University of Pretoria
Department of Economics Working Paper Series

International Consumption Risk Sharing and Trade Transaction Costs

Matthew Clance
University of Pretoria
Wei Ma
Xi'an Jiaotong-Liverpool University
Ruthira Naraidoo
University of Pretoria
Working Paper: 2019-32
April 2019

Department of Economics
University of Pretoria
0002, Pretoria
South Africa
Tel: +27 12 420 2413

International Consumption Risk Sharing and Trade Transaction Costs

Matthew Clance[†] Wei Ma[‡] Ruthira Naraidoo[*]

April 2019

Abstract

This paper investigates the implications of international consumption risk sharing for a panel 69 developed and developing countries over the period 1986-2006. We theoretically derive the international consumption insurance proposition within an international real business cycle setup that involves consumption correlation with the real exchange rate to incorporate salient features that impede consumption risk sharing, namely trade costs and capital market imperfections, making use of the gravity structural model to obtain the trade costs estimates and output volatility to proxy capital market imperfections. We analyze the implications of the theory based on panel data estimation. We find that trade costs significantly impede risk sharing for the aggregate sample of countries and a 10% increase in trade costs can decrease consumption by almost 0.7% and 0.6% for trade between developed and developing countries and for intra-developing country trade respectively while intra-developed country trade seems to be affected by temporary changes in trade costs. Developed countries seem to be in line with insuring against output volatility while low income group face asset market constraints as output uncertainty increases. Policy implication hence involves lowering international trade costs in an attempt to alleviate issues of consumption allocations.

Keywords : Trade costs, international consumption insurance, developed, developing, low income countries, capital market imperfection

JEL Classification : E21, E44, F14, F41, G15

[†]University of Pretoria, Department of Economics, Pretoria, 0002, South Africa. Email: matthew.clance@up.ac.za

[‡]Xi'an Jiaotong-Liverpool University, International Business School Suzhou, Suzhou, People's Republic of China. Email: wei.ma@xjtlu.edu.cn

[*]University of Pretoria, Department of Economics, Pretoria, 0002, South Africa. Email: ruthira.naraidoo@up.ac.za

1 Introduction

Consumption insurance against idiosyncratic income shocks for the individual units both across time and states of nature form the corner stone of modern dynamic macro models. At countries level, in open economy setups, full international consumption risk sharing where countries have heterogeneous income streams is obtained when there are no frictions in goods trade and financial markets are complete. The lack of consumption risk sharing in empirical cross country relationship and the greater income correlations has led Backus, Kehoe and Kydland (1992, 1995) to term this factual evidence as a major puzzle in international macroeconomics.[1] Trade costs and deviations from complete international asset markets hence stand as main candidates for such apparent lack of consumption risk sharing.

For instance, Atkeson (1991) states that underdeveloped countries have borrowing constraints with imperfect and limited access to financial markets. For developed countries, Tesar and and Werner (1993), Stockman and Dellas (1989), Cole and Obstfeld (1991) and Obstfeld (1992) among others have provided explanations based on portfolio of countries consisting of mainly domestic assets, nontraded goods consisting a large fraction of total consumption and pro-cyclicality properties of incomes across countries. While limited commitment in asset trade between developed and developing countries have often been put forward as an explanation for lack of risk sharing. Empirical studies (e.g., Backus and Smith 1993, Kollmann 1995, and Ravn 2001) conducted mainly on pairwise developed economies have surprisingly found that these economies are subjected to asset market frictions with Canova and Ravn (1996) finding that while over short cycles, risk sharing is present, at least over long cycles, risk sharing is very limited and Lewis (1996) finding in a large sample of countries that perfect consumption risk sharing holds for countries with low impediment in asset markets. The empirical studies undertaken are predominantly based on endowment exchange economies with the main testing equation involving consumption and real exchange rate correlations. One main disadvantage of this approach as noted by Fitzgerald (2012) is that it does not provide metric for the relative salience of asset market frictions and trade costs in impeding perfect consumption risk sharing. Moreover, it is conducted on pairwise countries time series while consumption insurance involves group of countries and hence does not provide information on different groups of countries.

Trade costs are usually modelled within gravity equations of bilateral trade and there is substantial evidence that trade costs are large, viz., Anderson and van Wincoop (2004). Specification and estimation of this static equation have been done in a large number of papers, see for instance, Eaton and Kortum (2002), Anderson and van Wincoop (2003), and Alvarez and Lucas (2007) and calibrated versions of these models for welfare analysis include Arkolakis, Costinot, and Rodriguez-Clare (2012). There is a substantial literature on how trade costs impede international consumption risk sharing within open economy macro models and these date back to the pioneering work of Backus, Kehoe, and Kydland (1992), Dumas (1992), Obstfeld and Rogoff (2001), Dumas and Uppal (2001), Heathcote and Perri (2004), Kose and Yi (2006), Ravn and Mazzenga (2004), and Fitzgerald (2008). To the best of our knowledge, Fitzgerald (2012) is the first study that has tried to integrate a gravity model of trade costs within a dynamic macro model with asset market frictions to provide an explanation of failure of risk sharing coming from these two spheres. The main finding of the study in a panel of 88 countries is that trade costs are sizeable and impede risk sharing among both developing and developed countries and asset market frictions while being insignificant in developed economies, still represent impediment to consumption risk sharing for developing countries.

With complete international asset market structure and no trade costs, relative consumption across countries should co-move with the real exchange rate and if there are no trade costs, relative prices are constant meaning that consumption across countries should correlate one to one with each other.[2] Hence this paper lies within the realm of this strand of the literature after Kollman (1990, 1995), Backus and Smith (1993), Canova and Ravn (1996) and Ravn (2001) and we model deviations from this setup to firstly capture capital market imperfections by allowing the inverse of the marginal utility of wealth to vary across states of nature and time. In our estimation we capture this effect by simply investigating how consumption moves with output volatility of a particular country since with full insurance this should not be the case. Secondly, in the presence of trade costs, relative consumption price indices across countries are not constant but move with state and time dependent trade costs. We model these relative price indices dependent on trade costs

[1] See Kollman (2017) for instance that develops a simple model of a two-country, two-traded good with complete financial markets to generate cross country output that are highly correlated internationally with country specific productivity shocks.

[2] Marrinan (1994) notes that not accounting for non-separability in the utility function should it exists will lead to rejection of international consumption insurance due to the difference induced between home and foreign consumption.

in general equilibrium with Armington CES demand specialization and iceberg costs of trade as done in Fitzgerald (2012). Hence the work while remaining in the realm of international real business cycle theory, it borrows from the gravity model to integrate the IRBC literature with trade transaction costs.

We use panel data estimation on a sample of 69 countries for the period 1986 to 2006 to obtain estimates of consumption correlation across countries, the correlation of domestic consumption with the real exchange rate, the impact of capital market imperfections via output volatility on consumption risk sharing and the extent to which trade costs can impede consumption insurance. We examine all these implications using the model in level, in changes (high frequency), using both fixed effects (exporter and importer) and pair fixed effects estimators. The analysis hopefully sheds light on four important issues. Firstly, to what extent aggregate consumption and real exchange rate across countries move together. Secondly, whereas the previous literature has focussed more on cross country consumption correlation with the real exchange in investigating international consumption risk sharing, we rely on salient features of trade costs in hampering trade and consumption risk sharing. Thirdly, to testify the previous theoretical literature on the extent of consumption insurance across income groups, by estimating the model across income categories, we are able to tell to what extent consumption insurance takes place among developed countries, developing countries and among developed-developing countries and the extent to which they are affected by trade transaction costs and output volatility. Fourthly, because our testing procedure does not require stationarity, we can focus attention both on the level and first difference version of our model and hence to some extent distinguish between consumption insurance for temporary and more permanent types of disturbances.

We find that domestic consumption correlation with foreign consumption is significant as generally found in the literature and that the correlation with the real exchange rate is negative as per theory, though these parameters differ from the suggested perfect risk sharing case. Furthermore, these correlations are much more sizeable for intra-developed country trade. Both permanent and temporary changes in trade costs have a big effect in hampering consumption for the world as a whole. The permanent effects are more pronounced for trade between developed and developing countries and intra-developing country trade while temporary changes in trade costs affect intra-developed country trade negatively. Capital market imperfections proxied by output volatility reveal that the world as a whole adopts precautionary savings when output volatility increases. An investigation across income groups shows differing impact for intra-developed country risk sharing, implying better insurance mechanism when faced with output volatility versus a lack of insurance for the low income group in the face of higher output uncertainty.

2 The Model

In this section, we elaborate the (competitive) decentralized problem for risk sharing. The economy is an infinite-periods endowment exchange economy model with trade transaction costs and incomplete asset markets, consisting of N countries indexed by $k = 1, ..., N$. Each country is represented by a single infinitely lived representative consumer with rational expectations who must decide how much to consume and how much to save for next period. In each period $t = 0, 1, ...$the economy experiences one of finitely many events

s out of the S states of nature. In short, we have an infinite horizon multiple-state setting. s_t denotes the state of nature in period t. The history of these states up to and including a date t determines the state of nature the economy occupies on date t. We denote the state of nature the economy occupies on date t by $s^t = [s_t, s_{t-1}, ..., s_0]$. The probability, as of period 0, of any particular history s^t is $\pi(s^t)$. The initial realization s_0 is given and we assume $\pi(s^0) = 1$ for simplicity. The representative consumer in country i maximizes expected discounted lifetime utility[3] given by

$$\sum_{t=0}^{\infty} \sum_{s^t} \beta^t \pi(s^t) u \left[c^i(s^t)\right] \quad (1)$$

[3]We assume the utility function of the representative consumer in country i to be represented by a time-separable utility function such as in Kollman (1995) following the International Real Business Cycle literature. The function can also be non-separable in consumption and an idiosyncratic variable to country i realized at time t which can denote all other components that affect utility such as nontradable consumption and leisure, government consumption or home production effects as in for instance Canova and Ravn (1996) following Benhabib, Rogerson and Wright (1992), etc. These might have important effects since the marginal utility of tradables consumption will depend on all these factors and have a long history in the literature. The focus in this paper is on trade transaction costs and we avoid such complexities in modelling these other variables.

where $c^i(s^t) \in R_+^S$ is the consumption bundle of consumer i, $c^i(s^t)$ denotes his consumption level in period t conditional on state s and where R_+^S is the nonnegative orthant of the S-dimensional Euclidean space at each date t. Since each country trades a distinct good, we assume implicitly that the consumption bundle of consumer i is a CES aggregator of these goods, which is modelled explicitly in the next subsection. β is the subjective discount factor. We assume that each country i is endowed with a smooth (in the sense of Debreu (1972)) utility function $u^i : R_+^S \to R$, and an output endowment vector $y^i \in R_+^S$, with output levels that fluctuate across S states of nature in period t. In terms of the asset market, suppose there is a single uncontingent internationally traded nominal bond that $\sum_i y^i\left(s^t\right) > 0$, $s = 1, 2, \ldots, S$, i.e., the consumption commodity is present in every state. This bond is denominated in the currency of country 1 (the numeraire currency) and each unit of these bonds pays one unit of currency of country 1 in all states s^{t+1} that can occur at $t+1$ and $q\left(s^t\right)$ is the corresponding price in units of the numeraire currency in period t .

Furthermore, we assume that the goods implicit in the consumption bundle are tradable with cost and we represent the average trade cost that country i faces by $\tau_i(s^t)$, which is a proportional rate of the respective consumer price index of country i, $P^i(s^t)$, i.e., goods trade may be costly and in order for one consumption unit to arrive in i, $1+\tau_i(s^t)$ units must be shipped, hence allowing prices to differ across locations. Hence we define the consumer price index that include all border costs as $\tilde{P}^i(s^t) = \left[1+\tau_i(s^t)\right] P^i(s^t)$, where $P^i(s^t)$ is the consumer price index assuming zero trade transaction costs.[4] All prices in this model are denominated in terms of a numeraire currency of the world. In the next section where we solve for demand by country i for each of the N goods from the rest of the world, we show how we arrive at this particular functional form for $\tau_i(s^t)$ which represents an average trade transaction cost across all N countries with respect to country i. The trade transaction costs dependent on the state of nature allows partial consumption risk sharing to take place and it might reflect such costs as transport cost, information costs, design costs, and various legal and regulatory costs together with all forms of government duties and in short capture border costs. Some of these costs are borne out by the exporter but we assume that the exporter passes on these trade costs to the importer. While these costs are usually included in the price index in trade theory, here we treat it as distinct since it is these very costs that we would like to measure their effects on international consumption risk sharing. We assume that these costs go as waste or simply they can be redistributed as lump-sum and hence will not affect the first order conditions of the model.

Let $D^i\left(s^t\right) \in R$ be the amount of nominal bonds that consumer i holds in period t. Let country i consumer budget constraint be expressed in terms of the numeraire currency. Then his budget set, denoted $B^i\left(P^i(s^t), q\left(s^t\right)\right)$, is given by[5]:

$$\begin{aligned} B^i\left(P^i(s^t), q\left(s^t\right)\right) &= \left\{ \left(c^i(s^t), D^i\left(s^t\right)\right) \in R_+^S \times R : \right. \\ \left[1+\tau_i(s^t)\right] P^i(s^t) c^i(s^t) + q\left(s^t\right) \cdot D^i\left(s^t\right) &= \left. P^i(s^t) y^i\left(s^t\right) + D^i\left(s^{t-1}\right) \right\} \end{aligned} \tag{2}$$

We now define the notion of equilibrium. An equilibrium is a collection $(q; (c^i, D^i))$ such that

- Utility maximization: (c^i, D^i) maximizes u^i in $B^i(P, q)$;
- The commodity market clears: $\sum_i (1+\tau_i) c^i = \sum_i y^i$.
- The asset market clears: $\sum_i D^i = 0$.

Setting the Lagrangean by creating the lagrange multiplier $\frac{1}{\lambda^i(s^t)}$:

$$\underset{c^i(s^t), D^i(s^t)}{Max} L^i = \sum_{t=0}^{\infty} \sum_{s^t} \beta^t \pi(s^t) \left\{ \begin{array}{c} u\left[c^i(s^t)\right] + \\ \frac{1}{\lambda^i(s^t)} \left[\begin{array}{c} P^i(s^t) y^i\left(s^t\right) + D^i\left(s^{t-1}\right) - \\ \left[1+\tau_i(s^t)\right] P^i(s^t) c^i(s^t) - q\left(s^t\right) \cdot D^i\left(s^t\right) \end{array} \right] \end{array} \right\} \tag{3}$$

The FOCs with respect to $c^i(s^t), D^i\left(s^t\right)$ for country i are respectively:

[4] An explicit derivation of this expression is provided in the next subsection.

[5] Adopting demand for individual traded goods across the N countries will yield the following budget constraint: $\sum_{k=1}^{N} \left[1+\tau^{ik}(s^t)\right] p^k(s^t) c^{ik}(s^t) + q\left(s^t\right) \cdot D^i\left(s^t\right) = P^i(s^t) y^i\left(s^t\right) + D^i\left(s^{t-1}\right)$ where the N producers of intermediate goods are assumed to be atomistic price takers and $\tau^{ik}(s^t)$ represents border (trade) costs so that in order for one unit of k good to arrive in i, $\left[1+\tau^{ik}(s^t)\right]$ units must be shipped. And $p^k(s^t)$ is the spot price of good k. These definitions are deferred for the next subsection.

$$u_c^i(s^t) = \frac{1}{\lambda^i(s^t)} \left(1 + \tau_i(s^t)\right) P^i(s^t) \tag{4}$$

and

$$q\left(s^t\right) \frac{1}{\lambda^i(s^t)} = \sum_{s^{t+1}} \beta\pi(s^{t+1}/s^t) \frac{1}{\lambda^i(s^{t+1})}, \tag{5}$$

where $u_c^i(s^t)$ denotes the marginal utility of consumption and and $\pi(s^{t+1}/s^t) = \pi(s^{t+1})/\pi(s^t)$ is the conditional probability of s^{t+1} given s^t.

The equivalent FOCs with respect to $c^j(s^t), D^j\left(s^t\right)$ for country j are respectively:

$$u_c^j(s^t) = \frac{1}{\lambda^j(s^t)} \left(1 + \tau_j(s^t)\right) P^j(s^t) \tag{6}$$

and

$$q\left(s^t\right) \frac{1}{\lambda^j(s^t)} = \sum_{s^{t+1}} \beta\pi(s^{t+1}/s^t) \frac{1}{\lambda^j(s^{t+1})}. \tag{7}$$

The $\lambda^i(s^t)$ is the inverse of the marginal utility of current per capita nominal wealth for country i evaluated at s^t (i.e., the inverse of the multiplier on the budget constraint). The λ^i's can also be interpreted as the per capita Pareto weights for each country in a sequence of intratemporal centralized social planning problem.

2.1 Final Good, Demand Aggregation, Price Index and Trade Transaction Costs

We assume as is standard in the literature that the production of the final good $c^i(s^t)$ takes the following CES aggregator form

$$c^i(s^t) = \left[\sum_{k=1}^{N} c^{ik}(s^t)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \tag{8}$$

whereby $c^{ik}(s^t)$ is the consumption in country i of intermediate good k at s^t. η is the elasticity of substitution among the goods and if $\eta \to \infty$, we are in the case of a one-good world. The agent in country i maximises this composite utility index given total real expenditure amount $\tilde{P}^i(s^t)c^i(s^t)$ has been chosen, with respect to its components, $c^{ik}(s^t)$ for $k = 1, ..., N$ subject to the following constraint

$$\tilde{P}^i(s^t)c^i(s^t) \equiv \sum_{k=1}^{N} \left[1 + \tau^{ik}(s^t)\right] p^k(s^t)c^{ik}(s^t), \tag{9}$$

where the N producers of intermediate goods are assumed to be atomistic price takers and $\tau^{ik}(s^t)$ represents border (trade) costs so that in order for one unit of k good to arrive in i, $\left[1 + \tau^{ik}(s^t)\right]$ units must be shipped. And due to trade costs, intermediate goods prices differ across countries and we assume the following form:

$$p^{ki}(s^t) \equiv \left[1 + \tau^{ki}(s^t)\right] p^{ii}(s^t), \tag{10}$$

where $p^{ii}(s^t)$ is the spot price of intermediate i in country i at s^t and $p^{ki}(s^t)$ is its spot price in country k and $\tau^{ki}(s^t)$ represents border (trade) costs so that in order for one unit of i's good to arrive in k, $\left[1 + \tau^{ki}(s^t)\right]$ units must be shipped, with $\tau^{ii}(s^t) = 0$. In what follows, $p^{ii}(s^t)$ is abbreviated and is replaced by $p^i(s^t)$ and $p^{ki}(s^t)$ is replaced by $\left[1 + \tau^{ki}(s^t)\right] p^i(s^t)$. All prices are expressed in terms of numeraire country 1 currency. We form the Lagrangean so that all prices are expressed relative to the general price level $\tilde{P}^i(s^t)$

$$\underset{c^{i1},...,c^{iN}}{Max} L = \left[\sum_{k=1}^{N} c^{ik}(s^t)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}} + \lambda\left(c^i(s^t) - \frac{1}{\tilde{P}^i(s^t)} \sum_{k=1}^{N} \left[1 + \tau^{ik}(s^t)\right] p^k(s^t)c^{ik}(s^t)\right) \tag{11}$$

The firs order conditions are as follows:

$$\left(\frac{c^{ik}(s^t)}{c^i(s^t)}\right)^{-\frac{1}{\eta}} = \lambda \frac{\left[1 + \tau^{ik}(s^t)\right] p^k(s^t)}{\tilde{P}^i(s^t)} \text{ for } k = 1, ..., N \tag{12}$$

From the conditions, combining any two demand functions for $k = 1, 2$, we obtain the relative consumption of goods 1 and 2 as a function of their relative price inclusive of the trade transaction costs:

$$\left(\frac{c^{i1}(s^t)}{c^{i2}(s^t)}\right)^{-\frac{1}{\eta}} = \frac{\left[1+\tau^{i1}(s^t)\right] p^1(s^t)}{\left[1+\tau^{i2}(s^t)\right] p^2(s^t)} \tag{13}$$

Thus an increase in the relative price of good 1 reduces their consumption relative to good 2, moreover, an increase in border costs of either countries will affect demand for their goods negatively with the effects depending on the elasticity of substitution η.

From the optimality conditions, the consumption price index $\tilde{P}^i(s^t)$ which measures the least expenditure of foreign goods that buys a unit of the consumption index, on which period utility depends, is given as follows (which is obtained by substituting the individual demand functions into the consumption index and solving for the price level):

$$\tilde{P}^i(s^t) = \left(\left\{\left[1+\tau^{i1}(s^t)\right] p^1(s^t)\right\}^{1-\eta} + ... + \left\{\left[1+\tau^{iN}(s^t)\right] p^N(s^t)\right\}^{1-\eta}\right)^{\frac{1}{1-\eta}} \tag{14}$$

where the general price level is a function of the N goods' prices together with the respective trade transaction costs. Or more compactly as:

$$\tilde{P}^i(s^t) = \left(\sum_{k=1}^{N}\left(\left[1+\tau^{ik}(s^t)\right] p^k(s^t)\right)^{1-\eta}\right)^{\frac{1}{1-\eta}} \tag{15}$$

All the prices are denominated in terms of the numeraire currency. In what follows, we make the simplifying assumption that at the aggregate macro level the trade transaction costs across the N countries are equivalent, namely, $\tau^{i1}(s^t) = ... = \tau^{iN}(s^t) = \tau_i(s^t)$, whereby $\tau_i(s^t)$ represents an aggregate (macro average) border costs that country i faces with respect to the rest of the world. This simplification allows us to write:

$$\tilde{P}^i(s^t) = \left[1+\tau_i(s^t)\right]\left(p^1(s^t)^{1-\eta} + ... + p^N(s^t)^{1-\eta}\right)^{\frac{1}{1-\eta}} \tag{16}$$

and defining a consumption price index $P^i(s^t)$ which would exist in a zero trading costs world whereby $\tau_i(s^t) = 0$, we can further write

$$\tilde{P}^i(s^t) = \left[1+\tau_i(s^t)\right] P^i(s^t). \tag{17}$$

This simplifying assumption is important in the derivation of the model though at the estimation level of the paper, we do take trade transaction costs of country i to be different across its N trading partners.

2.2 When asset markets are complete and frictionless and there are no trade transaction costs[6]

In a frictionless world with no trading costs and perfect asset market, the sequential competitive equilibrium of this economy is Pareto optimal. The competitive equilibrium allocation can, therefore, be recovered as the solution to a centralized planning problem where for appropriate time-and-state-invariant $\left\{\lambda^1, ..., \lambda^N\right\}$ the planner chooses sequences c^i to maximize its objective which is the exante weighted sum of expected utilities. The $\lambda^i s$ can also be interpreted as the per capita Pareto weights for each country in a sequence of intratemporal planning problems and these weights determines the relative national wealth levels in the counterpart market equilibrium, as we illustrate below. The social planner's problem is:

$$\underset{\{c^i(s^t)\}_{i=1}^N}{Max} \sum_{i=1}^{N}\lambda^i\sum_{t=0}^{\infty}\beta^t\sum_{s^t}\pi(s^t)u\left[c^i(s^t)\right] \tag{18}$$

subject to the aggregate resource constraint

$$\sum_{i=1}^{N}c^i\left(s^t\right) = \sum_{i=1}^{N}y^i\left(s^t\right) \text{ for all } s^t. \tag{19}$$

[6]See Fitzgerald (2012) for a similar discussion on frictionless markets.

Optimization with respect to the tradable consumption yields the FOC

$$\beta^t \lambda^i \pi(s^t) \frac{u_c^i(s^t)}{P^i(s^t)} = \mu(s^t) \tag{20}$$

where $\mu(s^t)$ is the Lagrange multiplier on the aggregate constraint equation (19). Equating equation (20) for countries i and j, we obtain a fundamental risk-sharing condition whereby $\left(\frac{\lambda^i}{\lambda^j}\right)^{-1}$ is a term that is time-invariant (and invariant across states of the world) implying that holding constant the bilateral real exchange between the two countries (in terms of their respective aggregate consumption goods), $R^{ij}(s^t) = \frac{P^i(s^t)}{P^j(s^t)}$:

$$u_c^i(s^t) = \left(\frac{\lambda^i}{\lambda^j}\right)^{-1} u_c^j(s^t) R^{ij}(s^t), \tag{21}$$

country's i consumption can be expressed as an increasing function of country's j consumption. And we can obtain the high-frequency implications of complete markets by taking the first difference of the above equation to show that the relative intertemporal marginal rate of substitution in consumption across countries move with the change in the real exchange rate.

2.3 Testing the failure of consumption risk sharing

We can make use of the first order conditions for aggregate consumption for country i and j respectively, equations (4) and (6) to tell us that relative marginal utility of consumption can vary over time and across states for two main reasons. Firstly, if there are frictions to asset markets, then consumption will respond to current output such that the relative wealth term $(\frac{\lambda^i(s^t)}{\lambda^j(s^t)})$ may respond to temporary output:

$$\frac{u_c^i(s^t)}{u_c^j(s^t)} = \left(\frac{\lambda^i(s^t)}{\lambda^j(s^t)}\right)^{-1} \frac{(1+\tau_i(s^t))\, P^i(s^t)}{(1+\tau_j(s^t))\, P^j(s^t)}. \tag{22}$$

Capital market frictions on consumption risk sharing is regarded in the literature as one of the main explanation as to why international consumption comovements do not match the risk-sharing predictions of standard complete market models. Examples of such capital market restrictions are liquidity constraints, short-sale constraints, government taxes on holdings of foreign assets, restrictions from borrowing on international markets due to defaults by government or domestic residents among others. Since the focus of this paper is on trade transaction costs, we simply capture the impact of frictions in asset markets on consumption by the volatility in output since the latter is what drives consumption in the face of imperfections in capital markets.

Secondly, in order for consumption risk sharing to take place, goods must be traded and shipped internationally. If transaction and shipping costs are costly, agents will optimally choose not to smooth consumption perfectly. The effect of transaction costs is captured by the trade transaction costs on the consumption real exchange rate $\frac{P^i(s^t)}{P^j(s^t)}$, which are $(\tau_i(s^t))$ and $(\tau_j(s^t))$ as formulated above. Since the relation in equation (22) is a bilateral relationship between country i and j, we define the bilateral trade transaction cost between country i and j $\frac{(1+\tau_i(s^t))}{(1+\tau_j(s^t))}$ as $\left(1+\tau^{ij}(s^t)\right)$ for short to obtain our main testing equation[7]:

$$u_c^i(s^t) = \left(\frac{\lambda^i(s^t)}{\lambda^j(s^t)}\right)^{-1} u_c^j(s^t) R^{ij}(s^t) \left(1+\tau^{ij}(s^t)\right). \tag{23}$$

With the model in high frequency, we have from the above equation in difference form or combining equations (4) and (5):

$$\frac{u_c^i(s^{t+1})}{u_c^i(s^t)} = \left(\frac{\lambda^i(s^{t+1})/\lambda^i(s^t)}{\lambda^j(s^{t+1})/\lambda^j(s^t)}\right)^{-1} \frac{u_c^j(s^{t+1})}{u_c^j(s^t)} \frac{R^{ij}(s^{t+1})}{R^{ij}(s^t)} \frac{\left(1+\tau^{ij}(s^{t+1})\right)}{\left(1+\tau^{ij}(s^t)\right)}. \tag{24}$$

Equations (23) and (24) are the two main models that we put to the data.

[7] We note that the real exchange rate will as usual include all mutilateral resistance terms as present in trade theory.

To obtain *testable implications* for models (23) and (24), we follow the IRBC literature and assume a log period utility function[8] and dropping state-contingent notation for brevity:

$$u_t(c) = \ln(c) \tag{25}$$

When the preferences specified in (25) are assumed, model (23) above yields the following restriction on logged transformation between consumption in countries i and j:[9]

$$\ln c_t^i = \ln c_t^j - \ln R_t^{ij} + \left(\ln\left(\lambda_t^i\right) - \ln\left(\lambda_t^j\right)\right) - \ln\left(1 + \tau_t^{ij}\right) \tag{26}$$

For the high frequency model (24), we have

$$\Delta \ln c_t^i = \Delta \ln c_t^j - \Delta \ln R_t^{ij} + \left(\Delta \ln\left(\lambda_t^i\right) - \Delta \ln\left(\lambda_t^j\right)\right) - \Delta \ln\left(1 + \tau_t^{ij}\right) \tag{27}$$

To evaluate whether equations (26) and (27) are consistent with the data, we represent the term $\left(\ln\left(\lambda_t^j\right) - \ln\left(\lambda_t^j\right)\right)$ by some measure of output volatility for country i ($\ln \sigma_{iy,t}^2$) to capture the effect of capital market imperfections so that the resulting equations are

$$\ln c_t^i = a_1 + a_2 \ln c_t^j + a_3 \ln R_t^{ij} + a_4 \ln \sigma_{iy,t}^2 + a_5 \ln\left(1 + \tau_t^{ij}\right) + \varepsilon_t^1 \tag{28}$$

and

$$\Delta \ln c_t^i = a_2 \Delta \ln c_t^j + a_3 \Delta \ln R_t^{ij} + a_4 \Delta \ln \sigma_{iy,t}^2 + a_5 \Delta \ln\left(1 + \tau_t^{ij}\right) + \varepsilon_t^2, \tag{29}$$

Imperfect risk sharing is tested by the hypothesis that $a_1 \neq 0$, $a_2 \neq 1$, $a_3 \neq -1$, $a_4 \neq 0$ and $a_5 \neq 0$ and ε_t is not an iid. In principle, we expect $a_4 > 0$ and $a_5 < 0$, so that capital market imperfection and trade transaction costs should decrease consumption risk sharing, i.e., faced with more output volatility, a country should save more in terms of insurance and trade transaction costs should impede consumption.

Futhermore, we test the hypothesis by income for intra-developed country trade (HighxHigh), intra-developing country trade (LowxLow) and trade between developing and developed countries (LowxHigh). These classifications should provide valuable information in terms of consumption risk sharing (a_2 parameter), the extent of capital markets integration (a_4) and the impact of trade transaction costs (a_5).

3 Data and Test results

The consumption risk sharing equation is estimated using annual data from three sources and the dependent variable is aggregate real per capita consumption (c_{it}): 1) World Bank's World Development Indicators (WDI), 2) Penn World Tables (PWT), and 3) International Monetary Fund's International Financial Statistics (IFS). Real gross domestic product per capita (RGDPpc) in constant 2010 prices is from WDI. The variables consumer price index (CPI) and real per capita consumption are from the IFS. The nominal exchange rate is from the PWT and is used to adjust consumption expenditure to dollars.

The GDPpc is used to calculate output volatility using the regression

$$\ln(RGDPpc_{i,t}) = b_1 + b_2 \ln(RGDPpc_{i,t-1}) + b_3 \ln(RGDPpc_{i,t-2}) + b_4 \ln(RGDPpc_{i,t-3}) + u_{i,t}$$

where we use square of the residual to estimate GDP volatility ($\sigma_{iy,t}^2$).

The gravity model is the standard model used to determine trade costs in International Economics. To estimate the bilateral trade, the gravity model is estimated in its multiplicative form which has become

[8]The IRBC literature usually assumes an iso-elastic instantaneous period utility function of the form $u_t(c) = \frac{1}{\sigma} c^{\sigma}$; see Kollman (1995) for instance. In this paper, we assume $\sigma = 1$ for simplicity.

[9]We note here that the real exchange rate data by construction includes the trade costs τ_t^{ij} and hence is collinear with the variable τ_t^{ij} used in our estimation. However this is deemed necessary to capture the effects of trade costs in the model.

standard in the literature, using aggregate manufacturing trade data for 69 countries over the period 1986-2006 similar to Bergstrand et al. (2015). Appendix A provides a detailed description of the gravity model and its estimation:[10]

$$X_{ijt} = \exp\left[\beta_0 + \beta_1 \ln(Dist_{ij}) + \beta_2 Contig_{ij} + \beta_3 Lang_{ij} + \beta_4 Legal_{ij} + \beta_5 Colony_{ij}\right] * \exp\left[\beta_6 ComCol_{ij} + \beta_7 SMCTRY_{ii} + \delta_{ij} + \gamma_i + \alpha_j\right] \quad (30)$$

where $\ln(Dist)$ is the population weighted log of distance between trade partners[11], γ is the exporter fixed effect, and α is the importer fixed effect. The gravity equation typically uses time-invariant controls for contiguity, common language, colonial history, and Regional Trade Agreements which are represented in the model by $Contig$, $Lang$, $Legal$, $Colony$, and $ComCol$. The variable $SMCTRY$ is a covariate to indicate intra-national trade (or trade to self) and meant to capture "home bias".

To estimate the model, we use the Pseudo Poisson Maximum Likelihood (or PPML). We provide the estimates in Tables 1 through 4 for the full, the HighxHigh, HighxLow and LowxLow samples respectively and the coefficients on all variables are fairly standard with the expected sign. To proxy for bilateral border costs, we use the estimates of the gravity specification and covariates to calculate,

$$\hat{\tau}_{ij}^{1-\sigma} = \exp\left[\hat{\beta}_1 \ln(Dist_{ij}) + \hat{\beta}_2 Contig_{ij} + \hat{\beta}_3 Lang_{ij} + \hat{\beta}_4 Legal + \hat{\beta}_5 Colony_{ij} + \hat{\beta}_6 ComCol\right] \quad (31)$$

for each cross section. In Fig. 1, we plot the time-series evolution of the mean of the fitted values of trade costs based on the structural estimation of the nonlinear gravity equation. The types of bilateral trade are intradeveloped-country trade (High Inc), trade between developed and developing countries (High/Low Inc), and intradeveloping-country trade (Low Inc). Also reported is the trade cost for all trade (Full). Trade costs are expressed as a percentage of the sales price, so a value of 3 for instance, implies a trade cost of 200 percent. Some of these trade costs are large but in line with Anderson and van Wincoop (2004) and Fitzgerald (2012). One discernable facts with respect to Fig. 1 is the upward trend of trade costs post 2000 with evidence that intradeveloping-country trade costs peak between 2000 and 2005.

Table 5 reports the results for the world as a whole from model equation (28) using OLS, exporter fixed effect, importer fixed effect, both fixed effects, and both fixed effects with pair fixed effects. The sign of the parameters on foreign consumption and the real exchange rate are as expected, however differing from the magnitude implied by perfect risk sharing of 1 and -1 respectively. The R^2 are 0.12, 0.99 and 0.99 for the OLS, both fixed effects and both fixed effects with pair fixed effects estimations. The null hypothesis that trade costs is insignificant, $a_5 = 0$ is rejected with the estimates from both fixed effects and both fixed effects with pair fixed effects standing at -0.022 and -0.058 respectively, indicating that a 10% increase in trade costs can go to decrease consumption by as much as 0.6% for the panel of 69 countries. The null hypothesis that frictions in international asset markets does not impede consumption risk sharing in the world as a whole, $a_4 = 0$ does not hold. These results imply that frictions in international asset markets causes some form of precautionary savings in the face of higher output uncertainty and the estimates show that a 10% increase in variance of output, i.e., greater uncertainty reduces consumption by approximately 0.03 and 0.02% respectively for both fixed effects and both fixed effects with pair fixed effects estimates. However, trade costs may be quantitatively large in impeding consumption risk sharing.

We next investigate the results by income groups to examine if different groups of countries (developed and developing) face different magnitude of frictions when intradeveloped-country trade (HighxHigh), intradeveloping-country trade (LowxLow) and trade between developing and developed countries (LowxHigh) take place. Hence we repeat the exercise above for the sample of developed (high income) countries, for the sample of developing (low income) countries and for trade between low and high income countries and the results are provided in Table 6. Since both fixed effects and pair fixed effects results are qualitatively similar, we focus on the pair fixed effects results. The R^2 across the three models are comparatively similar

[10] A country list is in Table 1 of Appendix B.

[11] As noted by Bergstrand et al. (2015), the bilateral distance is calculated using

$$Dist_{ij} = \sum_{k\in i} \frac{Pop_k}{Pop_i} \sum_{l\in j} \frac{Pop_l}{Pop_j} Dist_{kl}$$

where $Pop_{k(l)}$ is the population of agglomeration $k(l)$ in country i(j) and Dist_{kl} is the distance between each agglomeration. The method was originally described in Mayer and Zignago (2011) and is the accepted method to calculate internal distance where distance will not be set to zero when country i = country j.

with a somewhat better fit for the inter-group trade, i.e., LowxHigh, together with a higher trade costs estimate for this same group. The slope parameter on foreign consumption is around 0.75 for the developed country subsample compared to 0.24 for the low income group and 0.16 for the inter-group trade. While the parameters for the high and low income groups are in line with previous literature estimates yet the inter-group trade estimate tend to show that risk sharing might be more problematic between developed and developing countries. A 10% increase in trade costs decreases consumption by as much as 0.7% for the inter-group trade, 0.6% for the low income group and trade costs appear to be insignificant for the panel of developed countries trade. Inspection at the volatility of income impact on consumption, a_4, tells us that while increases in income volatility decreases consumption for the developed country subsample, the opposite effect is noticed for the group of low income countries. One explanation for these results tell us that the negative estimate is in line with apriori expectation that faced with higher uncertainty in income, one would increase consumption insurance and a positive effect would show that consumption moves more with income, a lack of consumption insurance, as evidenced with the low income group.

The estimate for the high frequency model by income groups is provided in Table 7, i.e., the first difference model equation (29) reveals as expected a low fit for the model, with parameter signs in line with the model prediction for the full sample estimation of the world as a whole and significant negative impact of trade costs on consumption risk sharing. The estimation by income groups reveals that the model at high frequency is particularly relevant for the high income group intra-trade. Whereas we find earlier that long run changes in trade costs do not affect intra-developed country trade, short run changes however do impact trade negatively for this group.

Comparison with other studies: The testing model we presented is in line with previous literature which tests the correlation between consumption across countries and the real exchange rate, viz., Backus and Smith (1993), Kollman (1995), Ravn (2001) among others and Canova and Ravn (1996) for a different testing procedure using the residuals from a stationary model. The key difference lies in the incorporation of salient features that test for capital market imperfection and trade costs, viz., the volatility of output and trade costs obtained from a gravity model. Hence it parallels Fitzgerald (2012) in spirit of incorporating important elements that impede international consumption risk sharing. It differs from Fitzgerald (2012) testing equation who undertakes the risk sharing test within the gravity model and computing quantity and price terms for consumption risk sharing, e.g., consumption values, real exchange rates by estimation methods of prices and quantities consistent with fitting a structural gravity model of bilateral trade to the data. Whereas the model here is derived within the international real business cycle framework and the estimation is based on the data at hand.

In terms of the estimates obtained in this work, the correlation between domestic and foreign consumption is remarkably high for the group of developed countries. Backus, Kehoe and Kydland (1992) points to the low correlation for advanced economies which is at odd with the prediction of an international real business cycle model and these were reiterated by Backus and Smith (1993) and Ravn (2001) who found that although foreign consumption is significant, yet the real exchange rate is rarely significant and with the wrong sign. In this work, however, we find that the correlation with foreign consumption and the real exchange rate though lower than 1 and -1 respectively, yet the sign are in line with theory and that these correlations are more sizeable for high income groups versus low income countries. To some extent, the results are in line with Fitzgerald (2012) who finds much sizeable parameters for developed economies subsample, however using estimated data from his model. The work differs from most previous literature in that the effects of international consumption risk sharing are tested directly using trade costs and output volatility, which is the main essence of Fitzgerald (2012) study. On this basis, we found that permanent changes in trade costs impede consumption risk sharing for the subsample of low income countries and the inter-group trade. Where as temporary changes in trade costs seem to affect intra-developed country trade negatively. Furthermore, uncertainty in income depresses consumption of developed countries in line with insurance practice while it increases consumption of developing countries, who often do not have means of insuring against income fluctuations. Canova and Ravn (1996) found that output does not affect risk sharing for a group of developed economies while Fitzgerald (2012) found optimal risk sharing for developed economies and imperfect risk sharing for developing economies when it comes to capital market imperfections.

Caveat to our study due to data limitation for the large sample of countries involves using total aggregate per capita consumption in testing international risk sharing though using tradables consumption might provide more precise estimates. Secondly, nonseparability in the utility function in terms of nontradables, government expenditures which partially substitutes for private consumption, employment if utility is nonseparable in consumption, lagged consumption if habit persistence exists, have important conclusion of rejecting international consumption insurance while this might not be true due to the wedge induced between home and foreign consumption (Marrinan, 1994). Furthermore, the choice of functional form for the utility of the representative agent has consequences on rejection of risk sharing, see for instance Mace (1991) found that adopting a quadratic utility function changes the results while Canova and Ravn (1996) found no such effects with different specifications. We have used a CRRA specification with log-utility abstraction and it may be that a (locally) quadratic utility function is more appropriate (see Townsend 1994). While we take all these limitations into account and admit that the parameter estimates in front of foreign consumption might differ, yet trade costs should not be correlated with any of these variables and hence the impact of trade costs on consumption should be free from these criticisms so long as border costs are exogenous.

4 Conclusion

Asset market imperfections and trade costs are main impediments to optimal risk sharing in consumption. We incorporate these two salient features in a model of bilateral consumption correlation with the real exchange rate, departing from the usual framework by modelling time and state variant marginal utility of wealth and relative price changes due to trade costs. In line with previous literature, the parameters of correlation with consumption and real exchange deviate from perfect risk sharing prediction, with however the correct sign on the real exchange rate and parameters more sizeable for developed economies. Trade costs are significant in hampering consumption for the world as a whole and a 10% increase in trade costs in the long run decreases consumption by a sizeable 0.6% for intra-developing country trade and 0.7% for the inter-group trade while temporary changes in trade costs impact intra-developed country trade negatively. Output uncertainty leads developed economies to take more insurance whereas developing economies are constrained by their lack of access to financial markets. As policy recommendation, while government intervention both in terms of providing automatic stabilizers in the economy and the development of new financial market institutions to help the economies to achieve optimal allocations in an attempt to bridge capital market imperfections, the gain in welfare from our analysis seems small given that output volatility impact on consumption is relatively small. However, ensuring low trade transaction costs may have marked redistributive effects.

References

[1] Alvarez, Fernando, and Robert E. Lucas, Jr. 2007. "General Equilibrium Analysis of the Eaton-Model of International Trade." Journal of Monetary Economics 54 (6): 1726-68.

[2] Anderson, James E., and Eric van Wincoop. 2003. "Gravity with Gravitas: A Solution to the Puzzle." American Economic Review 93 (1): 170-92.

[3] Anderson, James E., and Eric van Wincoop. 2004. "Trade Costs." Journal of Economic Literature (3): 691-751.

Anderson, J. E. and Yotov, Y. V. (2010a), 'Specialization: Pro- and Anti-Globalizing, 1990-2002', Cambridge, MA, National Bureau of Economic Research, NBER Working Paper No. 16301.

[4] Arkolakis, Costas, Arnaud Costinot, and Andres Rodriguez-Clare. 2012. "New Trade Models, Old Gains?" American Economic Review 102

[5] Atkeson, A., "International Lending with Moral Hazard and Risk of Repudiation," Econometrica 59 (1991), 1069-1084.

[6] Debreu, G. (1972). Smooth preferences. Econometrica, 40(4):603–615

[7] Backus, D., P. Kehoe, and F. Kydland, "International Real Business Cycles," Journal of Political Economy 101 (1992), 745-775.

[8] Backus, D., P. Kehoe, and F. Kydland, "International Business Cycles: Theory and Evidence," T. Cooley, ed., Frontiers of Business Cycle Research (Princeton: Princeton University Press, 1995)

[9] Backus, D and SMITH, G. 'Consumption and Real Exchange Rates in Dynamic Exchange Economies with Nontraded Goods,' Journal of International Economics, November 1993, 35: 297-316.

[10] Benhabib, J., Rogerson, R. and Wright, R. 1992. 'Homework in Macroeconomics II: Aggregate Fluctuations,' Journal of Political Economy, 99: 1166-1187.

[11] Canova, F. and Ravn, M. 1996. "International Consumption Risk Sharing." International Economic Review 37 (3): 573-601.

[12] Cole, H. and M. Obstfeld, "Commodity Trade and International Risk Sharing: How Much Do Financial Markets Matter?" Journal of Monetary Economics 28 (1991), 3-24.

[13] Dumas, Bernard. 1992. "Dynamic Equilibrium and the Real Exchange Rate in a Spatially Separated World." Review of Financial Studies 5 (2), 153-180.

[14] Dumas, Bernard, and Raman Uppal. 2001. "Global Diversification, Growth, and Welfare with Integrated Markets for Goods." Review of Financial Studies 14 (1), 277-305.

[15] Fitzgerald, Doireann. 2008. "Can Trade Costs Explain Why Exchange Rate Volatility Does Not into Consumer Prices?" Journal of Monetary Economics 55 (3): 606-28.

[16] Fitzgerald, Doireann. 2012. "Trade Costs, Asset Market Frictions, and Risk Sharing: Dataset." American Economic Review 102 (6): 2700-2733.

[17] Heathcote, Jonathan, and Fabrizio Perri. 2004. "Financial Globalization and Real Regionalization." Journal of Economic Theory 119 (1), 207-243.

[18] Kollman, R, 'World Business Cycles and Incomplete International Asset Markets,' manuscript, Economics Department, University of Chicago, 1990.

[19] Kollman, R., "Consumption, Real Exchange Rates and the Structure of International Asset Markets," Journal of International Money and Finance 14 (1995), 191-211.

[20] Kollman, R., "Explaining International Business Cycle Synchronization," Society for Economic Dynamics Meeting Papers no. 1489.

[21] Kose, M. Ayhan, and Kei-Mu Yi. 2006. "Can the Standard International Business Cycle Model Explain the Relation between Trade and Comovement?" Journal of International Economics 68 (2): 267-95.

[22] Lewis, K., "What Can Explain the Apparent Lack of International Consumption Risk Sharing?" Journal of Political Economy 104 (1996), 267-297.

[23] Mace, B., "Full Insurance in the presence of Aggregate Uncertainty" Journal of Political Economy 99 (1991), 928-956.

[24] Marrinan, J., "Government Consumption and Private Consumption Correlations," mimeo, Universitat Pompeu Fabra, 1994.

[25] Obstfeld, M. "International Risk Sharing and Capital Mobility: Another Look," Journal of International Money and Finance 11, 1992, 115-121.

[26] Obstfeld, Maurice, and Kenneth Rogoff. 2001. "The Six Major Puzzles in International Macroeconomics: Is There a Common Cause?" In National Bureau of Economic Research Macroeconomics Annual 2000 , edited by Ben S. Bernanke and Kenneth Rogoff, 339-90. Cambridge, MA: MIT Press.

[27] Stockman, A. and H. Dellas, "International Portfolio Nondiversification and Exchange Rate Variability," Journal of International Economics 26 (1989), 271-289.

[28] Tesar, L., "International Risk Sharing and Nontraded Goods," Journal of International Economics 35 (1993), 69-90.

[29] Ravn, Morten 0. 2001. "Consumption Dynamics and Real Exchange Rate." Unpublished.

[30] Ravn, Morten O., and Elisabetta Mazzenga. 2004. "International Business Cycles: The Quantitative Role of Transportation Costs." Journal of International Money and Finance 23 (4): 645-71.

[31] Tesar, L., and I. Werner, " Home Bias and High Turnover," Journal of International Money and Finance 14 (1995), 236-251.

[32] Townsend, R., "Risk and Insurance in Village India," Econometrica 62 (1994), 539-591.

[33] Van Wincoop, E., "Welfare Gains from International Risk Sharing," Journal of Monetary Economics 34 (1994), 175-200.

[34] Anderson, J. E. and Y. V. Yotov, "Specialization: Pro- and Anti-globalizing, 1990- 2002," NBER Working Papers 16301 (2010), National Bureau of Economic Research, Inc.

[35] Bergstrand, J., M. Larch, and Y. Yotov, "Economic integration agreements, border effects, and distance elasticities in the gravity equation," European Economic Review 78 (2015), 307– 327.

@TechReportCEPII:2011-25, author=Thierry Mayer and Soledad Zignago, title=Notes on CEPII's distances measures: The GeoDist database, year=2011, month=December, institution=CEPII, type=Working Papers, url=http://www.cepii.fr/CEPII/en/publications/wp/abstract.asp?NoDoc=3877, number=2011-25,

Appendix A

The gravity model is estimated using aggregate manufacturing trade data for 69 countries over the period 1986-2006 from Bergstrand and Yotov (2015).[12] The authors use CEPII's *Trade, Production and Bilateral Protection Database* that reports bilateral trade and production data for 26 industrial sectors to construct intranational trade. Intranational trade is the difference in domestic production and exports to account for domestic sales. There are many missing observations so the number of observations are reduced. Even with this limitation, we can account for "home bias" and "internal dist" in the gravity specification and estimate the model using Poisson quasi maximum likelihood (PQML). Intranational data is required to account for "home bias" and "internal dist", or compare international distance to internal distance and to account for the fact that domestic trade is typically larger than international trade.

The traditional gravity specification use proxy variables as trade determinants and include geographic distance, common land border, common language, and common legal origin. All listed trade determinants have been shown by the literature to effect international trade flow. Since the gravity specification be estimated in cross-sections, we follow Bergstrand and Yotov (2015) and include a binary variable, $SMCTRY$, that is 1 if a trade observation is intranational and 0 otherwise and also include intranational distance, $Dist\_Intra$. As noted by Bergstrand and Yotov (2015), previous estimations that have excluded intranational trade have not properly controlled for the relative trade costs of international to intranational trade. Anderson and Yotov (2010) find that including $SMCTRY$ controls for factors that differentiate between intranational and international trade. Bergstrand and Yotov (2015) also finds that including $Dist\_Intra$ captures factors other than bilateral distance that discriminate between intranational and international trade.

[12] A country list is in Table 1 of the Appendix B.

Table 1: Gravity Estimates (Full Sample) Cross-sections Every 4 Years

(1)	(2) 1986	(3) 1990	(4) 1994	(5) 1998	(6) 2002	(7) 2006
ln(Distance)	-0.728***	-0.669***	-0.619***	-0.689***	-0.763***	-0.791***
	(0.093)	(0.096)	(0.084)	(0.075)	(0.065)	(0.062)
Contiguity	0.651***	0.747***	0.787***	0.743***	0.618***	0.542***
	(0.212)	(0.216)	(0.171)	(0.158)	(0.149)	(0.146)
Common Language	0.315**	0.218*	0.264**	0.373***	0.374***	0.330***
	(0.129)	(0.131)	(0.126)	(0.125)	(0.124)	(0.121)
Common Legal	0.096	0.062	0.092	0.008	-0.007	0.006
	(0.111)	(0.116)	(0.106)	(0.101)	(0.096)	(0.085)
Colonial History	0.537***	0.395**	0.294	0.272	0.191	0.161
	(0.162)	(0.162)	(0.179)	(0.214)	(0.159)	(0.144)
Common Colonizer	0.333	0.520	0.812*	0.313	0.151	0.241
	(0.439)	(0.448)	(0.445)	(0.350)	(0.372)	(0.335)
RTA	0.000	0.162	0.109	0.143	0.066	0.041
	(.)	(0.115)	(0.146)	(0.137)	(0.126)	(0.104)
SMCTRY	3.405***	3.260***	3.206***	2.927***	2.720***	2.519***
	(0.252)	(0.272)	(0.233)	(0.202)	(0.179)	(0.167)
Importer FE	Yes	Yes	Yes	Yes	Yes	Yes
Exporter FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs	4761	4761	4761	4761	4761	4761

Robust Standard errors in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$

Table 2: Gravity Estimates (HighxHigh Sample) Cross-sections Every 4 Years

(1)	(2) 1986	(3) 1990	(4) 1994	(5) 1998	(6) 2002	(7) 2006
ln(Distance)	-0.628***	-0.601***	-0.568***	-0.595***	-0.627***	-0.667***
	(0.083)	(0.087)	(0.096)	(0.081)	(0.071)	(0.072)
Contiguity	0.454**	0.499**	0.519***	0.484***	0.389***	0.466***
	(0.198)	(0.194)	(0.173)	(0.152)	(0.130)	(0.144)
Common Language	0.086	-0.004	0.125	0.306**	0.325***	0.202
	(0.129)	(0.131)	(0.132)	(0.132)	(0.125)	(0.126)
Common Legal	0.274***	0.227**	0.293***	0.208*	0.203**	0.216**
	(0.105)	(0.106)	(0.105)	(0.108)	(0.100)	(0.096)
Colonial History	0.167	-0.027	-0.174	-0.158	-0.167	-0.108
	(0.259)	(0.232)	(0.248)	(0.313)	(0.171)	(0.220)
Common Colonizer	1.432**	1.549**	1.718**	1.189**	1.197**	1.519***
	(0.680)	(0.697)	(0.736)	(0.577)	(0.537)	(0.532)
RTA	0.000	0.248**	0.079	0.122	0.220	0.071
	(.)	(0.123)	(0.222)	(0.161)	(0.157)	(0.141)
SMCTRY	2.983***	2.828***	2.801***	2.627***	2.551***	2.372***
	(0.215)	(0.224)	(0.236)	(0.205)	(0.181)	(0.184)
Importer FE	Yes	Yes	Yes	Yes	Yes	Yes
Exporter FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs	1225	1225	1225	1225	1225	1225

Robust Standard errors in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$

Table 3: Gravity Estimates (HighxLow Sample) Cross-sections Every 4 Years

(1)	(2) 1986	(3) 1990	(4) 1994	(5) 1998	(6) 2002	(7) 2006
ln(Distance)	-0.558***	-0.445***	-0.576***	-0.709***	-0.857***	-0.885***
	(0.097)	(0.129)	(0.105)	(0.092)	(0.097)	(0.081)
Contiguity	1.818***	2.097***	1.526***	1.467***	1.300***	0.913***
	(0.299)	(0.441)	(0.422)	(0.296)	(0.205)	(0.155)
Common Language	0.475*	0.538	0.380	0.274	0.343	0.460*
	(0.260)	(0.419)	(0.305)	(0.261)	(0.280)	(0.270)
Common Legal	-0.090	-0.131	-0.048	-0.133	-0.251	-0.280
	(0.170)	(0.261)	(0.266)	(0.228)	(0.227)	(0.197)
Colonial History	0.873***	0.746***	0.648***	0.775***	0.564**	0.239
	(0.206)	(0.289)	(0.233)	(0.247)	(0.261)	(0.216)
Common Colonizer	0.704	0.131	0.981**	0.573**	0.580**	0.544**
	(0.541)	(0.455)	(0.389)	(0.290)	(0.279)	(0.262)
RTA	0.000	1.339***	0.473	0.477**	0.271*	0.383**
	(.)	(0.336)	(0.339)	(0.231)	(0.158)	(0.154)
SMCTRY	4.832***	4.876***	3.953***	3.518***	3.088***	2.856***
	(0.350)	(0.534)	(0.403)	(0.329)	(0.339)	(0.280)
Importer FE	Yes	Yes	Yes	Yes	Yes	Yes
Exporter FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs	2378	2378	2378	2378	2378	2378

Robust Standard errors in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$

Table 4: Gravity Estimates (LowxLow Sample) Cross-sections Every 4 Years

(1)	(2) 1986	(3) 1990	(4) 1994	(5) 1998	(6) 2002	(7) 2006
ln(Distance)	-1.156***	-1.136***	-1.168***	-1.307***	-1.365***	-1.398***
	(0.147)	(0.127)	(0.114)	(0.143)	(0.105)	(0.124)
Contiguity	-0.106	-0.052	0.317	0.122	-0.293	-0.347
	(0.385)	(0.331)	(0.317)	(0.351)	(0.296)	(0.285)
Common Language	0.040	0.275	0.427*	0.235	0.365*	0.475***
	(0.237)	(0.275)	(0.228)	(0.226)	(0.211)	(0.175)
Common Legal	0.322	0.360**	0.290	0.412*	0.089	0.031
	(0.199)	(0.171)	(0.204)	(0.247)	(0.190)	(0.188)
Colonial History	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)
Common Colonizer	0.553	-0.083	-0.137	-0.400	-0.745***	-0.829***
	(0.342)	(0.256)	(0.191)	(0.253)	(0.230)	(0.208)
RTA	0.000	0.478*	0.280	0.037	-0.225	-0.031
	(.)	(0.245)	(0.192)	(0.237)	(0.196)	(0.195)
SMCTRY	4.639***	4.277***	3.635***	2.795***	2.529***	2.129***
	(0.452)	(0.370)	(0.373)	(0.481)	(0.327)	(0.409)
Importer FE	Yes	Yes	Yes	Yes	Yes	Yes
Exporter FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs	1156	1156	1156	1156	1156	1156

Robust Standard errors in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$

Table 5: Level Estimations

(1)	(2) OLS	(3) Exporter FE	(4) Importer FE	(5) Both FEs	(6) Both FEs and Pair
$\ln(c_j)$	0.078***	-0.010	0.001	0.575***	0.529***
	(0.004)	(0.032)	(0.000)	(0.004)	(0.005)
$\ln(R^{ij})$	-0.107***	-0.194***	0.001***	-0.051***	-0.051***
	(0.001)	(0.001)	(0.000)	(0.002)	(0.002)
$\ln(\sigma^2_{iy,t})$	-0.069***	-0.068***	-0.006***	-0.003***	-0.002***
	(0.002)	(0.002)	(0.000)	(0.000)	(0.000)
$\ln(1{+}\tau_{ij}^{1-\sigma})$	0.108***	0.072***	-0.057***	-0.022***	-0.058***
	(0.006)	(0.006)	(0.001)	(0.001)	(0.001)
Importer FE	No	Yes	No	Yes	Yes
Exporter FE	No	No	Yes	Yes	Yes
Pair FE	No	No	No	No	Yes
Adjusted R^2	0.120	0.198	0.987	0.992	0.992
Obs	60988	60988	60988	60988	60988

Robust Standard errors in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$.

Table 6: Level Estimations by Income

(1)	(2) HighxHigh	(3) LowxHigh	(4) LowxLow	(5) HighxHigh w/ Pair	(6) LowxHigh w/ Pair	(7) LowxLow w/ Pair
$\ln(c_j)$	0.729***	0.268***	0.392***	0.744***	0.155***	0.238***
	(0.007)	(0.007)	(0.009)	(0.008)	(0.008)	(0.010)
$\ln(R^{ij})$	-0.246***	-0.051***	-0.010***	-0.249***	-0.049***	-0.010***
	(0.006)	(0.002)	(0.003)	(0.006)	(0.002)	(0.003)
$\ln(\sigma^2_{iy,t})$	-0.006***	-0.001***	0.001	-0.005***	-0.000*	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\ln(1{+}\tau_{ij}^{1-\sigma})^{HH}$	0.002			0.002		
	(0.001)			(0.003)		
$\ln(1{+}\tau_{ij}^{1-\sigma})^{HL}$		-0.051***			-0.068***	
		(0.001)			(0.001)	
$\ln(1{+}\tau_{ij}^{1-\sigma})^{LL}$			-0.032***			-0.061***
			(0.001)			(0.001)
Importer FE	Yes	Yes	Yes	Yes	Yes	Yes
Exporter FE	Yes	Yes	Yes	Yes	Yes	Yes
Pair FE	No	No	No	Yes	Yes	Yes
Adjusted R^2	0.971	0.994	0.976	0.972	0.994	0.978
Obs	14412	30784	15792	14412	30784	15792

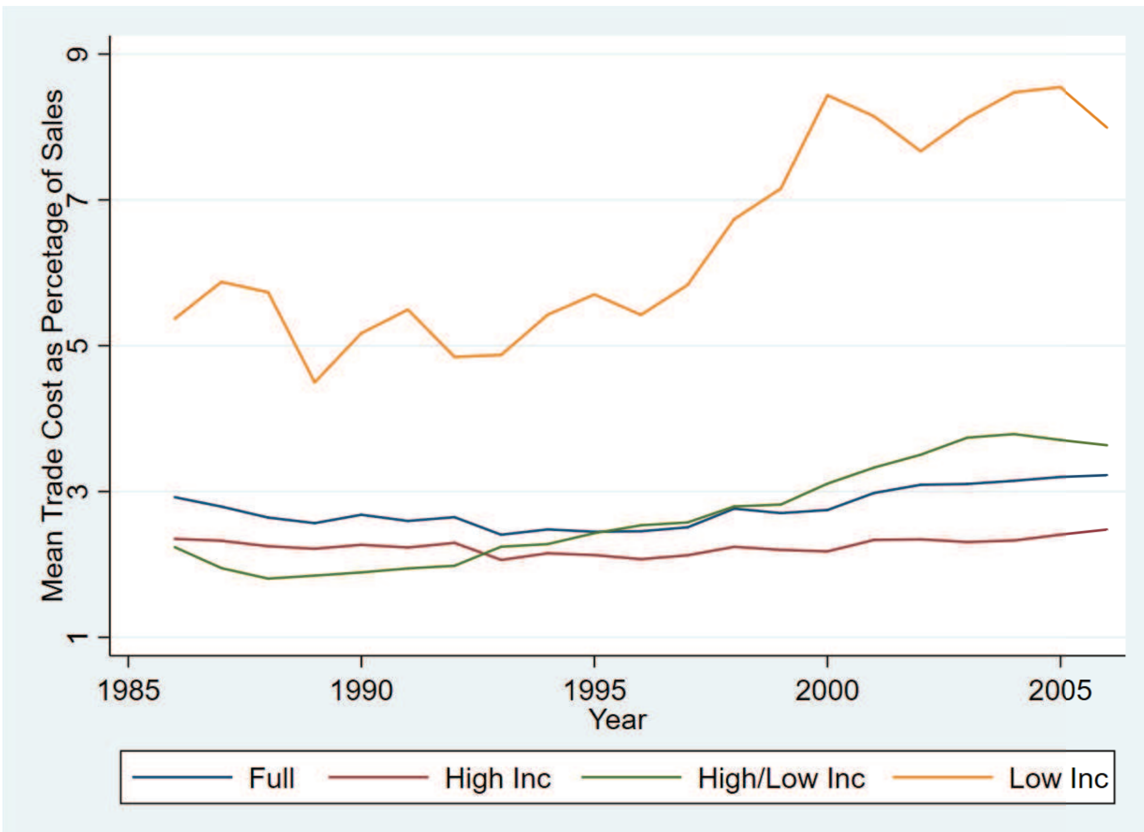
Robust Standard errors in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$. Note that the Columns (3) and (6) have high income country i and low income country j or reciprocally in the estimation.

Table 7: First Difference Estimations

(1)	(2) FD	(3) HighxHigh	(4) LowxHigh	(5) LowxLow
$\Delta \ln(c_j)$	0.017***	0.067***	0.001	0.020**
	(0.004)	(0.009)	(0.005)	(0.008)
$\Delta \ln(R^{ij})$	-0.027***	-0.082***	-0.027***	-0.020***
	(0.002)	(0.005)	(0.002)	(0.002)
$\Delta \ln(\sigma^2_{iy,t})$	-0.000***	0.000	-0.000**	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
$\Delta \ln(1+\tau_{ij}^{1-\sigma})$	-0.003***			
	(0.001)			
$\Delta \ln(1+\tau_{ij}^{1-\sigma})^{HH}$		-0.004***		
		(0.001)		
$\Delta \ln(1+\tau_{ij}^{1-\sigma})^{HL}$			0.002***	
			(0.001)	
$\Delta \ln(1+\tau_{ij}^{1-\sigma})^{LL}$				0.001
				(0.001)
Constant	0.022***	0.025***	0.023***	0.020***
	(0.000)	(0.000)	(0.000)	(0.000)
Adjusted R^2	0.014	0.046	0.015	0.011
Obs	57073	13407	28804	14862

Robust Standard errors in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$. Note that Columns (4) has high income country i and low income country j or reciprocally in the estimation.

Figure 1:



Mean Trade Cost as Percentage of Sales
9
7
5
3
1
1985
1990
1995
2000
2005
Year
Full
High Inc
High/Low Inc
Low Inc

Appendix B

Table 1: Country List

Argentina	Iceland	Nigeria
Australia	India	Norway
Austria	Indonesia	Panama
Belgium	Iran, Islamic Rep.	Philippines
Bolivia	Ireland	Poland
Brazil	Israel	Portugal
Bulgaria	Italy	Qatar
Cameroon	Japan	Romania
Canada	Jordan	Senegal
Chile	Kenya	Singapore
China	Korea, Rep.	South Africa
Colombia	Kuwait	Spain
Costa Rica	Macao SAR, China	Sri Lanka
Cyprus	Malawi	Sweden
Denmark	Malaysia	Switzerland
Ecuador	Malta	Tanzania
Egypt, Arab Rep.	Mauritius	Thailand
Finland	Mexico	Trinidad and Tobago
France	Morocco	Tunisia
Germany	Myanmar	Turkey
Greece	Nepal	United Kingdom
Hong Kong SAR, China	Netherlands	United States
Hungary	Niger	Uruguay