		Trade costs		Trade costs		No trade costs	
variable	interaction	coeff.	s.e.	coeff.	s.e.	coeff.	s.e.	coeff.	s.e.
ln(private cons.)	none	.	.	.	.	-0.31	0.06 **	.	.
ln(emp. rate)	none	.	.	.	.	-0.22	0.35	.	.
ln(1+dist)	1970-1974	-0.76	0.04 **	-0.76	0.04 **	-0.77	0.04 **	.	.
ln(1+dist)	1975-1979	-0.77	0.04 **	-0.77	0.04 **	-0.77	0.04 **	.	.
ln(1+dist)	1980-1984	-0.76	0.04 **	-0.76	0.04 **	-0.76	0.04 **	.	.
ln(1+dist)	1985-1989	-0.77	0.04 **	-0.77	0.04 **	-0.77	0.04 **	.	.
ln(1+dist)	1990-1994	-0.78	0.04 **	-0.78	0.04 **	-0.77	0.04 **	.	.
ln(1+dist)	1995-2000	-0.75	0.04 **	-0.75	0.03 **	-0.73	0.04 **	.	.
not contiguous	1970-1974	-0.08	0.15	-0.08	0.15	0.00	0.15	.	.
not contiguous	1975-1979	-0.11	0.14	-0.11	0.14	-0.05	0.14	.	.
not contiguous	1980-1984	-0.07	0.12	-0.07	0.12	-0.08	0.12	.	.
not contiguous	1985-1989	0.08	0.15	0.08	0.15	0.04	0.15	.	.
not contiguous	1990-1994	0.10	0.16	0.10	0.16	0.04	0.15	.	.
not contiguous	1995-2000	-0.02	0.12	-0.02	0.12	-0.05	0.12	.	.
no common lang.	1970-1974	-0.44	0.15 **	-0.44	0.15 **	-0.39	0.13 **	.	.
no common lang.	1975-1979	-0.31	0.14 **	-0.31	0.14 **	-0.31	0.13 **	.	.
no common lang.	1980-1984	-0.29	0.12 **	-0.29	0.13 **	-0.26	0.12 **	.	.
no common lang.	1985-1989	-0.25	0.13 *	-0.25	0.14 *	-0.23	0.12 *	.	.
no common lang.	1990-1994	-0.21	0.13	-0.21	0.13	-0.21	0.13	.	.
no common lang.	1995-2000	-0.11	0.11	-0.11	0.12	-0.19	0.12	.	.
no com. legal hist.	1970-1974	-0.50	0.09 **	-0.50	0.10 **	-0.52	0.09 **	.	.
no com. legal hist.	1975-1979	-0.47	0.09 **	-0.47	0.09 **	-0.47	0.09 **	.	.
no com. legal hist.	1980-1984	-0.47	0.08 **	-0.47	0.09 **	-0.48	0.08 **	.	.
no com. legal hist.	1985-1989	-0.58	0.10 **	-0.58	0.10 **	-0.57	0.09 **	.	.
no com. legal hist.	1990-1994	-0.61	0.09 **	-0.61	0.10 **	-0.60	0.08 **	.	.
no com. legal hist.	1995-2000	-0.60	0.08 **	-0.60	0.09 **	-0.59	0.07 **	.	.
importer fixed effects		no		no		yes		no	
importer-year fixed effects		yes		no		no		no	
exporter-year fixed effects		yes		no		yes		no	
symmetric-year fixed effects		no		yes		no		no	
year fixed effects		no		no		no		yes	
R ²		0.83		0.81		0.82		0.09	
N		15004		15004		15004		15004	

Dependent variable is $\log(1+IM_{ij}/EXP_iGDP_j)$. * significant at 10%; ** significant at 5%

Standard errors clustered at the country-pair level

Table 4: Likelihood ratio tests for 22 developed countries, 1970-2000

Null	Alternative	LR	d.f.	N	p-value
Trade costs, no asset market friction	trade, asset friction	482	658	15004	0
Trade costs, financial autarky	trade, asset friction	1666	682	15004	1
No trade costs	trade, asset friction	25018	1357	15004	1

LR test statistic is asymptotically distributed as chi-squared with d.f. as given

A p-value greater than 0.05 indicates rejection of the null at the 5% significance level

Table 5: Likelihood ratio test for 73 countries, by sub-period

Null	Alternative	LR	d.f.	N	p-value
1970-1984					
Trade costs, no asset market friction	trade, asset friction	4872	1020	79935	1
Trade costs, financial autarky	trade, asset friction	5437	1095	79935	1
No trade costs	trade, asset friction	59971	2193	79935	1
1985-2000					
Trade costs, no asset market friction	trade, asset friction	1364	1093	85264	1
Trade costs, financial autarky	trade, asset friction	4452	1168	85264	1
No trade costs	trade, asset friction	63353	2338	85264	1

LR test statistic is asymptotically distributed as chi-squared with d.f. as given

A p-value greater than 0.05 indicates rejection of the null at the 5% significance level

Table 6: Variability of implied per capita Pareto weights

Summary stats on coefficient of variation								
			OECD 22			Non-OECD 51		
Variable	rho	eta	Mean	Min	Max	Mean	Min	Max
Pareto weight	1	n.a.	0.13	0.06	0.31	0.33	0.09	0.72
Pareto weight	1.5	3	0.29	0.16	0.58	0.58	0.23	1.09
Pareto weight	1.5	6	0.21	0.09	0.47	0.50	0.17	0.94
Pareto weight	1.5	9	0.20	0.08	0.45	0.49	0.16	0.95
Pareto weight	3	3	1.17	0.69	2.45	1.73	0.63	3.11
Pareto weight	3	6	0.54	0.22	1.22	1.08	0.34	2.10
Pareto weight	3	9	0.44	0.17	0.88	0.98	0.30	1.80
Pareto weight	5	3	2.05	0.68	3.68	2.91	1.31	5.33
Pareto weight	5	6	1.09	0.59	2.04	1.88	0.72	3.83
Pareto weight	5	9	0.82	0.36	1.67	1.57	0.55	2.97
GDP share	n.a.	n.a.	0.13	0.06	0.29	0.34	0.06	0.78

Coefficient of variation for each country is standard deviation of estimated weight over 1970-2000 divided by mean for the same period. Reported statistics are for the distribution of this statistic across countries within the particular subsample.

Table 7: Fitted trade costs for full sample of 73 countries
 Allowing trade costs to vary every 5 years

Period	Panel 1				Panel 2			
	Asset market friction				No asset market friction			
	Mean	Min	Max	Median	Mean	Min	Max	Median
1970-1974	1473	217	2208	1582	1537	196	2281	1678
1975-1979	1324	300	1910	1406	1374	275	2005	1465
1980-1984	1270	382	1728	1350	1348	416	1880	1423
1985-1989	1251	287	1638	1333	1291	287	1873	1366
1990-1994	1104	263	1561	1174	1042	235	1490	1107
1995-2000	974	250	1421	1032	887	215	1231	940

Elasticity of substitution set at 6

Trade costs are expressed as a percentage of the home country price

Sample includes trade with self

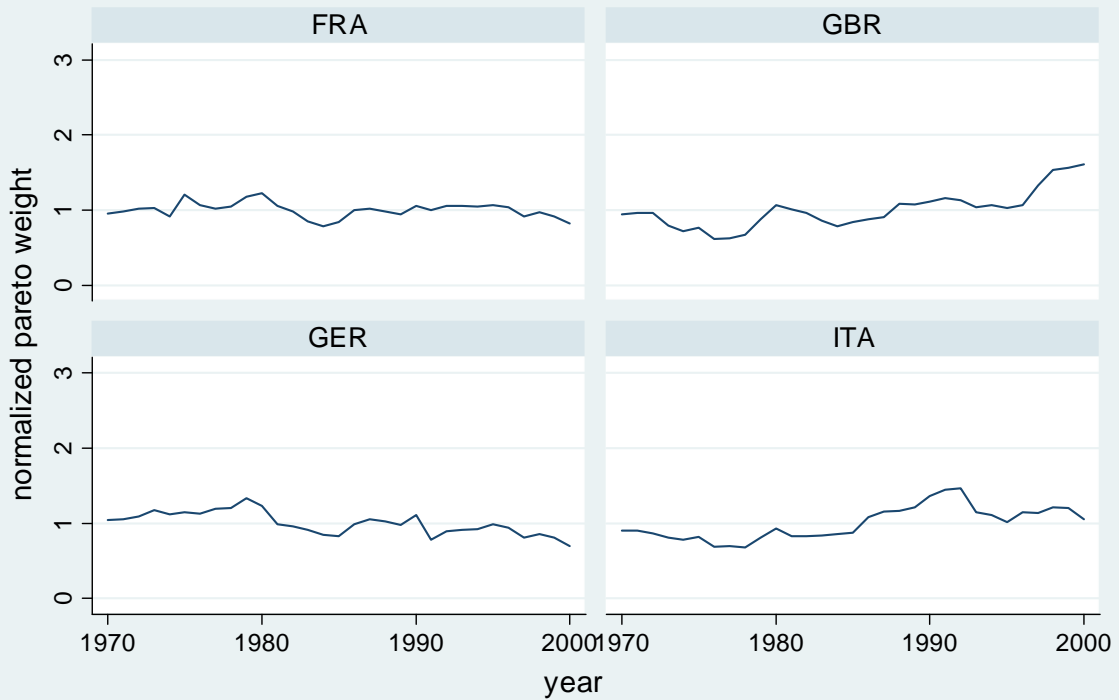
Table 8: Hybrid test, 1970-2000

		(1)		(2)		(3)		(4)	
		Full sample				Developed countries			
variable	interaction	coeff.	s.e.	coeff.	s.e.	coeff.	s.e.	coeff.	s.e.
ln(rel. gdp per c.)	none	.	.	1.87	0.23 **	.	.	0.54	0.29 *
ln(private cons)	none	0.35	0.07 **	-1.51	0.23 **	-0.31	0.06 **	-0.85	0.28 **
ln(emp. rate.)	none	1.09	0.37 **	0.86	0.37 **	-0.22	0.35	-0.21	0.35
ln(1+dist)	6	yes		yes		yes		yes	
not contiguous	6	yes		yes		yes		yes	
no common lang.	6	yes		yes		yes		yes	
no colonial rel.	6	yes		yes		no		no	
no com. col. rel.	6	yes		yes		no		no	
no com. legal hist.	6	yes		yes		yes		yes	
importer fixed effects		yes		yes		yes		yes	
exporter-year fixed effects		yes		yes		yes		yes	
R ²		0.51		0.51		0.82		0.82	
N		165199		165199		15004		15004	

Dependent variable is $\log(1+IM_{ij}/EXP_iGDP_j)$.

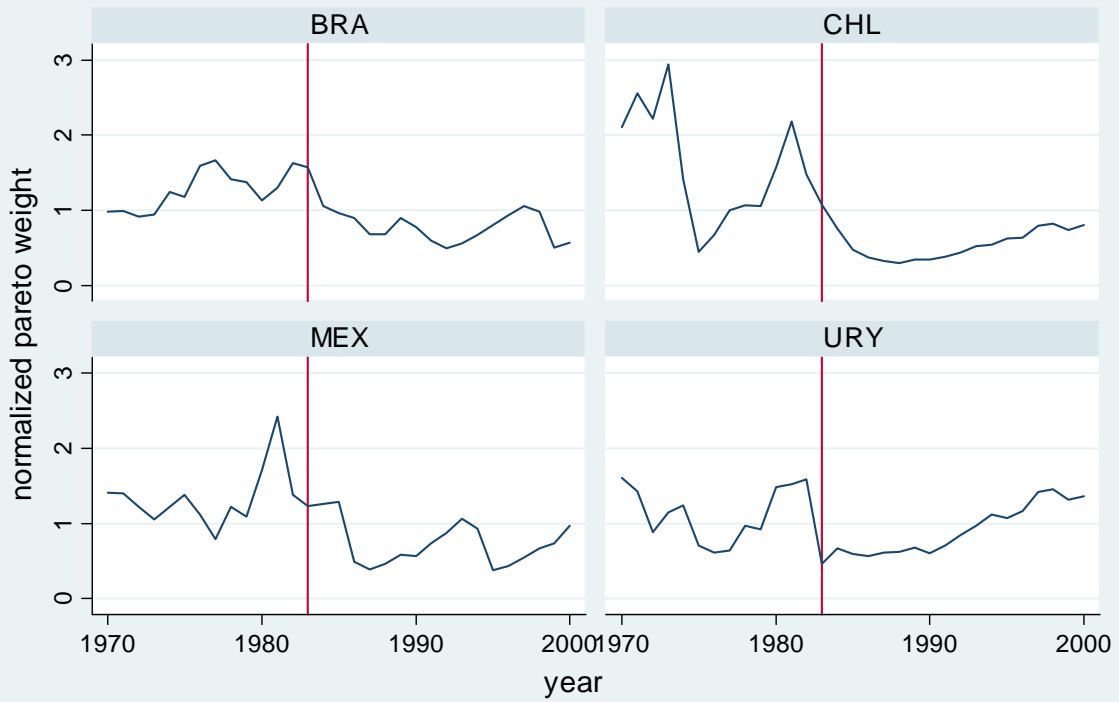
Standard errors clustered at the country-pair level. * significant at 10%; ** significant at 5%

Normalized Pareto Weight for 4 European countries



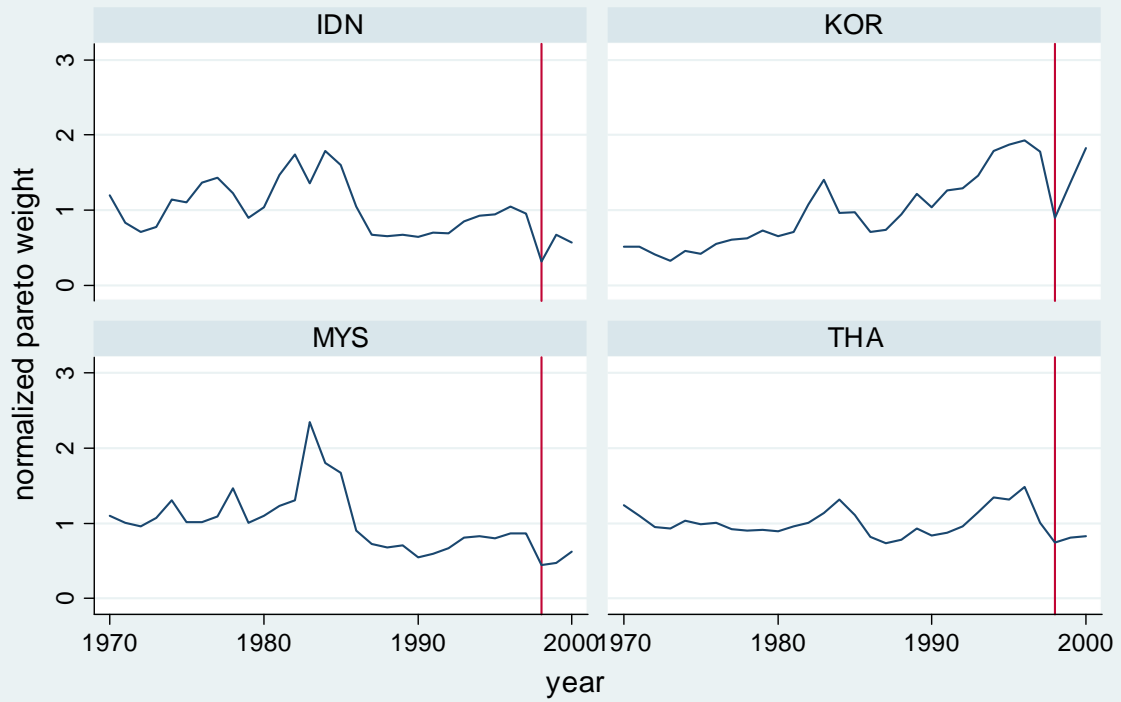
eta = 6; rho = 1.5

Normalized Pareto Weight for 4 Latin American countries



eta = 6; rho = 1.5

Normalized Pareto Weight for 4 East Asian countries



eta = 6; rho = 1.5

Countries in the sample

Developed countries

Australia	Greece	Portugal
Austria	Iceland	Spain
Belgium	Ireland	Sweden
Canada	Italy	Switzerland
Denmark	Japan	UK
Finland	Netherlands	USA
France	New Zealand	
Germany	Norway	

Developing countries

Algeria	Ghana	Pakistan
Barbados	Guatemala	Paraguay
Benin	Honduras	Peru
Bolivia	Hong Kong	Philippines
Brazil	Hungary	Rwanda
Burkina Faso	Iceland	Senegal
Burundi	Indonesia	South Africa
Chile	Israel	Sri Lanka
China	Jamaica	Syria
Colombia	Korea	Thailand
Congo	Madagascar	Togo
Costa Rica	Malawi	Trinidad and Tobago
Cote d'Ivoire	Malaysia	Tunisia
Dominican Republic	Mali	Turkey
Ecuador	Mexico	Uruguay
Egypt	Morocco	Venezuela
El Salvador	Niger	Zambia
Gabon	Nigeria	