International Trade and the Risk in Bilateral Exchange Rates

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12 May 2021

Abstract

Exchange rate volatility falls after a trade deal, driven by a decline in the systematic component of risk. The average trade deal increases trade by 50 percent over five years and reduces systematic risk by a third of a standard deviation across countries. We examine this connection in an Armington model where the structure of trade networks determines the risk in exchange rates. We estimate our model to current data and find i) that countries at the periphery of the world trade network benefit the most from lower trade barriers and ii) that a counterfactual experiment of a trade war between the US and China shows a global increase in currency risk, with effects concentrated among peripheral countries.

*We thank Hanno Lustig and Minnesota (Carlson) for helpful comments.

Introduction

Connecting international finance and macroeconomics rests on the dynamics of exchange rates. While our theories have long predicted currency values to be strongly affected by fundamentals like output and trade, a robust empirical link has remained remarkably elusive. The "exchange rate disconnect puzzle" summarizes a massive body of work's struggle at bridging exchange rates and fundamentals (see for example Meese and Rogoff (1983) and Engel and West (2005)).

Recently, however, Verdelhan (2018) reveals the presence of a strong factor structure in bilateral exchange rates. Refocusing away from variation of individual exchange rates and towards understanding their systematic risk provides a new approach to reconciling the puzzle. It also appeals to the wisdom of portfolio construction that dates back to at least Black, Jensen and Scholes (1972) and that has profoundly shaped thinking in modern finance.

In this paper, we present new evidence on the direct impact of international trade on currencies' systematic risks using the surge in imports following trade agreements. In doing so, we establish not only that trade policy affects international discount rates, which influence the cost of hedging and the flow of capital, but also a solid step towards unifying finance and international trade.

A novelty in our work is the use of trade deals as an instrument in uncovering the effect of trade on currency risk. We begin in Section I by confirming Baier and Bergstrand's (2007) result that a typical agreement grows bilateral trade by 50 percent over the next five years. We then show that instrumented trade growth reduces the exchange rate's systematic risk by a third of a standard deviation across countries. By contrast, not instrumenting trade produces a statistically indistinguishable effect.

Our three measures of systematic risk follow recent developments in international finance. We estimate currency betas and record the R-squareds from regressions of changes in a bilateral exchange rate on a country's base factor. Akin to market portfolios, base factors average out all foreign country-specific shocks, leaving exposure to only domestic shocks and global common factors. To these we add a new measure of unshared risk that divides a bilateral pair's exchange rate variance (how much risk is not shared) by the sum of the pair's base factor variances (how much risk there is to share). It has an economic interpretation close to (one minus) the risk-sharing index of Brandt, Cochrane and Santa-Clara (2006), but is constructed using only currency data. For all measures, an exchange rate's systematic risk falls when two countries become "closer", in the sense that their pricing kernels now load more identically on a common set of factors. More similar exposure translates all else equal into more stable exchange rates.

In our empirical analysis we run a multi-year difference specification in panel data to control for self-selection into trade deals following Baier, Bergstrand and Feng (2014). We do this by including pre-trends and country-pair and country-year fixed effects. The country-year effects capture changes in importer and exporter characteristics such as multilateral resistance terms, and in this difference specification the country-pair effects control for unobservable pair-specific changes that could have occurred (Trefler, 2004). Our identifying assumption is that trade deals only impact currency risk through their effect on trade.

Theoretically, we think of trade deals as representing a change in trade costs, which represent a broad notion of barriers—physical, institutional, cultural, informational, tariff, and non-tariff, like domestic shipping regulations—that impede the transportation of goods and thus risk sharing. Accordingly, in Section II we formulate an international economy of trade in goods hindered by both trade costs and asset market frictions. The model, which borrows from the theoretical foundations of the gravity equation, endogenizes the currency factor structure from granular origins (Gabaix, 2011).

Key terms in gravity models are those of multilateral resistance: equilibrium constructs that influence bilateral trade and that depend on the network of *all* countries' trade costs. Since Anderson and van Wincoop (2003) it has been known that accounting for these terms is crucial for the estimation of trade costs which otherwise would be biased due to omitted variables. Since trade costs are a first-order determinant of a country's exposure to global risk, it is plausible that this bias spills into exchange rates. We therefore structurally estimate trade costs in Section III before evaluating the model.

Our gravity model predicts core countries are larger and face lower resistances and are more exposed to global shocks relative to peripheral countries. Thus when an adverse global shock occurs, core countries' currencies appreciate relative to peripheral countries, causing investors in the core to perceive peripheral currencies as risky ex ante.

We then examine counterfactual experiments on trade policy's role in determining the covariation of exchange rates in Section IV, as recent work in international macroeconomics has highlighted the importance of exchange rates in affecting firm policies.

Our first counterfactual implements a change trade costs to replicate the import growth observed in the first stage and then compare the model's predictions for the second stage with the data. It allows us to see how global shock exposures change as a function of a country's characteristic in response to a trade agreement, and thus where the gains from trade concentrate. We find that peripheral countries, which are often poorer, are found to disproportionately benefit from a reduction in trade costs, consistent with our empirical evidence. Intuitively, trade deals that substantially weaken a peripheral's multilateral resistance are effective in bringing it into the trade network's core. Because they faced the highest barriers ex ante, peripheral countries experience the greatest relative reductions ex post.

Next, we study the impact of a trade war between two major economies, the United States and China, on the risk exposures of all countries. Our counterfactual shows that peripheral countries bear collateral damage and the brunt of the war: these countries' currency volatilities rise, largely attributable to a growth in their systematic risk exposure. Because of the trade war of a large two, risk-sharing across all has worsened. Overall, our paper underscores that trade deals are not just about trade.

A. Literature

Our work continues to uncover the fundamental drivers of currency prices. The empirical literature on the exchange rate disconnect puzzle is quite extensive and began with Meese and Rogoff (1983) who showed that exchange rate forecasts based on a random walk became less accurate by conditioning on macroeconomic variables.[1] A renewed take on the puzzle

[1]See Frankel and Rose (1995) and Cheung, Chinn and Pascual (2005) for surveys. More recently, Lilley, Maggiori, Neiman and Schreger (2019) look at how fundamentals and exchange rates have become more

comes from Engel, Mark and West (2015) and Verdelhan (2018) who demonstrate that a large amount of variation in bilateral exchange rates is explained by common factors. Building on this work, Lustig and Richmond (2020) relate currency exposures to gravity-type measures of distance, whether it be cultural, institutional, or simply geographical. Jiang and Richmond (2020) parameterize a network of international trade using trade shares to develop a measure of network closeness. They show that closer countries have more correlated consumption growth rates, stock returns, and exchange rate movements. These papers focus on time invariant measures and parameterizations. Our main contribution here is that our trade network and therefore exchange rate factor structure are endogenous and change over time in response to trade deals.

A subsequent branch focuses on the weak correlations between exchange rates and macroeconomic quantities that are surprisingly different from those predicted by theory (Backus, Kehoe and Kydland (1992), Backus and Smith (1993), Evans and Lewis (1995), and Lewis (1996)). Obstfeld and Rogoff (2000) and Anderson and van Wincoop (2004) argue that trade costs are key to resolving several major puzzles in international economics and they have been extensively studied in this literature. These costs, however, have played only a modest role in international finance: see Dumas (1992), Hollifield and Uppal (1997), Verdelhan (2010), Ready, Roussanov and Ward (2017a), Ready, Roussanov and Ward (2017b), Maggiori (2017), and Barrot, Loualiche and Sauvagnat (2019), although these papers use two-country models that are unsuitable to study the cross-section of bilateral exchange rates. We instead specify a multi-country setup that is closer to Fitzgerald's (2012), but in contrast to her work we look at our model's implications for the exchange rate factor structure.[2]

Our interest in systematic risk places the paper into the large literature on sources of foreign exchange return premia.[3] Hassan (2013) shows that the size of a country is an important determinant of cross-sectional variation in currency returns, simply because larger countries' bonds better insure against shocks that affect a larger fraction of the world economy. Richmond (2019) focuses on the propagation of these shocks through the hubs of the global trade network, identifying countries like the Netherlands and Singapore as more exposed to global risk. Like these two papers, our model only quantitatively generates the quantity of risk and does not jointly account for its price, for example by including disaster or long-run risk. Unlike them, size and network centrality are endogenous to our model's structure of trade costs. We therefore can, and do, evaluate how these characteristics change over time in response to trade policy.

I. The Role of Trade in Exchange Rate Variation

We first review the measurement of the systematic risk of bilateral exchange rates. We then discuss data sources before turning to our empirical results.

reconnected from 2007 onward.

[2]Few studies in international finance use multi-country models, though none specify trade costs: Heyerdahl-Larsen (2014), Mueller, Stathopoulos and Vedolin (2017), Colacito, Croce, Gavazzoni and Ready (2018a).

[3]A partial list is Lustig and Verdelhan (2007), Colacito and Croce (2011), Lustig, Roussanov and Verdelhan (2011), Colacito and Croce (2013), Gabaix and Maggiori (2015), Lettau, Maggiori and Weber (2014), Corte, Riddiough and Sarno (2016), Stathopoulos (2017), Colacito, Croce, Ho and Howard (2018b).

A. Measurement of Currency Risk

To motivate our measures we follow the literature (Verdelhan (2018) for example) and start by specifying innovations to the log stochastic discount factor (SDF). From this we can construct currency returns and decompose them into sources of risk.

A.1. Dynamics of Exchange Rates

Country i's SDF follows a two-factor process

$$-\Delta\mathbf{E}_t[m_{i,t+1}] = \delta_i u_{i,t+1} + \varphi_i u_{g,t+1}. \tag{1}$$

For compactness we define the innovations operator, $\Delta\mathbf{E}_t[x_{t+1}] \equiv x_{t+1} - \mathbf{E}_t[x_{t+1}]$, as we are only interested in second moments. While our exogenous shocks here, u_i and u_g, do not translate directly into real shocks, in the model of Section II we show how they map into country-level supply shocks and how gravity granularly creates global shocks.[4] For now, we interpret u_i as a country-specific shock that is uncorrelated across countries and u_g as a global aggregate shock that is orthogonalized to all u_i; the respective (positive) exposures to these shocks are δ_i and φ_i. The shocks' means are zero and their distributions are otherwise unrestricted, but for illustration we set all variances equal to σ_t^2 for what follows.

Under complete markets, an assumption which we later relax, the innovation to a log return of a spot exchange rate is the difference between country j's and i's SDF innovations. Given its specification we have the following innovation dynamics for the exchange rate's log return:

$$\begin{aligned}\Delta\mathbf{E}_t[\Delta s_{ij,t+1}] &= \Delta\mathbf{E}_t[m_{j,t+1}] - \Delta\mathbf{E}_t[m_{i,t+1}] \\ &= \delta_i u_{i,t+1} - \delta_j u_{j,t+1} + (\varphi_i - \varphi_j)u_{g,t+1}. \end{aligned} \tag{2}$$

The exchange rate is the price of foreign currency i per unit of the domestic currency j. To fix ideas, call the United States the domestic currency throughout our analysis, though in our empirics we consider different domestic countries. Thus when an adverse shock originates from the US ($u_{j,t+1} < 0$), the dollar appreciates. Furthermore, if the US has a relatively large global exposure, $\varphi_j > \varphi_i$, then coincident to an adverse global shock, the dollar also appreciates. The notion of closeness among country pairs we refer to can be easily seen: as φ_i becomes closer to φ_j, the exchange rate's exposure to global shocks goes to zero.

Country j's base factor is defined as the average appreciation of all currencies with respect to it: $\Delta base_{j,t+1} \equiv \frac{1}{N}\sum_{i=1}^{N}\Delta s_{ij,t+1}$. Lustig and Richmond (2020) show it correlates highly with each country's level factor, the first principal component extracted from all bilateral exchange rates with respect to the base country.

In this literature the large N limit is often taken for clarity, and following this approach innovations to j's base factor become

$$\Delta\mathbf{E}_t[\Delta base_{j,t+1}] = -\delta_j u_{j,t+1} + (\overline{\varphi} - \varphi_j)u_{g,t+1}, \tag{3}$$

[4] Burnside and Graveline (2020) argue structural assumptions about frictions in goods markets and preferences are needed to truly interpret variation in exchange rates.

where we denote the average with $\overline{x} = \frac{1}{N}\sum_{i=1}^{N} x_i$, with some abuse of notation. In this limit, other countries' idiosyncratic shocks average out and we find that j's base factor loads only on its own shock u_j and the global shock u_g. The latter depends on the difference between its own SDF loading and the average foreign currency loading on the global shock. If all countries were to share similar φ, then all SDFs would comove with the global shock identically and j's base factor's loading on the shock would be close to zero.

A.2. Measuring the Systematic Variation in Bilateral Exchange Rates

To recover the quantity of systematic currency risk in i taken on by a currency investor from j, we regress the pair's exchange rate return on j's base factor. The slope coefficient recovers the rate's common exposure to global risk[5]

$$\Delta s_{ij,t+1} = a_{ij} + \beta_{ij}\Delta base_{j,t+1} + \varepsilon_{ij,t+1}. \tag{4}$$

We consider four measures of currency risk: volatility σ, the slope coefficient β, the regression's R^2, and unshared risk, ρ. As N gets large, they become

$$\sigma_{ij}^2 = \mathrm{Var}_t(\Delta s_{ij,t+1}) = \sigma_t^2(\delta_i^2 + \delta_j^2 + (\varphi_i - \varphi_j)^2) \tag{5}$$

$$\beta_{ij} = \frac{\mathrm{Cov}_t(\Delta s_{ij,t+1}, \Delta base_{j,t+1})}{\mathrm{Var}_t(\Delta base_{j,t+1})} = \frac{\delta_j^2 + (\overline{\varphi} - \varphi_j)(\varphi_i - \varphi_j)}{\delta_j^2 + (\overline{\varphi} - \varphi_j)^2} \tag{6}$$

$$R_{ij}^2 = \beta_{ij}^2 \frac{\mathrm{Var}_t(\Delta base_{j,t+1})}{\mathrm{Var}_t(\Delta s_{ij,t+1})} = \beta_{ij}^2 \times \frac{\delta_j^2 + (\overline{\varphi} - \varphi_j)^2}{\delta_i^2 + \delta_j^2 + (\varphi_i - \varphi_j)^2} \tag{7}$$

$$\rho_{ij} = \frac{\mathrm{Var}_t(\Delta s_{ij,t+1})}{\mathrm{Var}_t(\Delta base_{i,t+1}) + \mathrm{Var}_t(\Delta base_{j,t+1})} = \frac{\delta_i^2 + \delta_j^2 + (\varphi_i - \varphi_j)^2}{\delta_i^2 + (\overline{\varphi} - \varphi_i)^2 + \delta_j^2 + (\overline{\varphi} - \varphi_j)^2}. \tag{8}$$

Writing about these in turn, it is clear that volatility is the least preferred measure of systematic risk as its estimate is influenced by country-specific risk and its time variation σ_t^2. The slope coefficient is a ratio and thus naturally improves on σ_{ij} by removing a substantial part of time variation in country-specific risk. Analogous to a stock market beta, β_{ij} records the incremental systematic risk that an investor in j takes on when investing in i's currency. However, the coefficient can be increasing or decreasing in φ_i depending on φ_j's location relative to $\overline{\varphi}$ and φ_i. For this reason, R-squared is a betterment on β_{ij}. Squaring both $(\varphi_i - \varphi_j)$ and $(\overline{\varphi} - \varphi_j)$ produces monotonicity of R_{ij}^2 with respect to the distance of i from j. It measures the fraction of variance of i's currency due to systematic risk from j's perspective.

To these measures we add unshared risk that does not require a regression framework. As in R-squared, the squaring of all differences yields monotonicity. It has an economic definition very close to (one minus) the risk-sharing index of Brandt et al. (2006): this can be seen by using (1) to rewrite (8) as

$$\rho_{ij} = \frac{\mathrm{Var}_t(m_{j,t+1} - m_{i,t+1})}{\mathrm{Var}_t(m_{i,t+1}) + \mathrm{Var}_t(m_{j,t+1}) + 2\overline{\varphi}(\overline{\varphi} - \varphi_i - \varphi_j)}, \tag{9}$$

[5] In the case where the domestic country is the US, Verdelhan (2018) shows that the slope coefficient is the loading on the dollar factor, which explains a large fraction of the variation in bilateral dollar exchange rates.

where the only small difference is in the denominator, $2\overline{\varphi}(\overline{\varphi}-\varphi_i-\varphi_j)$.[6] It therefore inherits the intuition that countries which better share risk internationally have lower unshared risk. Another difference is that our risk-sharing index only requires currency data and bypasses the difficulty in estimating the mean return on the stock market needed to implement the Hansen-Jagannathan bound.

Altogether, we prefer R-squared and unshared risk to the other two risk measures, but we report all as they each possess distinct economic meaning. All four are expected to decrease as countries become closer.

B. Data

Our sources draw from databases on exchange rates, international trade and macroeconomic aggregates, and trade deals. We discuss these in turn before describing our computation of the risk measures.

B.1. Exchange Rates

We use exchange rate data from Bloomberg that span 1973 to 2019 at the daily frequency, as we focus on the accurate estimation of second moments. All exchange rates are relative only to the US dollar and we triangulate to recover all bilateral pairs. Our 45 countries are the developed and emerging markets listed by Morgan Stanley Capital International as of June 2020. We follow Lustig and Richmond (2020) and omit currencies after joining the Euro. Throughout, we include the Euro when constructing base factor loadings, but the Euro countries are dropped in regressions due to lack of gravity data. We identify pegged currencies using Ilzetzki, Reinhart and Rogoff's (2017) classification.

B.2. Fundamentals and Trade Deals

Trade flows are from the IMF's Direction of Trade Statistics database from 1973 to 2019. The IMF trade data do not include services, only the value of merchandise exports and imports. We get data on output (GDP), inflation (CPI), and consumption from the World Bank's Development Indicators and on gravity variables from CEPII's Research and Expertise on the World Economy (Head and Mayer (2014)).

The data on trade agreements comes from the database on Economic Integration Agreements (EIA) constructed by Baier and Bergstrand (2007).[7] The data cover annually the economic integration level for bilateral country pairings since 1950. Every year each country pair is assigned one of seven distinct levels of integration. The levels in order of increasing intensity are

1. No Agreement
2. Non-Reciprocal Preferential Trade Agreement (preferential terms and customs concessions given by developed countries to developing ones, such as the US's Generalized System of Preferences)

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[6] Our structurally estimated model recovers this empirically unobservable term to be near -0.035, much smaller than $2\,\mathrm{Var}(m)$ that stock market data tells us is over 0.50 (see Brandt et al.'s (2006) footnote 2).

[7] The data is available on Jeffrey Bergstrand's website at `https://sites.nd.edu/jeffrey-bergstrand/database-on-economic-integration-agreements/` (last accessed on 20 June 2020).

3. Preferential Trade Agreement (preferential terms to members of the agreement versus non-members)
4. Free Trade Agreement (trade barriers substantially eliminated among members, but each member can treat non-members differently)
5. Customs Union (same as free trade arrangement, but treat non-members the same)
6. Common Market (same as customs union, but also includes free movement of labor and capital) and
7. Economic Union (same as common market, but also monetary and fiscal policy coordination)

Because of the small number of deeper EIAs, we combine customs unions, common markets, and economic unions into one agreement, CUCMECU, leaving our other four classifications as no agreement, one-way and two-way preferential trade agreement (OWPTA and TWPTA), and free trade agreements (FTA).

B.3. Computing Risk and Summary Statistics

We use equation (4), $\Delta s_{ij,t+1} = a_{ij} + \beta_{ij}\Delta base_{j,t+1} + \varepsilon_{ij,t+1}$, to estimate β_{ij} and R^2_{ij}. Here, $\Delta s_{ij,t+1}$ is the daily change in the value of the foreign currency quoted in domestic currency j and the base factor is the (equally-weighted) average of the foreign currencies quoted in the domestic currency.

Given our interest in the change of risk around trade deals, we estimate rolling regressions for each day using a 1,800-day window and restrict country-pairs to where there are at least 100 days of data. We compute daily measures of volatility σ_{ij} and unshared risk ρ_{ij} with the same rolling window. We then aggregate all measures by averaging over all daily estimates within an year. In the end, we are left with a panel of country-pairs and yearly estimates of currency risk. Because volatility is a daily estimate, for comparison we annualize it with the square root rule.

We present summary statistics of bilateral exchange rate and bilateral trade in Table 1. All moments come from annual country-pair observations following the aggregation described above. The split between developed and emerging markets is in Appendix Table A.1. The average change in currency prices over a year is effectively zero (not reported) with an annualized volatility of 14.8 percent and a median of 12 percent.

By construction, the average base factor loading β is close to one. However this measure varies a lot across country-pairs as can be seen from its high standard deviation. The average R-squared of the estimated regressions means that approximately half of the variation in bilateral exchange rates is explained by systematic risk. Perhaps unsurprisingly, emerging market's average R-squared is higher (see Table A.1).

In the lower panel of Table 1, we present statistics for bilateral imports, our measure of trade. The average across EIA variables tell the percentage of yearly country-pairs in our sample that had an agreement. For example, we observe 9.6 percent of observations under a CUCMECU agreement. Unshared risk has an average over 90 percent and is possibly quite high because of around three-fifths of our panel reporting no trade agreement, highlighting the substantial distortions to international risk sharing that trade costs potentially generate. As time passes, however, every country eventually completes one trade deal with another.

C. Trade Deals and Trade

We first confirm the results in Baier and Bergstrand (2007) and show bilateral trade flows are bolstered after a trade deal is signed. Precisely, we estimate

$$\Delta_{t,t+h}\text{log Imports}_{ij,t} = \beta\text{Trade Deal}_{ij,t} + \gamma X_{ij,t} + \varepsilon_{ij,t}. \tag{10}$$

and include in $X_{ij,t}$ fixed effects for year of the deal and, importantly, the country-pair to absorb unobserved pair-specific variables that could influence the likelihood of a trade deal. These regressions' results are tabulated in Table 2 for a window of five years (columns (1) and (2)) and ten years (columns (3) and (4)) before and after the trade deal. The estimated coefficient β shows that trade grows by 50 percent within five years after the deal and that the effect continues to cumulate for another five, reaching 70 percent ten years after the deal.

This specification, however, has a low amount of variation as it only has a before and after for every deal—the country-pair fixed effect explains virtually all variation. More concerning is that trade and the likelihood of a deal are slow-moving variables that could be influenced by macroeconomic conditions, so our estimates could be picking up these unobservable factors.

To alleviate these problems, we follow Baier et al.'s (2014) and estimate the following model

$$\Delta_{t,t+h}\text{log Imports}_{ij,t} = \beta\Delta_{t,t-h}\text{Trade Deal}_{ij,t} + \gamma X_{ij,t} + \varepsilon_{ij,t+h} \tag{11}$$

where we separately examine the role of distinct trade deals—CUCMECU, FTA, TWPTA, and OWPTA—and where our set of controls $X_{ij,t}$ include an additional five-year lag in imports for pre-trends, country-year fixed effects for time-variation in macroeconomic conditions, and either gravity variables or country-pair fixed effects for unobservable pair-specific changes that could have occurred, like a technological reduction in trade costs.

As we see in Table 3, only CUCMECUs and FTAs have a significant impact on bilateral trade. Imports increase by over 17 percent over five years following CUCMECUs and by around 14 percent following FTAs with no detectable effects for other forms of trade agreements.

D. Trade and Exchange Rate Risk

We now turn to our formal analysis of the effect of trade on exchange rate risk based on two regressions: staggered difference-in-difference and two-stage least squares.

D.1. Staggered Difference-in-Difference Regression

We first consider the change of trade and exchange rate risk around trade deals. Our event study takes the form of a staggered difference-in-difference regression:

$$y_{ij,t} = \alpha + \sum_{s\neq t^*}\beta_s\text{Trade Deal}_{ij} \times \text{Year}_s + \gamma X_{ij,t} + \epsilon_{ij,t}. \tag{12}$$

The trade deal dummy equals one if countries i and j share either a FTA or a CUCMECU and is zero otherwise. The set of controls $X_{ij,t}$ include gravity variables, year fixed effects, and the deal dummy. The β_s coefficients capture the effect of a trade deal on $y_{ij,t}$ for every year s before and after the year of the deal, t^*, when a strengthening of any bilateral agreement to a FTA or a CUCMECU occurs. Note that we do not include $s = t^*$ in the interaction, so the coefficients β_s measure the deviation in $y_{ij,t}$ from the time of the deal.

In column (1) of Table 4 we first confirm the impact of trade deals and plot the trajectory of bilateral trade around a deal in Figure 1. We only include FTA and CUCMECU trade agreements and find trade is bolstered by nearly 20 percent over five years and over 40 percent after ten.

Turning now to our first set of results on the impact of trade on currency risk, we report the estimates in columns (2) through (5) of Table 4 and plot the time paths of all risk measures in Figure 2. All four measures display a marked decline over ten years following the deal and become statistically significant after five years. After most trade agreements are struck, they typically have a five year "phase-in", so it is not surprising the effects materialize after a lag.

All four risk measures decline, ranging from 1.3 percentage points for volatility up to 20 for beta, and all are economically significant. Note that for trade some of the coefficient estimates for the years prior to the event are negative and statistically different from zero. This suggests some degree of anticipation, common for long trade negotiations. There is a lower level of trade until one year before the event, rather than an strong pre-trend increase.

As a robustness check, we include bilateral fixed effects in (12), exploiting uniquely the time series variation across each country pair. In Appendix Table A.2, we find effects that are comparable economically to our headline numbers: the magnitudes are slightly smaller but still statistically significant.

Our staggered design in (12) differs from the standard difference-in-difference regression as our individual units (country pairs) are not treated simultaneously but throughout the sample period. Staggering can introduce a discrepancy between the estimated coefficients and the actual average treatment effect (see Callaway and Sant'Anna (2019) and Goodman-Bacon (2020) for details). We use the methodology introduced in Callaway and Sant'Anna (2019) and report results using their estimator in Appendix Table A.3. We draw similar conclusions to our baseline estimates.

Last it is important to note that our method is not immune to reverse causality, though it is unlikely to affect our estimates. Because the risk of exchange rates will impact trade through second moments, it is unlikely to be large.[8]

D.2. Two-Stage Least Squares Regression

We now move on to our second approach that is the second stage of our two-stage least squares regression. We use the change in bilateral trade around trade deals shown in Table 3 to instrument the effect of trade growth on bilateral exchange rate risk. Our second-stage takes the form

$$\Delta_{t,t+h} y_{ij} = \alpha + \beta \Delta_{t,t-5} \log \widehat{\text{Imports}}_{ij,t} + \gamma X_{ij,t} + u_{ij,t}, \tag{13}$$

[8] Chaney (2016) shows how the level of exchange rate can have muted effect on trade. The complete analysis of the second moment of exchange rates on trade is beyond the scope of this paper.

where $\Delta_{t,t-h}\log\widehat{\text{Imports}}_{ij,t}$ had been estimated in the first stage (10). We include domestic and foreign country-year fixed effects to rule out differential trends across countries driving the results. We consider two different specifications, one controlling for gravity variables and other replacing them with a country-pair fixed effect. Our exclusion restriction assumes that trade deals only affect currency variation through their effect on trade. We present the results for the four measures of exchange rate risk across specifications in Tables 5 and 6.

In Table 5, we find that volatility and unshared risk decline in response to an growth in bilateral trade. Given a 50 percent increase in imports, volatility falls by 0.65 (0.013×0.5) to 1.9 (0.038×0.5) percentage points. Since average volatility is 14.8 percent, this translates to a drop of 4 to 12 percent. Unshared risk's reduction between 12 and 21 percent is more drastic, being between one- to two-thirds of its standard deviation of 30.7 percent. Both effects persist at the ten-year horizon.

We report the results using the common factor regression in (4) in Table 6. The 50 percent growth in imports yields a fall in β between 0.13 to 0.205 at the five-year horizon, over a fifth of its standard deviation. Trade reduces systematic risk as R-squared falls by approximately 10 percent at the five-year horizon or about a third of its standard deviation across countries.

These results are in stark contrast to a simple regression of currency risk on trade. Appendix Tables A.4 and A.5 show the OLS estimates yield insignificant outcomes across all four risks.

Overall, both analyses provide direct evidence of how exchange rate risk falls when two countries become more integrated in goods markets and thus closer. The general takeaway is that when trade increases by 50 percent, risk, respectively, falls by about a third of its standard deviation across countries. The effects are stable across specifications, persistent up to the ten-year horizon, and are all economically and statistically significant.

E. Core and Peripheral Countries

The previous results reflects average effects across arbitrary countries agreeing on a FTA or a CUCMECU. We extend our analysis to see if deals have a different impact on currency risk depending on the countries' location in the global trade network. We calculate a trade centrality index for each country i at date t following Richmond (2019):

$$v_{it} = \sum_{j=1}^{N} \frac{\widetilde{X}_{ijt} + \widetilde{X}_{jit}}{\widetilde{G}_{it} + \widetilde{G}_{jt}} \ \widetilde{s}_{jt}, \tag{14}$$

where $\widetilde{X}_{ij}$ is the total exports from country i to j; $\widetilde{G}_j$ is j's GDP; and $\widetilde{s}_j$ is j's global share of exports in percent—j's total exports divided by all countries' total exports. Countries have a high index if they have a high trade intensity, $(\widetilde{X}_{ijt}+\widetilde{X}_{jit})/(\widetilde{G}_{it}+\widetilde{G}_{jt})$, with partners responsible for a large fraction of global trade.

Based on this index and depending on their relation to the median country's, we classify countries as peripheral (below) and core (equal or above) every year in our sample. We then run our two-stage least squares regression for each of the two groups. The results are presented in Appendix Tables A.6–A.9.

For peripheral countries, the results show statistically significant negative coefficients for almost every specification. The magnitudes are particularly high in the first five years.

For example, following a 50 percent increase trade five years after a deal, the decline in R-squared ranges between 0.135 to 0.16, closer to a half of a standard deviation. The coefficients for the ten-year horizon are lower, but they retain their statistical significance for all measures except for exchange rate volatility.

For core countries, there are only significant effects at the ten-year horizon. We conclude that trade has a stronger and faster effect in reducing the systematic exchange risk for peripheral countries in the global trade network.

II. A Gravity Model for International Finance

We now turn to a quantitative investigation of the effect of trade on currency risk. In this section, we present a standard structural framework in the international trade literature that ties trade to relative prices (Anderson and van Wincoop (2003) for example). In Section III we structurally estimate trade costs and analyze the model and in Section IV we explore the model's predictions in two counterfactual experiments.

For clarity, we consider an Armington model where each country produces one differentiated good and consumer demand originates from constant elasticity of substitution (CES) preferences (see Armington (1969) and Anderson (1979)). While the Armington assumption abstracts from natural specialization due to comparative advantage, it gives a good description of aggregate trade flows between countries and most importantly provides a transparent link to exchange rates. The model's equilibrium delivers a tight link between trade barriers and trade flows in the form of a gravity equation. Countries that are far from the rest of the world have a large resistance to trade and are isolated from international trade flows.

To understand the behavior of exchange rates we introduce productivity shocks at the country-level which, coupled with households' risk aversion, introduces risk into the international economy. We also depart from complete international asset markets whereby households' across countries cannot fully share the risk they face. Collectively, these essential elements tie together trade flows across countries and exchange rates to provide a theoretical foundation of how trade deals affect the factor structure of exchange rates.

A. Preferences and Technology

There are N countries indexed by i, j, k. To fix ideas, country j is the base country and imports goods from country i and exports to k. Country j has population L_j and an infinitely-lived representative household with time-separable utility with constant relative risk aversion and rate of time preference $\rho > 0$,

$$U_j = \mathbf{E}\left[\int_0^\infty e^{-\rho t} u\left(C_j(t)\right) dt\right], \tag{15}$$

where $u(C) = C^{1-\gamma}/(1-\gamma)$, and labor is employed linearly to produce the country's tradable good with productivity $z_j(t)$.

Countries can trade bilaterally subject to iceberg transportation costs: in order for one unit of i's good to be imported by j, $\tau_{ij} \geq 1$ units must be shipped. We place two restrictions on the trade cost matrix: all diagonal elements equal one, $\tau_{jj} = 1$ for all j; and the triangle inequality, $\tau_{ik} \leq \tau_{ij}\tau_{jk}$ for all i, j, k, which implies that it is never cheaper to ship a good via an intermediate location rather than sell directly to a destination.[9]

Consumers have homothetic preferences over the set of goods produced in countries across the world. If the household in country j consumes the quantity q_{ij} of the good imported from each country i she receives intratemporal utility

$$C_j(t) = \left(\sum_{i=1}^{N} (q_{ij}(t))^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}}. \tag{16}$$

Households' utility C_j is a CES aggregator of all goods imported and produced locally (q_{jj}), and η is the elasticity of substitution between individual goods.

B. Asset Markets and Equilibria

The degree of international risk sharing determines equilibrium allocations. We examine equilibria under polar opposite international asset market structures: financial autarky and complete markets. We describe our approach to modeling intermediate cases of imperfect risk-sharing in Section III. While international markets may not be complete, our representative agent assumption requires us to have complete markets within a country.

Our economy is static and can be casted as a sequence of one-period problems. For notational clarity we ignore dependence on time t when there is no ambiguity or importance.

B.1. Financial Autarky

In financial autarky, households are precluded from trading in international asset markets to smooth consumption. We discuss the firms' problems before turning to households.

Firms maximize profits and choose the optimal quantity of labor to hire given the wage rate w_j. Markets are competitive markets and firms set the domestic price of the tradable good to $p_{jj} = w_j/z_j$.

Let p_{ii} denote the exporter's free on board (f.o.b.) price in country i. Then on a cost-insurance-freight (c.i.f.) basis, we have $p_{ij} = p_{ii}\tau_{ij}$. For each good shipped, from i to j the exporter incurs exports costs equal to $\tau_{ij} - 1$ of country i goods. The exporter passes these costs on to the importer. Thus, the value of imports of j from i is $p_{ij}q_{ij}$, the origin's production value, $p_{ii}q_{ij}$, plus the trade cost $(\tau_{ij} - 1)p_{ii}q_{ij}$ that the exporter passes on.

At each point in time, country j takes prices $\{p_{ij}\}_i$ as given and chooses consumption C_j and the demand for goods $\{q_{ij}\}_i$ to maximize (15) subject to (16) and its budget constraint

$$\sum_{i=1}^{N} p_{ij}q_{ij} = w_j L_j. \tag{17}$$

[9] The trade cost specification is equivalent to the shipping industry being competitive, working at zero profits and solely covering the cost of resources. Greenwood and Hanson (2015) and Ready et al. (2017b) show shipping dynamics influence trade costs and carry trade profits. While the presence of hub-and-spoke networks in global trade suggest that the triangle inequality is not an innocuous assumption and that temporal lags in shipping could be important, we maintain it to impose the no-arbitrage condition present in virtually all of the international finance literature.

We close the model by solving for $\{w_j\}_j$ with the global resource constraint on tradable goods

$$z_j L_j = \sum_{k=1}^{N} \tau_{jk} q_{jk}, \quad \text{for all } j. \tag{18}$$

Walras' law implies that the equilibrium is unique only up to a normalization. We normalize w for the United States to equal 1.

Appendix B gives the complete derivation of the first-order conditions. Under financial autarky, consumption is tightly linked to output, $P_j C_j = w_j L_j$, and trade is balanced as the value of total imports including domestic absorption $\sum_i p_{ij} q_{ij}$ equals the value of total exports $p_{jj} z_j L_j$ for every country.

B.2. Complete Markets

With a complete set of tradable state contingent claims, the central planner chooses an optimal allocation of consumption $\{C_j\}$ and goods $\{q_{ij}\}_i$ for a suitable choice of Pareto weights $\{\lambda_j\}$ for each country's representative household

$$\mathbf{E}\left[\sum_{j=1}^{N} \lambda_j \int_0^{\infty} e^{-\rho t} u\left(C_j(t)\right) dt\right], \tag{19}$$

subject to every country's resource constraint (16) and the global resource constraint (18). We follow Fitzgerald (2012) and interpret λ_j as the inverse of the marginal utility of wealth for country j which equals the inverse of the multiplier on the country's budget constraint in the decentralized economy.

We derive first-order conditions in Appendix B. In contrast to financial autarky, complete markets allow unbalance trade to smooth consumption over time by deviating from output ($P_j C_j \neq w_j L_j$, in general). In particular, a marginal increase of q_{ij} trades off an improvement of j's marginal utility with a tightening of i's global resource constraint.

C. Exchange Rates and Gravity

In equilibrium, household's j demand for differentiated goods follows the CES demand system,

$$q_{ij} = p_{ij}^{-1} \cdot \left(\frac{p_{ij}}{P_j}\right)^{1-\eta} \cdot P_j C_j, \tag{20}$$

which clarifies the determinants of the demand for good q_{ij}: a direct price effect, p_{ij}; a substitution effect through the local price index, $(p_{ij}/P_j)^{1-\eta}$; and an income effect, $P_j C_j$.

In contrast to a Cobb-Douglas specification where $\eta = 1$, if the price of good i, p_{ij}, increases relative to the price index in country j, P_j, households will substitute away from q_{ij} to all the other goods in their consumption basket $\{q_{kj}\}_{k \neq i}$. Thus, a change in a single bilateral trade cost will affect, through substitution, all countries' consumption allocations.

This is evident from the expression for the price index in country j,

$$P_j = \left[\sum_{i=1}^{N} (\tau_{ij} p_{ii})^{1-\eta} \right]^{\frac{1}{1-\eta}}, \tag{21}$$

which depends on the trade costs of all imported goods and doubles as an index of inward bilateral trade costs. Greater trade barriers, and thus higher average prices, reduce a country's consumption for a given income.

The definition of the real exchange rate S_{ij} of i in units of j is standard and equals the ratio of consumption price levels

$$S_{ij}(t) = \frac{\lambda_j(t) u'(C_j(t))}{\lambda_i(t) u'(C_i(t))} = \frac{P_j(t)}{P_i(t)}. \tag{22}$$

Under this ratio, if S_{ij} rises, then j's currency appreciates relative to i's. We emphasize here with the dependence on time t that relative marginal utilities of consumption fluctuate for two reasons. First, asset market frictions imply that the relative marginal utility of wealth, $\lambda_j(t)/\lambda_i(t)$, can vary over time along with output. Second, because trade costs impede risk sharing regardless of asset market structure, relative utility will not be equal. Instead, the real exchange rate, $P_j(t)/P_i(t)$, which summarizes relative trade costs, will comove with output. If, for example, τ_{ij} were equal to one for all i, j, then P_j would become identical across all countries and, in the absence of financial market imperfections, the global economy would achieve perfect risk sharing.

C.1. Gravity and Multilateral Resistance

The gravity framework places inward and outward multilateral resistance as central in determining trade shares and exposures to shocks. We already defined inward resistance in (21). To see outward resistance, we first multiply the global resource constraint in (18) by p_{jj} to give

$$w_j L_j = p_{jj}^{1-\eta} \Pi_j^{1-\eta} \tag{23}$$

and define $\Pi_j^{1-\eta} = \sum_{k=1}^{N} P_k^{\eta-1} \tau_{jk}^{1-\eta} w_k L_k$ as country j's index of outward bilateral trade costs. This index can be thought of as if the country exported its product to a single world market facing a global trade cost of Π_j.

Moving on, by multiplying the CES demand equation by p_{ij} and substituting in (23) we obtain the gravity equation

$$p_{ij} q_{ij} = w_i L_i \times P_j C_j \times \left(\frac{P_j \Pi_i}{\tau_{ij}} \right)^{\eta-1}. \tag{24}$$

The value of imports, $p_{ij} q_{ij}$, depends on the product of countries' outputs ($w_i L_i \times P_j C_j$) and terms due to trade costs. A higher bilateral trade barrier, τ_{ij}, has a direct effect of reducing trade between the two countries. An increase in outward resistance faced by the exporter, Π_i, is accompanied by a decline in its supply price, p_{ii}; for a given τ_{ij}, this grows trade between the two countries. Finally, a rise in the importer's inward resistance lowers the relative price of goods from i, leading to greater trade. Country j's imports from i depend on all resistances, $\{\tau_{ij}\}$, that, in turn, determine the cross-section of currency exposure.

D. Risk and Currency Exposure

We focus on a stationary economy and assume that the vector of productivity for the N countries in the economy follows a mean-reverting process in logarithms. We collect every productivity into a N-vector $z = (z_1, \ldots, z_N)'$ and write the stochastic process

$$d \log z = -\kappa \log z dt + \nu \cdot dB, \tag{25}$$

where $\kappa > 0$ is the rate of mean reversion, ν is a scalar that captures the volatility of productivity, and B is a vector of Brownian motions in $\mathbb{R}^N$ that are independent from each other. With independence of productivity shocks, trade across countries is their only link. The correlation of countries' business cycles will be fully determined by the structure of trade barriers.

Our general equilibrium analysis prevents closed-form solutions to goods' prices. As a way to progress, however, we can specify these prices as a diffusion process

$$dp_{jj} = \mu_j(\{p_{jj}\}_j)dt - \sigma_j(\{p_{jj}\}_j)'dB, \text{ for all } j. \tag{26}$$

In writing this, we highlight the dependence of p_{jj}'s drift and volatility on prices (conditional on parameters) and note a negative productivity shock translates to an increase in prices.

D.1. Exposure to Global Shocks

The log change of currency S_{ij} follows immediately, $d \log S_{ij} = d \log P_j - d \log P_i$. The dynamics of j's consumption price in (21) determines its exposure to the underlying shocks. To understand the risk of exchange rates, which are relative prices, we use Ito's lemma to derive expressions of volatility

$$d \log P_j = \mu^{P_j} dt - \sum_{i=1}^{N} \tau_{ij}^{1-\eta} P_j^{\eta-1} p_{ii}^{-\eta} \sigma_i' dB = \mu^{P_j} dt - \sum_{i=1}^{N} \omega_{ij} \frac{\sigma_i'}{p_{ii}} dB, \tag{27}$$

where the second equality multiplied and divided by p_{ii} and substituted in (23). This equation expresses country j's exposure to imports from i as a weighted function of volatility and prices:

$$\varphi_{ij} = \omega_{ij} \cdot \frac{\sigma_i'}{p_{ii}} = \frac{p_{ij} q_{ij}}{P_j C_j} \cdot \frac{\sigma_i'}{p_{ii}}. \tag{28}$$

Importantly, the weights ω_{ij}, which sum to one across i, correspond to import shares.

Equations (27) and (28) are intuitive—an exposure in import shares translates into an exchange rate exposure—and provides a powerful connection between international trade and finance. Country j's exposure, φ_{ij}, closely relates to the multilateral resistance terms defined in (24) and therefore to the standard gravity equation. As in gravity, larger direct bilateral trade costs attenuate exposure while higher levels of inward or outward resistance amplify it for similar reasons. Exposure, moreover, is greater to larger and highly productive countries, $w_i L_i / p_{ii} = z_i L_i$, as well as those with more price variability, σ_i.

Taking a step back, this expression reproduces the core-periphery structure common to many modern models of international finance. Core countries disproportionately bear more global risk. In bad times, core countries' marginal utilities rise relatively more and their currencies appreciate. From their perspective, peripheral countries' currencies appear risky ex ante as they depreciate in bad times. For example, Hassan (2013) shows large countries are core; Richmond (2019) identifies core countries that serve as hubs to the global trade network, like Netherlands and Singapore.[10] We provide a new link based on gravity, thus tying our work closely to the literature in international trade.

D.2. Base Factors and Other Risk Measures

Given the exposure of global exposure of each country's price index, we are able to relate risk in the model to the empirical measures of exchange rate risk from Section I. As before, the definition of the base factor for country j is the average appreciation of its currency vis-à-vis all others:

$$dbase_j = d\log P_j - \frac{1}{N}\sum_{i=1}^{N} d\log P_i. \tag{29}$$

By defining the vector of exposure for country j, $\varphi_j = (\varphi_{1j}, \ldots, \varphi_{Nj})$, we are able to derive the measures of exchange rate risk based on the country's vectors as a sufficient statistics:

$$\sigma_{ij}^2 = \mathrm{Var}_t(d\log P_j - d\log P_i) = \varphi_j'\varphi_j + \varphi_i'\varphi_i - 2\varphi_i'\varphi_j \tag{30}$$

$$\beta_{ij} = \frac{\mathrm{Cov}_t(d\log P_j - d\log P_i, dbase_j)}{\mathrm{Var}_t(dbase_j)} = \frac{(\varphi_j - \varphi_i)'(\varphi_j - \overline{\varphi})}{(\varphi_j - \overline{\varphi})'(\varphi_j - \overline{\varphi})} \tag{31}$$

$$R_{ij}^2 = \beta_{ij}^2 \times \frac{\mathrm{Var}_t(dbase_j)}{\mathrm{Var}_t(d\log P_j - d\log P_i)} = \beta_{ij}^2 \times \frac{(\varphi_j - \overline{\varphi})'(\varphi_j - \overline{\varphi})}{(\varphi_j - \varphi_i)'(\varphi_j - \varphi_i)} \tag{32}$$

$$\begin{aligned}\rho_{ij} &= \frac{\mathrm{Var}_t(d\log P_j - d\log P_i)}{\mathrm{Var}_t(dbase_j) + \mathrm{Var}_t(dbase_i)} \\ &= \frac{(\varphi_j - \varphi_i)'(\varphi_j - \varphi_i)}{(\varphi_j - \overline{\varphi})'(\varphi_j - \overline{\varphi}) + (\varphi_i - \overline{\varphi})'(\varphi_i - \overline{\varphi})}.\end{aligned} \tag{33}$$

These measures are exact and do not rely on the large N limit required by their empirical counterparts. Consequently, our gravity model naturally generates aggregate shocks from origins that are granular (Gabaix, 2011).

These measures, moreover, allow us to define endogenously a core country if $\varphi_j > \overline{\varphi}$ and peripheral if $\varphi_j < \overline{\varphi}$ as $\overline{\varphi}$ is determined within equilibrium. For this reason, our model is unable to identify a general and absolute decline in global risk exposure, similar to how trade models cannot identify a uniform reduction in trade barriers and can only speak to relative changes. Under this definition, the β of a peripheral country i from the perspective of a core country j will have a value greater than one. Thus when looking at currency returns from the perspective of core countries, peripheral countries will, on average, have high base factor loadings.

[10] Corte et al. (2016) show net creditors of external liabilities as core, Ready et al. (2017a) depict core countries as those that tend to export final goods and import commodities, and Colacito et al. (2018a) link core exposure to global growth news shocks.

III. Structural Estimation and Main Model Predictions

Having described the theoretical model in Section II, we now turn to structurally estimating trade costs and evaluating model predictions before using it to examine counterfactuals in Section IV.

A. Structural Estimation of Trade Costs

We conduct our structural estimation under financial autarky, as this asset structure obviates the choices of a planner's Pareto weights and risk aversion. We do, however, need to choose productivity levels and the elasticity across goods, η. We put productivity at $z_j = 1$ for all j. Prior work places the elasticity parameter in the range of five to ten (Anderson and van Wincoop (2004)) and we set $\eta = 6$.[11]

Rather than employ the gravity equation, which is currency dependent, we use import shares, ω_{ij} defined in (28), in our estimation that are normalized by the output of the importing country. Normalizing by output makes shares invariant to sample selection, whereas normalizing by the sample's total imports would not. We normalize the US's GDP to one by setting L_j to one. (Recall that $w_j = 1$ for $j = USA$; hence $w_j L_j = 1$.)

Given this setup, we estimate τ_{ij} for all i and j by minimizing the distance between the model's and the data's import shares and GDP with an algorithm based on tatonnement. During estimation, we enforce the diagonal of the matrix to one and the triangle inequality: for every i, j, k, we find the minimum triad across τ_{ij}, τ_{ik}, and τ_{jk} and set the minimum to satisfy the inequality by equating it with the sum of the other elements in the triad.

Figure 3 depicts the outcome. Indirectly targeted moments are domestic absorption, $\omega_{jj} = 1 - \sum_{i \neq j} \omega_{ij}$, and imports in US dollars. All targets, both direct and indirect, possess high correlations of 0.87 and over as seen in each panel. A discrepancy between model and data is that in the data imports are gross measures while GDP is value-added, so in the data domestic absorption can be negative.[12]

We summarize the trade cost estimates in Table 7. The mean of average costs, $(\sum_i \tau_{ij} - 1)/N$, is 1.75, close to the 170 percent barrier estimated in Anderson and van Wincoop (2004) as representative of all transport, border-related, and local distribution costs. In general, import and export trade costs are lower for most developed countries. Measures of resistance that adjust for equilibrium prices portray China, Japan, and the US as possessing the smallest averages of inward and outward resistance.

[11] Armington and CES assumptions are widely used in the trade literature in spite of a well-known shortcoming: the elasticity of substitution across goods needs to be high to have trade costs materially affect trade. A more recent strand of work (for example Melitz (2003) and Chaney (2008), among others) identifies the size or productivity distribution of firms as material to trade barriers and trade and creates an important role for the extensive margin to affect trade. All of these models, however, generate similar implications for welfare (Arkolakis, Costinot and Rodríguez-Clare, 2012).

[12] Previous work scales the import share's numerator or denominator; for example, Fitzgerald (2012) scales GDP by two to form gross output. Value-added exports represent about 73 percent of gross exports and trade in intermediate goods accounts for around two-thirds of international trade (Johnson and Noguera, 2012).

A.1. Remaining Calibration and Discussion of Asset Market Structure

We now complete the remaining calibration of our model. While our economy does not grow over time, it does fluctuate with the underlying productivity shocks that result in business cycles. We set $\kappa = 0.385$ to target a half-life of output gaps of $\log(2)/\kappa = 1.8$ years, near the range provided in Chari, Kehoe and McGrattan (2000) of between 2 and 2-1/2 years in the United States. We jointly set $\gamma = 7$ and $\sigma = 0.45$ to match consumption and exchange rate volatility.

We then simulate our economy many times over a time period that matches the length of our data sample and average over the simulated moments. Consumption and output are time-aggregated from a monthly to an annual frequency. Table 8 summarizes our work that targets informative moments standard to asset pricing, international macroeconomics, and international finance.

First, complete markets generate a consistent ordering of consumption and currency volatility to the data. Financial autarky fully exposes countries to productivity shocks, resulting in consumption volatility several times larger than in the data. As stressed in Backus et al. (1992), in complete markets cross-country consumption correlations exceeds those of output correlations, which is counterfactual to the data.

Related is the Backus-Smith puzzle: under the additional assumption of constant relative risk aversion, a regression of exchange rate changes on relative consumption growth yields a slope coefficient equal to γ. This puzzle is seen simply by rearranging (22) under constant λ_j's:

$$d \log S_{ij} = \gamma(d \log C_i - d \log C_j) \tag{34}$$

At the heart of these puzzles is the connection between quantities and prices, which are functions of risk. Complete markets allocate risk to those countries who are best suited to bear it and, as a result, core countries often exhibit greater variation in marginal utility than do peripheral ones. This, by itself, seems unintuitive as asset market frictions and volatility are problems commonly thought of being concentrated in developing economies. Nevertheless, a well-known phenomenon of financial markets is that during bad times, the US dollar appreciates, even if those bad times originate in the US.

Several approaches in the literature have been used to resolve these puzzles. For example, Colacito and Croce (2011) employ recursive preferences, Hassan (2013) uses restricted participation in asset markets, and Pavlova and Rigobon (2012) make markets incomplete.[13]

Our approach lets Pareto weights deviate linearly from the constant vector achieved under complete markets to the vector that varies under financial autarky:

$$\widehat{\lambda}_j(t) = (1 - \phi_j)\lambda_j(t) + \phi_j \lambda_j, \tag{35}$$

where $\phi_j \in [0, 1]$ indexes market completeness. We first calculate Planner weights as an output of the structural estimation: $\lambda_j = P_j / C_j^{-\gamma}$. We then implement (35) by solving the financial autarky model for a path of productivity shocks and then, for each realization of $\lambda_j(t)$ along the path, we resolve the complete markets economy using $\widehat{\lambda}_j(t)$ rather than λ_j.

[13] Additionally, Alvarez, Atkeson and Kehoe (2002), Chien, Lustig and Naknoi (2015), Dou and Verdelhan (2015) use segmented markets and Chari et al. (2000), Gabaix and Maggiori (2015), and Favilukis, Garlappi and Neamati (2015) also assume incomplete markets.

In this way we adopt Basak and Cuoco's (1998) insight that a complicated problem of restricted stock market participation can instead be solved by allowing Pareto weights, $\lambda_j(t)$, to vary over time, as in incomplete markets. While parameterizing ϕ_j to a priori features of countries seems reasonable, our goal is simply to weaken the dependence between prices and quantities. We choose, therefore, a single value $\phi_j = \phi = 0.95$ that creates the correct ordering of average cross-country consumption and output correlation and average consumption and currency volatility.

The model's Backus-Smith coefficient is obtained by a pair-wise average. In complete markets it should be identical to γ yet we see that time aggregation lowers its magnitude.

B. Main Model Predictions

In this section, we look at the main predictions of the model that connect trade and systematic risk. They are depicted in Figure 4.

First, we confirm that trade costs capture distance and generally increase along with the risk exposure as measured by base loadings. Panel A is a scatter plot of the average beta across simulations, β_{ij}, on the elements, τ_{ij}, of the trade cost matrix. Countries that are further apart tend to have a greater difference in exposure.

In Panel B we scatter each country's import exposure (in logs), φ_{ij}, on the trade cost matrix and shows a negative relationship. Intuitively, a country's import exposure declines with distance. The figure also shows that core countries, those with high average import exposures, generally have lower average trade costs.

As a step towards giving further insight we calculate $\overline{R_j^2} = \sum_{i \neq j} R_{ij}^2/(N-1)$. This is a measure of *outward* systematic risk that answers, "How much systematic risk do I typically face as a currency investor in country j?" We see this measure positively correlates with average trade costs, $\overline{\tau}_j = \sum_{i \neq j} \tau_{ij}/(N-1)$, in Panel C. Core countries are acutely exposed to systematic risk, so when looking out to the periphery they see very little. In contrast, peripheral countries, which face high inward trade costs, see a great deal when looking into the core.

Altogether, when looking out core countries see low R-squareds but high betas. When an adverse global shock hits, marginal utilities rise more in core countries, appreciating their currencies, especially with respect to the most peripheral countries. Thus an appreciation in j's base factor corresponds with a big appreciation of S_{ij} for distant i—high betas. This is because peripherals are relatively less exposed to the global shock—low R-squareds.

This observation is corroborated in Panel D where we define j's total import exposure as $\sum_{i \neq j} \varphi_{ij}$, which is effectively the volatility term of exchange rates in (27) less domestic absorption exposure φ_{jj}. Because productivity volatility is constant across countries, total import exposure is like a variance decomposition of exchange rates. The scatter shows that core countries tend to possess the highest total import exposures. This translates into core countries having the greatest exposure to global shocks and displaying the most correlated currency movements. Put differently, there is a large common component of exchange rate risk among core countries. Most of peripheral countries' exchange rates, by contrast, are driven by country-specific shocks.

IV. Counterfactuals

Having calibrated the model, in this section we run two counterfactuals. The first replicates our empirical method in the model and compare the model's and the data's predictions for systematic risk. The second counterfactual implements a US-China trade war and studies in particular how it affects peripheral countries.

A. Bilateral Reductions in Trade Costs

The empirical results of Section I showed that a typical trade deal raises imports by 50 percent over five years and reduces systematic risk by a third of a standard deviation across countries. Here, we replicate the first stage and look at the model's predictions for the second stage. Comparing in this way allows an independent test of the model's efficacy in matching the data.

We implement the first stage by adjusting bilateral trade costs to generate a 50 percent growth in imports across two countries i and j. We then compare the average change in risk measures across all $N(N-1)/2$ bilateral pairs.

The rows spanned by Before in Panel A in Table 9 summarizes the mean and standard deviation across countries in the model. In comparison to the empirical moments in Table 1, the model generates less dispersion than in the data, possibly because the data figures reflect changes in nominal prices not present in the real model. The ranking of variation across risk measures is consistent, however, as in both model and data factor loadings and shares of systematic risk are the greatest variation.

Rows listed After show the average change across all bilateral pairs after implementing the first stage in the model. In accordance with our empirical results, all four risk measures decline. The shifts range from 0.067 up to 0.179 of a standard deviation. In general, the shifts are less marked in the model.

In Panel B, we split the global economy into core and peripheral countries based on their relation to $\overline{\varphi}$, the model's endogenous average exposure to global risk. Consistent with the empirical results in Appendix Tables A.6–A.9 the effects of a trade deal are concentrated among peripheral countries. Countries that are initially the most risky benefit the most by the reduction in trade costs.

Why these effects concentrate on the peripheral derives from the gravity equation. The structural equation places a nonlinear relationship between multilateral resistance and import shares. Peripheral countries, which initially face the greatest trade costs, undergo the biggest drop in resistance. Altogether, the counterfactual highlights that poorer countries benefit disproportionately more than do rich countries from a decline in trade costs. That trade has an first-order effect on currency risk should not be understated.

B. A US-China Trade War

The recent decade has seen China becoming a budding superpower and emerging as a key player in global trade, and not without dispute. The recent trade war between the United States and China saw American average tariffs rise to 17.5 from 2.6 percent and a Chinese retaliation of going from 6.2 to 16.4 percent (Bekkers and Schroeter, 2020). Within categories of goods, we witnessed extremes and, as an example, watched Chinese imports of American soybeans fall to zero.

Tariffs, however, constitute only a portion of total trade costs in our model that are much more comprehensive. As a reasonable counterfactual we raise bilateral trade costs by 50 percent and see what an escalation into a severe war would look like. Table 10 tabulates the aftermath.

Panel A shows the impact on the United States and China. Import shares between countries fall drastically, but because their bilateral imports are relatively small to each country's output, measures of resistance are largely unchanged. Thus their size insulates them from damage.

On measures of risk, both countries fare worse. A currency investor contemplating the US or China views both countries as systematically riskier, a change concentrated on China. Risk sharing, moreover, has worsened across the bilateral pair.

Panel B reports the effects in percent change on countries peripheral to the US—Canada, Mexico, and the United Kingdom—and China—Korea, Malaysia, and Singapore. The trade war increases the outward resistance of all of these trading partners, thus lowering their output prices. Because most consumption is from domestic sources, their inward price index, on net, falls. The overall effect on the price level is small across countries and does not exceed a one percent change.

Canadian, Mexican, and British exports to China, $\omega_{i,CHN}$, and Chinese imports into these countries, $\omega_{CHN,j}$, expand to replace the void created by the US. A similar story plays out for the three Asian peripherals: because their output price has fallen, the US and China imports more from them.

Turning to risk, all six countries' average inward currency volatility rises and is matched by a relatively large increases in their systematic risk: American and Chinese investors in these six countries face higher R-squareds on average. Because of the trade war of two large countries, risk-sharing across all has also worsened on average.

Overall, the US-China trade war does not have a material effect on its initiators. Instead, the peripheral countries that depend on these giants bear collateral damage and the brunt of the war.

V. Conclusion

We provide direct evidence of a strong, temporal link between fundamentals and currency prices by refocusing our empirical work towards the exchange rate factor structure and away from simply changes in exchange rates. Key to uncovering this connection in our paper is the use of trade deals as an instrument for trade.

The typical deal raises bilateral imports across both countries by 50 percent over five years and leads to a reduction in all measures of exchange rate systemic risk: base loadings, the share of systematic risk, and our new measure of unshared risk fall by, generally, a third relative to the standard deviation across countries.

We use a structural model that generates a gravity equation to estimate trade costs and use it to replicate our first stage and see where the benefits of trade deals concentrate. In this exercise, we find that peripheral countries, which are often poorer, disproportionately benefit from trade deals through significant reductions in the systematic risk of their currencies.

Finally, in our counterfactual of a severe US-China trade war, we corroborate this lesson and find that countries peripheral to the United States and China suffer collateral damage and bear its brunt.

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Table 1. Summary Statistics Across Countries

	Observations	Mean	Median	Std. Dev.
Risk Measures				
Base Loading, β	49,038	1.027	0.996	0.772
Share of Systematic Risk, R^2	49,038	0.498	0.493	0.312
Volatility, σ	51,944	0.148	0.120	0.126
Unshared Risk, ρ	50,950	0.920	0.965	0.307
Trade Variables				
Imports (billions of USD)	87,192	6.046	0.587	27.44
Imports, five-year difference (billions of USD)	76,175	1.599	0.126	8.807
Imports, ten-year difference (billions of USD)	66,349	3.573	0.373	15.65
Imports, as a share of GDP	73,978	0.024	0.005	0.067
CUCMECU	103,500	0.096	0.000	0.295
FTA	103,500	0.122	0.000	0.327
TWPTA	103,500	0.039	0.000	0.193
OWPTA	103,500	0.160	0.000	0.367

This table summarizes statistics of nominal exchange rates and trade at the country level.
Base loadings and R-squareds are estimated from the regression in (4).
The import shares are estimated from IMF and CEPII data over the period 1973–2019.
Trade deals are divided in four different levels of economic integration as in (Baier and Bergstrand, 2007): customs unions, common markets, and economic unions (CUCMECU), free trade agreement (FTA), one-way and two-way preferential trade agreement (OWPTA and TWPTA).

Table 2. Change in Imports with Trade Deals

	$\Delta_{t,t+h}$ log Imports, by window			
	(1)	(2)	(3)	(4)
	5-year	5-year	10-year	10-year
After Trade Deal	0.525***	0.506***	0.725***	0.699***
	(0.015)	(0.015)	(0.018)	(0.018)
Distance	-0.000*		-0.000*	
	(0.000)		(0.000)	
Common Border	1.311***		1.289***	
	(0.257)		(0.253)	
Common Language	0.400		0.388	
	(0.258)		(0.255)	
Colonial Link	-0.012		-0.027	
	(0.356)		(0.343)	
Common Legal	0.620***		0.619***	
	(0.159)		(0.156)	
Constant	20.254***	20.358***	20.306***	20.390***
	(0.155)	(0.007)	(0.154)	(0.009)
Country pair f.e.	N	Y	N	Y
Year of deal f.e.	Y	Y	Y	Y
Observations	1,416	1,444	1,416	1,444
R-squared	0.356	0.991	0.357	0.986
F-statistic	229.6	1194.2	296.9	1542.5

This table reports the regression result of the change in log imports of base from foreign country around a trade deal over a five-year window in columns (1) and (2) and 10-year window in columns (3) and (4). The coefficient for "After Trade Deal" is interpreted in log changes from the average log value as expressed in the constant.

Trade deals are defined here as a change in any kind of bilateral agreement to a stronger FTA or CUCMECU deal (see Section B).

Columns (1) and (3) controls for gravity variables from CEPII, Columns (2) and (4) control for country-pair fixed effects. All regressions have a year-of-trade-deal fixed effect.

The sample period is 1973–2019 for 45 countries.

Standard errors are clustered at base-foreign country level. ***, **, and * indicate significance at the 1, 5, and 10 percent level, respectively

Table 3. First Stage: Trade and Trade Deals

	$\Delta_{t+5,t}$ log Imports			
	(1)	(2)	(3)	(4)
$\Delta_{t,t-5}$CUCMECU	0.18***	0.162***	0.171***	0.173***
	(0.036)	(0.039)	(0.034)	(0.035)
$\Delta_{t,t-5}$FTA	0.108***	0.133***	0.139***	0.145***
	(0.026)	(0.026)	(0.022)	(0.022)
$\Delta_{t,t-5}$TWPTA	-0.005	-0.045		
	(0.063)	(0.064)		
$\Delta_{t,t-5}$OWPTA	0.035	0.015		
	(0.029)	(0.03)		
$\Delta_{t-5,t-10}$ log Imports	-0.206***	-0.238***	-0.238***	-0.238***
	(0.027)	(0.026)	(0.026)	(0.026)
Gravity controls	Y	–	–	–
Country-pair f.e.	N	Y	Y	Y
Country-year f.e.	Y	Y	Y	Y
Exchange rate regime	All	All	All	No Pegs
Observations	65,178	65,178	65,178	63,955
R-squared	0.298	0.36	0.36	0.362

This table shows the estimates of a first stage OLS regression of log imports on trade agreement dummies. All regressions control for country-time fixed effects. Column (1) controls for gravity variables. In columns (2) through (4), the gravity variables are replaced by country-pair fixed effects. Column (4) also removes pegged currencies.

Standard errors are clustered at base-foreign country level. ***, **, and * indicate significance at the 1, 5, and 10 percent level, respectively.

Table 4. Time Effects of Trade Deal Change. Staggered Difference-in-Difference Regression.

Timing	Log Imports β	s.e.	Volatility, σ β	s.e.	Unshared Risk, ρ β	s.e.	R-squared β	s.e.	Base Loading, β β	s.e.
−10	−0.112**	(0.052)	0.002	(0.002)	0.041**	(0.018)	0.029*	(0.016)	0.127	(0.079)
−9	−0.121**	(0.05)	−0.002	(0.002)	0.026	(0.02)	0.021	(0.017)	0.091	(0.064)
−8	−0.116**	(0.049)	0	(0.002)	0.041**	(0.019)	0.033**	(0.016)	0.108**	(0.055)
−7	−0.133***	(0.046)	0	(0.002)	0.028	(0.02)	0.018	(0.016)	0.088*	(0.049)
−6	−0.107**	(0.045)	0.002	(0.002)	0.057***	(0.021)	0.036*	(0.019)	0.107**	(0.043)
−5	−0.11***	(0.043)	0.001	(0.002)	0.03	(0.019)	0.023	(0.016)	0.073*	(0.043)
−4	−0.133***	(0.04)	0.002	(0.002)	0.036**	(0.016)	0.021	(0.014)	0.058*	(0.031)
−3	−0.109***	(0.037)	0.006***	(0.002)	0.049***	(0.015)	0.035***	(0.013)	0.069***	(0.027)
−2	−0.113***	(0.029)	0.002	(0.001)	0.036***	(0.014)	0.018*	(0.011)	0.044**	(0.02)
−1	−0.059**	(0.026)	0.001	(0.001)	0.033***	(0.011)	0.016*	(0.009)	0.035**	(0.016)
1	0.043**	(0.021)	−0.001	(0.001)	−0.018***	(0.005)	−0.006	(0.006)	−0.008	(0.014)
2	0.082***	(0.025)	−0.001	(0.001)	−0.016**	(0.008)	−0.004	(0.007)	−0.009	(0.014)
3	0.113***	(0.031)	−0.001	(0.001)	−0.019*	(0.011)	−0.007	(0.01)	−0.026*	(0.016)
4	0.182***	(0.033)	−0.002	(0.001)	−0.027**	(0.014)	−0.012	(0.012)	−0.04**	(0.019)
5	0.203***	(0.035)	−0.002	(0.001)	−0.008	(0.014)	−0.006	(0.012)	−0.031	(0.02)
6	0.274***	(0.041)	−0.004**	(0.002)	−0.035**	(0.017)	−0.024*	(0.014)	−0.069***	(0.024)
7	0.339***	(0.046)	−0.006***	(0.002)	−0.055***	(0.017)	−0.037***	(0.014)	−0.101***	(0.025)
8	0.359***	(0.048)	−0.013***	(0.002)	−0.151***	(0.02)	−0.088***	(0.015)	−0.214***	(0.028)
9	0.35***	(0.049)	−0.013***	(0.002)	−0.135***	(0.019)	−0.08***	(0.014)	−0.213***	(0.038)
10	0.409***	(0.053)	−0.013***	(0.002)	−0.122***	(0.019)	−0.075***	(0.014)	−0.206***	(0.039)
Observations	64,728		39,964		36,706		38,069		38,083	
R-squared	0.857		0.971		0.292		0.676		0.637	

This table reports coefficients from a staggered difference-in-difference regression as in (12). The deal dummy equals one if countries i and j share either an FTA or a CUCMECU and zero otherwise. The set of control variables $X_{ij,t}$ includes gravity variables, time fixed effects, and the deal dummy. All time coefficients are deviations in $y_{ij,t}$ from the exact year of the trade deal change.

Table 5. Second Stage: Effect of Trade on Exchange Rate Risk

	Panel A: Volatility, σ					
	Five-year change			Ten-year change		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_{t,t-5} \log \widehat{\text{Imports}}$	-0.013*	-0.038***	-0.023***	-0.013**	-0.016**	-0.01*
	(0.008)	(0.013)	(0.009)	(0.007)	(0.006)	(0.005)
$\Delta_{t-5,t-10} \log \text{Imports}$	-0.003	-0.009***	-0.005**	0.001*	0	0
	(0.002)	(0.003)	(0.002)	(0.001)	(0.001)	(0)
Gravity Controls	Y	–	–	Y	–	–
Country pair f.e.	N	Y	Y	N	Y	Y
Country-year f.e.	Y	Y	Y	Y	Y	Y
Exchange rate regime	All	All	No Pegs	All	All	No pegs
Observations	32,499	32,499	31,845	18,614	18,614	18,072
First stage F-statistic	11.3	8.03	9.96	9.13	11.2	12.4
	Panel B: Unshared Risk, ρ					
	Five-year change			Ten-year change		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_{t,t-5} \log \widehat{\text{Imports}}$	-0.285***	-0.426***	-0.253***	-0.24***	-0.274***	-0.174**
	(0.109)	(0.146)	(0.094)	(0.091)	(0.091)	(0.068)
$\Delta_{t-5,t-10} \log \text{Imports}$	-0.057**	-0.098***	-0.057**	0.023**	0.002	0.002
	(0.024)	(0.035)	(0.023)	(0.01)	(0.009)	(0.006)
Gravity Controls	Y	–	–	Y	–	–
Country pair f.e.	N	Y	Y	N	Y	Y
Country-year f.e.	Y	Y	Y	Y	Y	Y
Exchange rate regime	All	All	No Pegs	All	All	No pegs
Observations	31,743	31,743	31,093	18,288	18,288	17,746
First stage F-statistic	10.3	8.21	10.2	9.37	11.2	12.4

This table shows the instrumental variable regressions of volatility (Panel A) and unshared risk (Panel B) on the change in imports, instrumented using trade deals. Columns (1) through (3) report the five-year change in volatility and columns (4) through (6) the 10-year change.

Controls include pre-trends, country-year fixed effects for both countries, gravity variables in columns (1) and (4), and country-pair fixed effects in columns (2), (3), (5), and (6). In columns (3) and (6) we remove pegged currencies.

We report standard errors clustered at the country-pair level in parentheses and the first-stage Cragg-Donald F-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent level, respectively.

Table 6. Second Stage: Effect of Trade on Common Factor Regressions

	Panel A: Base Loading, β					
	Five-year change			Ten-year change		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_{t,t-5} \log \widehat{\text{Imports}}$	-0.374**	-0.411**	-0.269**	-0.35***	-0.355***	-0.264**
	(0.153)	(0.172)	(0.134)	(0.123)	(0.13)	(0.112)
$\Delta_{t-5,t-10} \log \text{Imports}$	-0.07**	-0.091**	-0.058*	0.031**	0.003	0.003
	(0.032)	(0.041)	(0.032)	(0.014)	(0.012)	(0.009)
Gravity Controls	Y	–	–	Y	–	–
Country pair f.e.	N	Y	Y	N	Y	Y
Country-year f.e.	Y	Y	Y	Y	Y	Y
Exchange rate regime	All	All	No Pegs	All	All	No pegs
Observations	30,478	30,478	29,868	18,083	18,083	17,545
First stage F-statistic	10.6	8.18	10.1	9.89	11.2	12.4
	Panel B: Share of Systematic Risk, R^2					
	Five-year change			Ten-year change		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_{t,t-5} \log \widehat{\text{Imports}}$	-0.204***	-0.251***	-0.153**	-0.145***	-0.159***	-0.105**
	(0.074)	(0.091)	(0.064)	(0.055)	(0.057)	(0.047)
$\Delta_{t-5,t-10} \log \text{Imports}$	-0.04**	-0.058***	-0.035**	0.013**	0.002	0.002
	(0.016)	(0.022)	(0.015)	(0.006)	(0.005)	(0.004)
Gravity Controls	Y	–	–	Y	–	–
Country pair f.e.	N	Y	Y	N	Y	Y
Country-year f.e.	Y	Y	Y	Y	Y	Y
Exchange rate regime	All	All	No Pegs	All	All	No pegs
Observations	30,470	30,470	29,862	18,081	18,081	17,545
First stage F-statistic	10.6	8.17	10.1	9.89	11.2	12.4

This table shows the instrumental variable regressions of the slope coefficient (Panel A) and R-squared (Panel B) from equation (4) on the change in imports, instrumented using trade deals. Columns (1) through (3) report the five-year change in volatility and columns (4) through (6) the 10-year change.

Controls include pre-trends, country-year fixed effects for both countries, gravity variables in columns (1) and (4), and country-pair fixed effects in columns (2), (3), (5), and (6). In columns (3) and (6) we remove pegged currencies.

We report standard errors clustered at the country-pair level in parentheses and the first-stage Cragg-Donald F-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent level, respectively.

Table 7. Structurally Estimated Trade Costs by Country

	Average Import Trade Costs	Average Export Trade Costs	Inward Resistance	Outward Resistance
Australia	1.95	1.72	1.23	1.28
Austria	1.86	1.72	1.24	1.37
Belgium	0.81	1.27	0.98	1.35
Brazil	2.18	1.73	1.22	1.23
Canada	1.88	1.65	1.11	1.23
Chile	2.28	2.03	1.42	1.47
China	1.70	1.37	1.08	1.13
Colombia	2.52	2.30	1.43	1.44
Czech Republic	1.38	1.77	1.11	1.47
Denmark	1.80	1.71	1.27	1.39
Egypt	1.78	2.30	1.34	1.47
Finland	1.86	1.69	1.31	1.42
France	1.56	1.34	1.09	1.17
Germany	1.31	1.02	1.05	1.13
Greece	2.04	2.27	1.35	1.41
Hungary	1.63	1.80	1.26	1.51
India	1.99	2.05	1.23	1.25
Indonesia	2.11	2.04	1.30	1.35
Ireland	1.50	1.75	1.16	1.45
Israel	1.79	2.02	1.31	1.45
Italy	1.58	1.35	1.12	1.19
Japan	1.74	1.39	1.05	1.09
Korea	1.58	1.49	1.14	1.28
Malaysia	1.22	1.70	1.06	1.45
Mexico	2.10	2.02	1.19	1.27
Netherlands	0.82	1.34	0.95	1.29
New Zealand	2.29	2.09	1.43	1.49
Norway	1.98	1.89	1.29	1.38
Peru	2.58	2.10	1.51	1.51
Philippines	1.88	2.15	1.31	1.47
Poland	1.83	1.91	1.27	1.38
Portugal	1.88	2.08	1.30	1.44
Qatar	2.38	1.98	1.51	1.55
Russia	1.78	1.85	1.16	1.20
Singapore	0.87	1.50	0.97	1.46
South Africa	1.99	1.74	1.34	1.40
Spain	1.67	1.73	1.17	1.25
Sweden	1.70	1.47	1.22	1.34
Switzerland	1.41	1.45	1.13	1.33
Thailand	1.62	1.73	1.23	1.42
Turkey	1.94	2.08	1.28	1.34
United Kingdom	1.34	1.29	1.07	1.17
United Arab Emirates	1.49	1.99	1.23	1.43
United States	1.57	1.29	0.96	1.00
Mean	1.75	1.75	1.21	1.34
Standard Deviation	0.40	0.32	0.14	0.13

This table show the results of the structural estimation of trade costs under financial autarky (balanced trade). The estimation of the gravity model of Section II targets averages of output and import shares in the data. Figure 3 depicts the estimation's fit.

Table 8. Summary of Calibration

Panel A: Calibration			
Description	Parameter	Value	Target/Source
Elasticity between goods	η	6	Anderson and van Wincoop (2004)
Mean reversion of productivity	κ	0.385	Output gap half-life
Risk aversion	γ	7	Consumption and currency volatility
Productivity volatility	σ	0.45	

Panel B: Moments (Annual)				
	Data (95% CI)	Financial Autarky $\phi = 0$	$\phi = 0.95$	Complete Markets $\phi = 1$
Consumption volatility	(0.033, 0.036)	0.141	0.035	0.028
Currency volatility	(0.152, 0.160)	0.019	0.117	0.147
Cross-country consumption correlation	(0.119, 0.140)	0.023	0.315	0.888
Cross-country output correlation	(0.206, 0.227)	0.029	0.427	0.448
$\widehat{\lambda}(t)$ volatility		0.289	0.116	0
Backus-Smith coefficient	(-1.341, 1.475)	0.044	0.994	4.980

This table summarizes the calibration of the gravity model outlined in Section II. All data moments in Panel B are real and are reported as 95 percent confidence intervals corrected for cross-sectional correlation.

The model is simulated monthly over a time period that matches the length of our data sample and consumption and output are time-aggregated to annual observations. The inverse of the marginal utility of wealth across all countries is $\widehat{\lambda}(t)$ from (35).

The Backus-Smith coefficient is the slope coefficient of a regression of annual changes of exchange rates on an intercept and annual changes in relative consumption growth as in (34).

Table 9. Bilateral Reduction in Trade Costs

Panel A: Average Effects					
	Statistic	Volatility σ	Factor Loading β	Systematic Share R^2	Unshared Risk ρ
Before	Mean	0.117	1.000	0.515	0.720
	Stdev	0.035	0.355	0.258	0.090
After	Mean	0.106	0.938	0.498	0.704
Difference		-0.011	-0.062	-0.017	-0.016
Fraction of Stdev		0.315	0.175	0.067	0.179
Panel B: Conditional Effects					
Core	Statistic	Volatility σ	Factor Loading β	Systematic Share R^2	Unshared Risk ρ
Before	Mean	0.078	0.966	0.504	0.701
	Stdev	0.021	0.381	0.258	0.114
After	Mean	0.077	0.936	0.495	0.692
Difference		-0.002	-0.029	-0.009	-0.009
Fraction of Stdev		0.073	0.077	0.037	0.083
Peripheral					
Before	Mean	0.137	1.006	0.514	0.710
	Stdev	0.033	0.234	0.209	0.076
After	Mean	0.131	0.942	0.488	0.690
Difference		-0.006	-0.064	-0.026	-0.021
Fraction of Stdev		0.188	0.274	0.126	0.275

This table shows the results of a counterfactual simulation that changes trade costs to match a 50 percent growth in imports across two countries. We do this for each bilateral pair, $N(N-1)/2$ times, and track the average change across these pairs as After. We compare these to Before where we report the mean and standard deviation across countries.

Table 10. A US-China Trade War

Panel A: Effects on United States and China				
	United States		China	
Variable	Before	After	Before	After
Net Trade Cost, $\tau - 1$	0.947	1.420	1.242	1.860
Inward Resistance, P	0.973	0.976	1.224	1.258
Outward Resistance, Π	1.028	1.028	1.022	1.017
Import Share, ω	0.026	0.011	0.080	0.031
Systematic Risk, R^2	0.644	0.670	0.492	0.621
Unshared Risk, ρ	0.739	0.786	0.739	0.786

Panel B: Effects on Peripheral Countries, in Percent Change						
	Canada	Mexico	UK	Korea	Malaysia	Singapore
Trade Variables						
P_j	-0.12	-0.20	-0.24	-0.02	-0.09	-0.15
Π_j	0.09	0.29	0.55	0.33	0.29	0.16
$\omega_{USA,j}$	-0.12	-0.60	-0.20	1.90	1.35	0.86
$\omega_{CHN,j}$	8.35	7.42	2.22	0.12	-0.10	0.49
$\omega_{i,USA}$	2.90	1.54	3.40	5.41	10.59	6.84
$\omega_{i,CHN}$	22.42	25.86	21.66	16.56	13.22	14.63
Risk Measures						
$\overline{\sigma}_j$	2.23	2.22	4.84	1.22	2.32	2.14
$R^2_{i,USA}$	22.51	11.93	-1.55	3.70	0.78	0.25
$R^2_{i,CHN}$	21.96	23.51	4.79	14.41	5.32	3.50
$\rho_{i,USA}$	-1.01	0.91	-1.44	3.31	2.44	2.73
$\rho_{i,CHN}$	5.76	6.77	2.35	9.58	6.35	7.22

This table shows the results of a counterfactual US-China trade war where bilateral trade costs between the United States and China are raised by 50 percent. In Panel A, the values of import share, systematic risk, and unshared risk are with respect to the other country. In Panel B, average bilateral volatility is $\overline{\sigma}_j = \sum_{i \neq j} \frac{\sigma_{ij}}{N-1}$

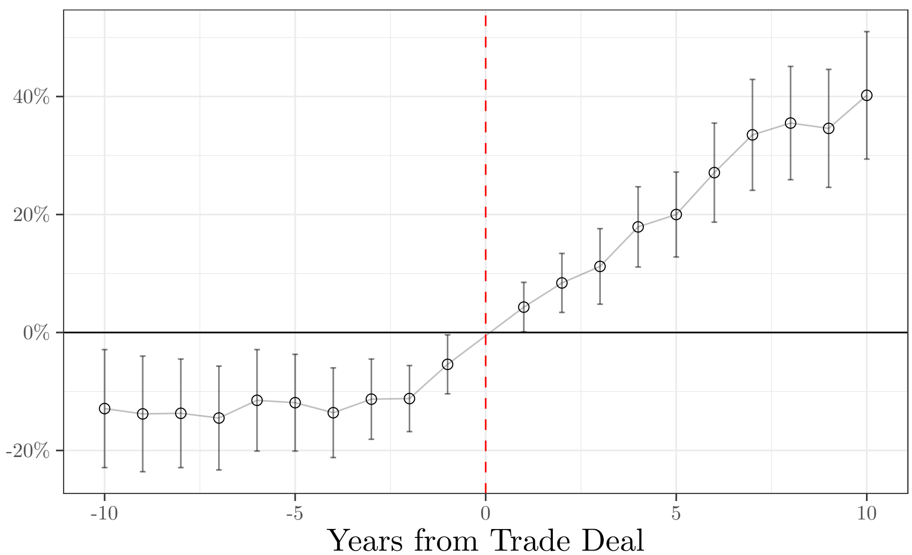

Figure 1. Change in Log Imports Around Trade Agreements.

This figure plots the estimates of our staggered difference-in-difference regression in (12) with trade as the dependent variable. We compare for each year around a trade deal country-pairs with and without an agreement. The regression includes domestic and foreign country-year fixed effects and the standard gravity controls described in Table 2. Our trade deal variable equals one if countries have a FTA or a CUCMECU and is zero otherwise.

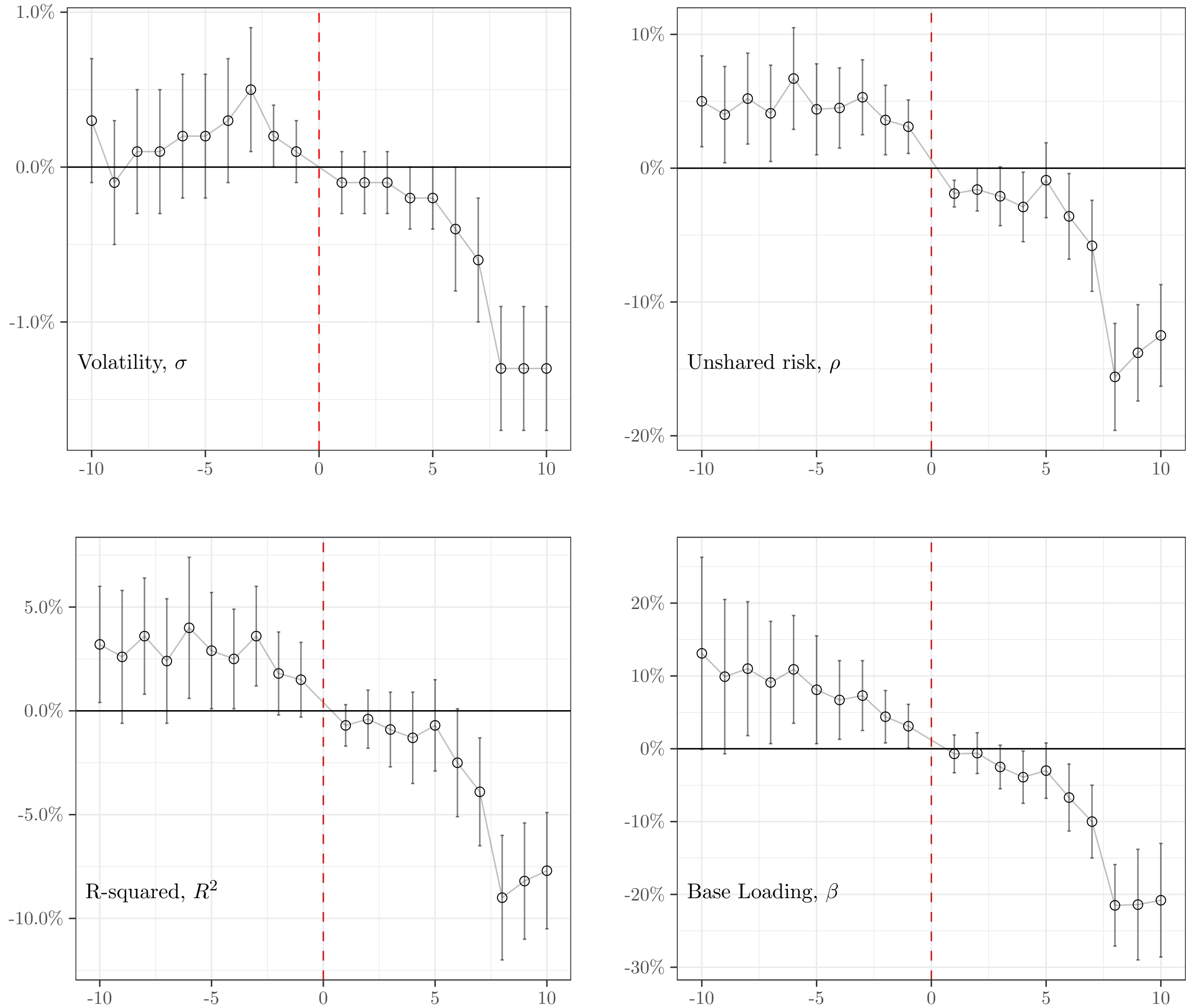

Figure 2. Change in Currency Risk Around Trade Agreements.

This figure plots the estimates of our staggered difference-in-difference regression in (12) with volatility, unshared risk, R-squared, or base loading as the dependent variable. We compare for each year around a trade deal country-pairs with and without an agreement. The regression includes domestic and foreign country-year fixed effects and the standard gravity controls described in Table 2. Our trade deal variable equals one if countries have a FTA or a CUCMECU and is zero otherwise.

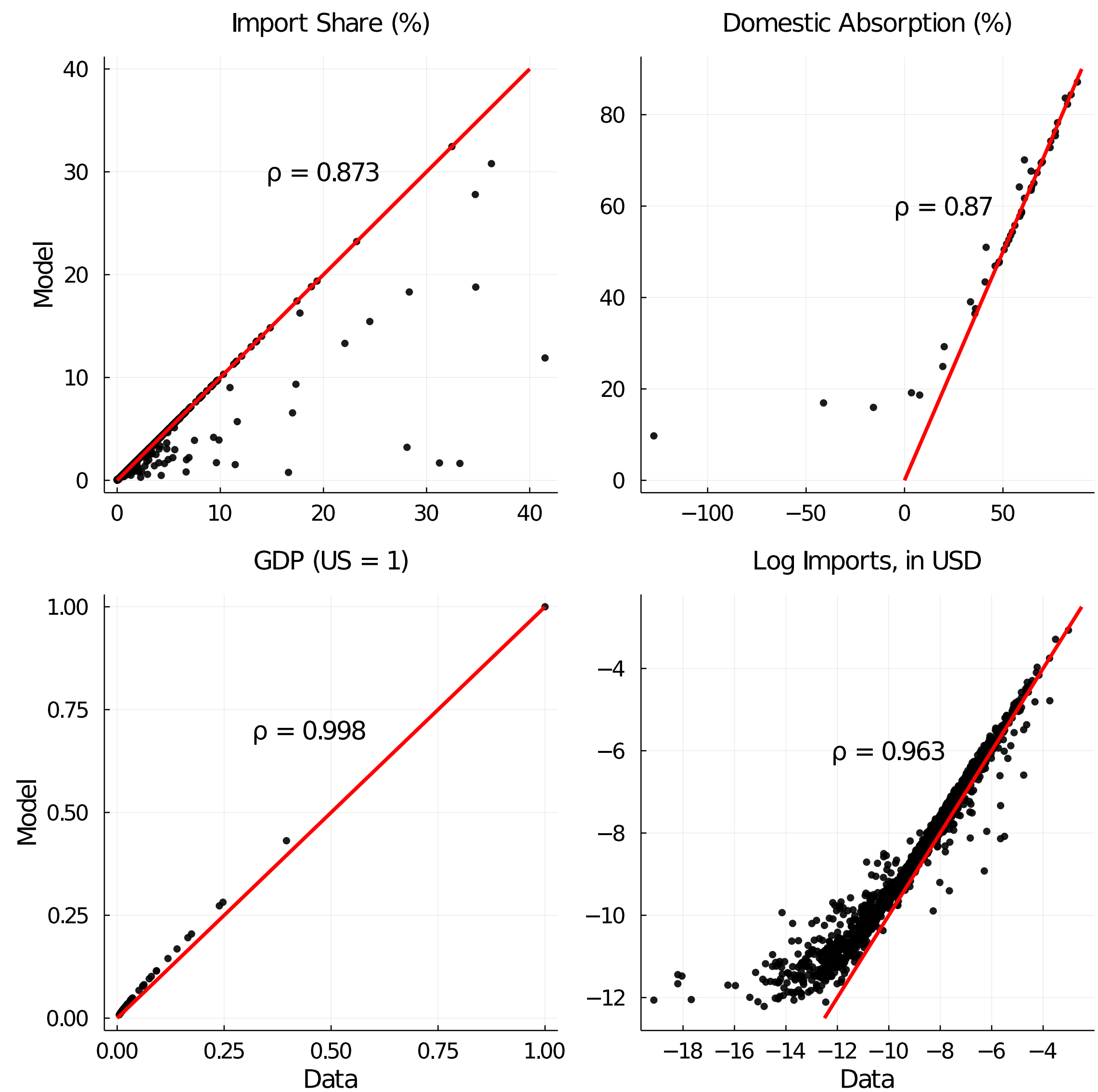

Figure 3. Structural Estimation of Trade Costs

This figure depicts the fit of the structural estimation of trade costs. The gravity model of Section II is solved under financial autarky and targets averages of output and import shares in the data. The correlation coefficient across model and data within each scatter is recorded by ρ.

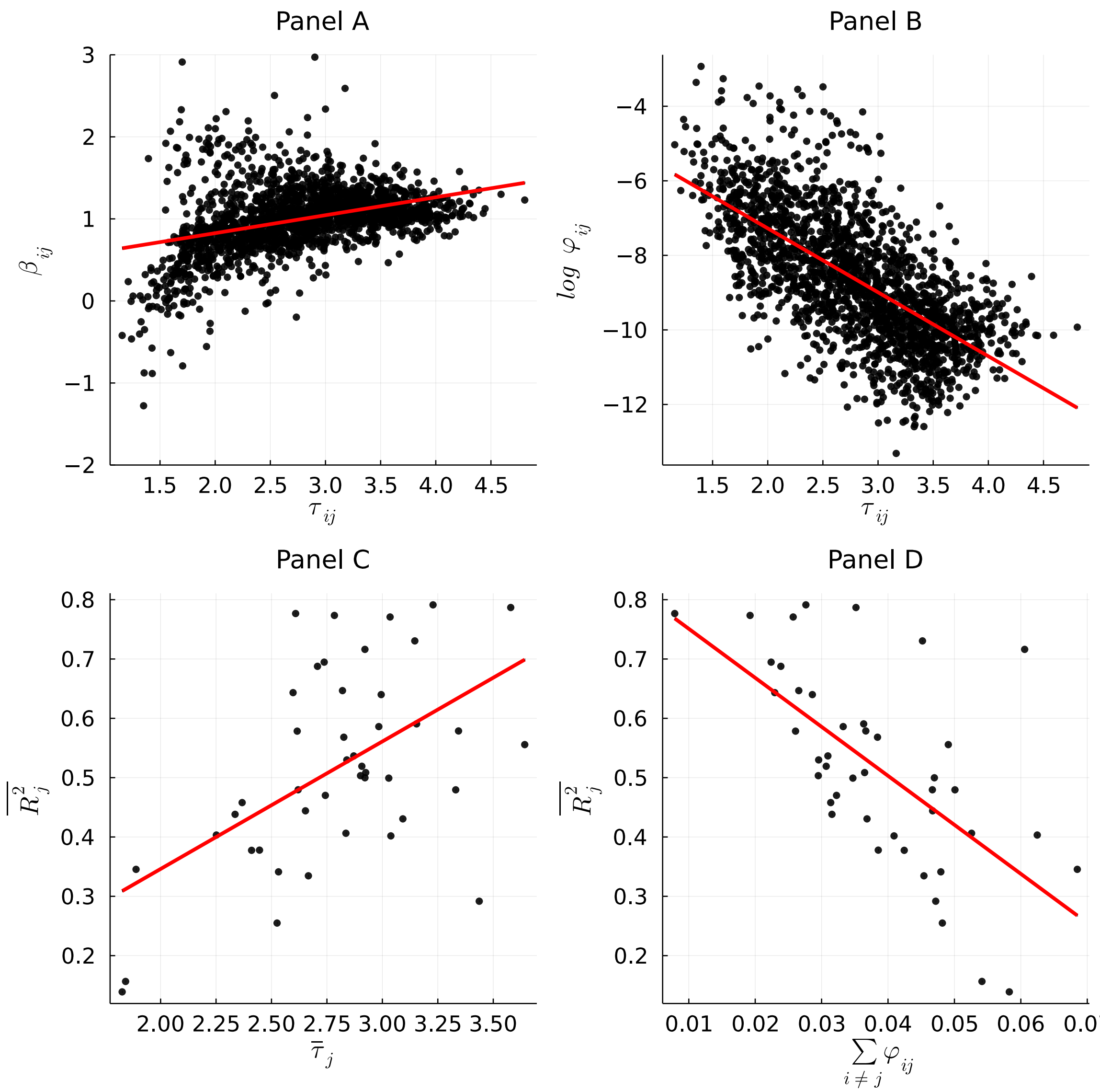

Figure 4. Main Model Predictions of Calibrated Economy

This figure shows the main predictions of the calibrated model in Section II under a market completeness of $\phi = 0.95$. The average inward trade cost is the average over i of trade costs of imported goods by j, $\overline{\tau_j} = \sum_{i \neq j} \tau_{ij}/(N-1)$. The average share of systematic risk is from the perspective a currency investor in j, $\overline{R_j^2} = \sum_{i \neq j} R_{ij}^2/(N-1)$. Total import exposure is $\sum_{i \neq j} \varphi_{ij}$.

A. Empirical Appendix

Table A.1. Summary Statistics for Developed and Emerging Countries

	Observations	Mean	Median	Std. Dev.
Developed				
Base Loading, β	25,229	1.034	0.993	0.930
Share of Systematic Risk, R^2	25,229	0.460	0.454	0.287
Volatility, σ	27,909	0.133	0.113	0.107
Unshared Risk, ρ	27,209	0.912	0.957	0.308
Imports (billions of USD)	46,179	8.262	0.952	34.61
Imports five-year difference (billions of USD)	40,454	1.965	0.180	10.47
Imports ten-year difference (billions of USD)	35,366	4.347	0.517	18.67
Imports, as a share of GDP	40,915	0.026	0.006	0.072
CUCMECU	54,000	0.148	0.000	0.355
FTA	54,000	0.146	0.000	0.353
TWPTA	54,000	0.023	0.000	0.150
OWPTA	54,000	0.055	0.000	0.229
Emerging				
Base Loading, β	23,809	1.020	0.998	0.557
Share of Systematic Risk, R^2	23,809	0.539	0.533	0.332
Volatility, σ	24,035	0.166	0.131	0.144
Unshared Risk, ρ	23,741	0.930	0.972	0.305
Imports (billions of USD)	41,013	3.552	0.342	15.49
Imports five-year difference (billions of USD)	35,721	1.185	0.086	6.403
Imports ten-year difference (billions of USD)	30,983	2.689	0.265	11.18
Imports, as a share of GDP	33,063	0.022	0.005	0.062
CUCMECU	49,500	0.040	0.000	0.195
FTA	49,500	0.095	0.000	0.294
TWPTA	49,500	0.056	0.000	0.229
OWPTA	49,500	0.275	0.000	0.446

The table reports summary statistics of exchange rates and trade at the country level.
Base loadings and the R-squared are estimated from the regression in (4).
The import shares are estimated from IMF and CEPII data over the period 1973-2019.
Trade deals are divided in four different levels of economic integration as in (Baier and Bergstrand, 2007): customs unions, common markets, and economic unions (CUCMECU), free trade arrangement (FTA), one-way and two-way preferential trade agreement (OWPTA and TWPTA).

Table A.2. Time Effects of Trade Deal Change. Staggered Difference-in-Differences with Country-Pair Fixed Effects

	log Imports		Volatility, σ		Unshared Risk, ρ		R-squared		Base Loading, β	
Timing	β	s.e.	β	s.e.	β	s.e.	β	s.e.	β	s.e.
−10	−0.1**	(0.046)	0.003*	(0.002)	−0.007	(0.016)	0.007	(0.013)	0.015	(0.025)
−9	−0.104**	(0.046)	−0.001	(0.002)	−0.016	(0.016)	0.005	(0.013)	−0.005	(0.026)
−8	−0.124***	(0.042)	0.002	(0.002)	−0.01	(0.016)	0.013	(0.013)	0.021	(0.025)
−7	−0.107***	(0.041)	−0.001	(0.002)	−0.02	(0.016)	0.001	(0.012)	−0.006	(0.025)
−6	−0.078*	(0.041)	0.001	(0.002)	−0.017	(0.015)	0	(0.011)	0.007	(0.024)
−5	−0.105***	(0.038)	0.001	(0.002)	−0.012	(0.013)	0.002	(0.011)	−0.002	(0.022)
−4	−0.132***	(0.036)	0.002	(0.002)	−0.01	(0.014)	−0.007	(0.01)	0.001	(0.021)
−3	−0.1***	(0.031)	0.005***	(0.002)	−0.007	(0.012)	0	(0.009)	0.022	(0.019)
−2	−0.058**	(0.026)	0	(0.001)	0.002	(0.01)	0.008	(0.007)	0.016	(0.015)
−1	−0.018	(0.021)	0	(0.001)	0.001	(0.007)	0.002	(0.006)	0.001	(0.01)
1	0.047**	(0.019)	−0.001	(0.001)	−0.013***	(0.004)	−0.005	(0.004)	−0.018**	(0.009)
2	0.083***	(0.023)	−0.001	(0.001)	−0.018***	(0.006)	−0.008*	(0.005)	−0.023**	(0.011)
3	0.11***	(0.03)	−0.001	(0.001)	−0.021**	(0.009)	−0.01	(0.006)	−0.03**	(0.012)
4	0.143***	(0.029)	−0.001	(0.001)	−0.018*	(0.01)	−0.008	(0.008)	−0.032**	(0.015)
5	0.167***	(0.032)	−0.001	(0.001)	−0.003	(0.011)	−0.004	(0.009)	−0.02	(0.017)
6	0.221***	(0.035)	−0.002	(0.001)	−0.016	(0.013)	−0.008	(0.01)	−0.037*	(0.019)
7	0.227***	(0.039)	−0.003*	(0.001)	−0.023*	(0.013)	−0.014	(0.01)	−0.047**	(0.021)
8	0.249***	(0.04)	−0.007***	(0.002)	−0.044***	(0.014)	−0.026**	(0.011)	−0.092***	(0.022)
9	0.252***	(0.041)	−0.007***	(0.002)	−0.06***	(0.014)	−0.031***	(0.011)	−0.093***	(0.022)
10	0.274***	(0.044)	−0.007***	(0.002)	−0.051***	(0.015)	−0.033***	(0.011)	−0.084***	(0.022)
Observations	63,463		39,094		35,914		37,370		37,268	
R-squared	0.949		0.964		0.722		0.877		0.721	

This table reports the coefficient of a staggered difference as in (12). The deal dummy equals one if countries i and j share either an FTA or a CUCMECU and zero otherwise. The set of control variables $X_{ij,t}$ includes country-pair fixed effects, time fixed effects, and the deal dummy. All time coefficients are deviations in $y_{ij,t}$ from the exact year of the trade deal change.

Table A.3. Staggered Difference-in-Differences with Aggregation from Callaway and Sant'Anna (2019)

Timing	log Imports β	log Imports s.e.	Volatility, σ β	Volatility, σ s.e.	Unshared Risk, ρ β	Unshared Risk, ρ s.e.	R-squared β	R-squared s.e.	Base Loading, β β	Base Loading, β s.e.
−10	−0.072***	(0.028)	0	(0.001)	0.024*	(0.013)	0.014**	(0.007)	0.021	(0.014)
−9	0.035	(0.027)	−0.001	(0.001)	0	(0.014)	0.004	(0.009)	−0.004	(0.017)
−8	0.008	(0.033)	−0.002	(0.002)	−0.02	(0.024)	−0.014	(0.017)	−0.018	(0.027)
−7	0.035	(0.032)	0	(0.001)	0.003	(0.014)	0.001	(0.009)	0.018	(0.028)
−6	0.06*	(0.033)	0.002***	(0.001)	0.02**	(0.009)	0.011	(0.007)	0.035*	(0.02)
−5	−0.03	(0.029)	0.004***	(0.002)	0.045**	(0.022)	0.023*	(0.013)	0.062**	(0.03)
−4	−0.048**	(0.024)	0.001	(0.001)	0.011	(0.01)	0.006	(0.008)	0.019	(0.017)
−3	−0.035	(0.029)	−0.001	(0.001)	0.008	(0.012)	0.002	(0.007)	0.001	(0.019)
−2	0.018	(0.026)	−0.001	(0.001)	−0.007	(0.014)	−0.004	(0.009)	−0.013	(0.021)
−1	0.063***	(0.024)	0.001	(0.002)	0.021	(0.024)	0.014	(0.014)	0.02	(0.03)
1	0.044	(0.029)	−0.003	(0.002)	−0.034*	(0.017)	−0.018*	(0.01)	−0.035	(0.025)
2	0.041	(0.034)	−0.003*	(0.002)	−0.037*	(0.019)	−0.019	(0.012)	−0.034	(0.025)
3	0.072**	(0.033)	−0.001	(0.003)	−0.046	(0.038)	−0.019	(0.025)	−0.022	(0.055)
4	0.075**	(0.036)	−0.001	(0.004)	−0.072	(0.051)	−0.03	(0.038)	−0.071	(0.1)
5	0.093**	(0.041)	−0.001	(0.006)	−0.069	(0.062)	−0.024	(0.051)	−0.124	(0.13)
6	0.136***	(0.044)	−0.003	(0.006)	−0.067	(0.059)	−0.023	(0.047)	−0.148	(0.141)
7	0.137***	(0.047)	−0.001	(0.006)	−0.046	(0.064)	−0.012	(0.052)	−0.144	(0.139)
8	0.162***	(0.048)	−0.007	(0.005)	−0.116***	(0.038)	−0.062	(0.047)	−0.312**	(0.13)
9	0.152***	(0.049)	−0.01	(0.007)	−0.167***	(0.043)	−0.084*	(0.05)	−0.318***	(0.116)
10	0.152***	(0.052)	−0.012*	(0.007)	−0.193***	(0.05)	−0.097*	(0.054)	−0.308***	(0.119)

This table reports the coefficient of a staggered difference as expressed in the specification (12). The deal dummy equals one if countries i and j share either an FTA or a CUCMECU and zero otherwise. The set of controls include country-pair and year fixed effects. To aggregate the difference-in-differences estimate across treated unit, we follow the implementation of Callaway and Sant'Anna (2019) and report coefficients and standard errors from a dynamic aggregation of the average treatment effect.

Table A.4. OLS Specification of Trade on Exchange Rate Risk

	Panel A: Volatility, σ					
	Five-year change			Ten-year change		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_{t,t-5}$ log Imports	0.024	0.019	0.018	0.026	0.022	0.021
	(0.019)	(0.021)	(0.021)	(0.017)	(0.015)	(0.016)
$\Delta_{t-5,t-10}$ log Imports	0.02*	0.018*	0.019*	0.008	0.01	0.01
	(0.01)	(0.011)	(0.011)	(0.01)	(0.008)	(0.008)
Gravity Controls	Y	–	–	Y	–	–
Country pair f.e.	N	Y	Y	N	Y	Y
Country-year f.e.	Y	Y	Y	Y	Y	Y
Exchange rate regime	All	All	No Pegs	All	All	No pegs
Observations	32,526	32,526	31,870	18,614	18,614	18,072
	Panel B: Unshared Risk, ρ					
	Five-year change			Ten-year change		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_{t,t-5}$ log Imports	0.162	0.025	0.011	0.216	0.16	0.148
	(0.179)	(0.187)	(0.186)	(0.182)	(0.173)	(0.183)
$\Delta_{t-5,t-10}$ log Imports	0.193*	0.127	0.14	0.084	0.073	0.073
	(0.106)	(0.107)	(0.109)	(0.105)	(0.088)	(0.087)
Gravity Controls	Y	–	–	Y	–	–
Country pair f.e.	N	Y	Y	N	Y	Y
Country-year f.e.	Y	Y	Y	Y	Y	Y
Exchange rate regime	All	All	No Pegs	All	All	No pegs
Observations	31,770	31,770	31,118	18,288	18,288	17,746

Table A.4 reports regressions of volatility (Panel A) and unshared risk (Panel B) on the change in imports. Columns (1) through (3) report the five-year change in volatility and columns (4) through (6) the ten-year change. All dependent variables were multiplied by 100 because of the small magnitude of the coefficients. Controls include pre-trends, country-year fixed effects for both countries, gravity variables in columns (1) and (4), and country pair fixed effects in columns (2), (3), (5), (6). In columns (3) and (6) we remove pegged currencies.

We report standard errors clustered at country-pair level in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent level.

Table A.5. OLS Specification of Trade on Common Factor Regressions

	Panel A: Base Loading, β					
	Five-year change			Ten-year change		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_{t,t-5}\log\text{Imports}$	0.666	0.664	0.676	0.878*	0.812	0.78
	(0.665)	(0.614)	(0.622)	(0.529)	(0.506)	(0.517)
$\Delta_{t-5,t-10}\log\text{Imports}$	0.527**	0.603**	0.636**	-0.103	0.081	0.069
	(0.231)	(0.246)	(0.25)	(0.183)	(0.141)	(0.146)
Gravity Controls	Y	–	–	Y	–	–
Country pair f.e.	N	Y	Y	N	Y	Y
Country-year f.e.	Y	Y	Y	Y	Y	Y
Exchange rate regime	All	All	No Pegs	All	All	No pegs
Observations	30,505	30,505	29,893	18,083	18,083	17,545
	Panel B: Share of Systematic Risk, R^2					
	Five-year change			Ten-year change		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_{t,t-5}\log\text{Imports}$	0.099	0.107	0.107	-0.042	0.009	-0.002
	(0.16)	(0.159)	(0.16)	(0.149)	(0.174)	(0.189)
$\Delta_{t-5,t-10}\log\text{Imports}$	0.027	0.062	0.076	0.001	0.068	0.091
	(0.108)	(0.111)	(0.115)	(0.102)	(0.08)	(0.082)
Gravity Controls	Y	–	–	Y	–	–
Country pair f.e.	N	Y	Y	N	Y	Y
Country-year f.e.	Y	Y	Y	Y	Y	Y
Exchange rate regime	All	All	No Pegs	All	All	No pegs
Observations	30,497	30,497	29,887	18,081	18,081	17,545

This table shows the instrumental variable regressions of the slope coefficient (Panel A) and R-squared (Panel B) from equation (4) on the change in imports. Columns (1) through (3) report the five-year change in volatility and columns (4) through (6) the ten-year change. All dependent variables were multiplied by 100 because of the small magnitude of the coefficients.

Controls include pre-trends, country-year fixed effects for both countries, gravity variables in columns (1) and (4), and country pair fixed effects in columns (2), (3), (5), (6). In columns (3) and (6) we remove pegged currencies.

We report standard errors clustered at country-pair level in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent level.

Table A.6. Second Stage: Effect of Trade on Exchange Rate Risk. Peripheral Countries

	Panel A: Volatility, σ					
	Five-year change			Ten-year change		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_{t,t-5} \log \widehat{\text{Imports}}$	-0.011	-0.041**	-0.023**	-0.008	-0.009	-0.003
	(0.009)	(0.018)	(0.012)	(0.006)	(0.007)	(0.006)
$\Delta_{t-5,t-10} \log \text{Imports}$	-0.003	-0.01**	-0.006**	0	0	0
	(0.002)	(0.004)	(0.003)	(0)	(0)	(0)
Gravity Controls	Y	–	–	Y	–	–
Country pair f.e.	N	Y	Y	N	Y	Y
Country-year f.e.	Y	Y	Y	Y	Y	Y
Exchange rate regime	All	All	No Pegs	All	All	No pegs
Observations	16,581	16,581	16,261	9,211	9,211	8,935
First stage F-statistic	7.61	4.25	5.29	6.76	6.31	6.83
	Panel B: Unshared Risk, ρ					
	Five-year change			Ten-year change		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_{t,t-5} \log \widehat{\text{Imports}}$	-0.294**	-0.535**	-0.32**	-0.183**	-0.237**	-0.137*
	(0.131)	(0.221)	(0.134)	(0.087)	(0.108)	(0.08)
$\Delta_{t-5,t-10} \log \text{Imports}$	-0.068**	-0.13**	-0.077**	0.011*	-0.003	-0.002
	(0.032)	(0.052)	(0.032)	(0.006)	(0.009)	(0.005)
Gravity Controls	Y	–	–	Y	–	–
Country pair f.e.	N	Y	Y	N	Y	Y
Country-year f.e.	Y	Y	Y	Y	Y	Y
Exchange rate regime	All	All	No Pegs	All	All	No pegs
Observations	16,226	16,226	15,908	9,120	9,120	8,844
First stage F-statistic	7.07	4.49	5.59	6.86	6.34	6.87

This table shows the instrumental variable regressions of volatility (Panel A) and unshared risk (Panel B) on the change in imports, instrumented using trade deals. Sample is restricted to base countries belonging to bottom 50% central countries, as defined by the centrality measure in equation (14). Columns (1) through (3) report the five-year change in volatility and columns (4) through (6) the 10-year change.

Controls include pre-trends, country-year fixed effects for both countries, gravity variables in Columns (1) and (4), and country pair fixed effects in columns (2), (3), (5), and (6). In columns (3) and (6) we remove pegged currencies.

We report standard errors clustered at the country-pair level in parentheses and the first-stage Cragg-Donald F-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent level, respectively.

Table A.7. Second Stage: Effect of Trade on Exchange Rate Risk. Peripheral Countries

	Panel A: Common Factor Regression, β					
	Five-year change			Ten-year change		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_{t,t-5}\log\widehat{\text{Imports}}$	-0.445**	-0.564**	-0.361*	-0.268**	-0.305**	-0.221*
	(0.183)	(0.265)	(0.184)	(0.112)	(0.136)	(0.114)
$\Delta_{t-5,t-10}\log\text{Imports}$	-0.096**	-0.133**	-0.083*	0.015*	-0.005	-0.003
	(0.042)	(0.062)	(0.044)	(0.009)	(0.012)	(0.008)
Gravity Controls	Y	–	–	Y	–	–
Country pair f.e.	N	Y	Y	N	Y	Y
Country-year f.e.	Y	Y	Y	Y	Y	Y
Exchange rate regime	All	All	No Pegs	All	All	No pegs
Observations	15,905	15,905	15,587	9,094	9,094	8,818
First stage F-statistic	6.97	4.08	5.13	6.78	6.31	6.83
	Panel B: Common Factor Regression, R^2					
	Five-year change			Ten-year change		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_{t,t-5}\log\widehat{\text{Imports}}$	-0.266***	-0.322**	-0.199**	-0.141**	-0.12*	-0.064
	(0.094)	(0.138)	(0.089)	(0.057)	(0.063)	(0.051)
$\Delta_{t-5,t-10}\log\text{Imports}$	-0.059***	-0.078**	-0.048**	0.008*	-0.001	0
	(0.022)	(0.032)	(0.021)	(0.004)	(0.005)	(0.003)
Gravity Controls	Y	–	–	Y	–	–
Country pair f.e.	N	Y	Y	N	Y	Y
Country-year f.e.	Y	Y	Y	Y	Y	Y
Exchange rate regime	All	All	No Pegs	All	All	No pegs
Observations	15,899	15,899	15,583	9,092	9,092	8,818
First stage F-statistic	6.97	4.05	5.09	6.78	6.31	6.83

This table shows the instrumental variable regressions of the slope coefficient (Panel A) and R-squared (Panel B) on the change in imports, instrumented using trade deals. Sample is restricted to base countries belonging to bottom 50% central countries, as defined by the centrality measure in equation (14). Columns (1) through (3) report the five-year change in volatility and columns (4) through (6) the 10-year change.

Controls include pre-trends, country-year fixed effects for both countries, gravity variables in Columns (1) and (4), and country pair fixed effects in columns (2), (3), (5), and (6). In columns (3) and (6) we remove pegged currencies.

We report standard errors clustered at the country-pair level in parentheses and the first-stage Cragg-Donald F-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent level, respectively.

Table A.8. Second Stage: Effect of Trade on Exchange Rate Risk.
Core Countries

	Panel A: Volatility, σ					
	Five-year change			Ten-year change		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_{t,t-5}\log\widehat{\text{Imports}}$	-0.005	-0.027	-0.018	-0.025**	-0.029**	-0.024**
	(0.012)	(0.017)	(0.014)	(0.012)	(0.011)	(0.01)
$\Delta_{t-5,t-10}\log\text{Imports}$	0	-0.005	-0.003	0.004*	0.002	0.002
	(0.002)	(0.004)	(0.003)	(0.003)	(0.002)	(0.002)
Gravity Controls	Y	–	–	Y	–	–
Country pair f.e.	N	Y	Y	N	Y	Y
Country-year f.e.	Y	Y	Y	Y	Y	Y
Exchange rate regime	All	All	No Pegs	All	All	No pegs
Observations	15,199	15,199	14,865	9,137	9,137	8,871
First stage F-statistic	3.54	2.97	3.35	4.98	6.21	6.59

	Panel B: Unshared Risk, ρ					
	Five-year change			Ten-year change		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_{t,t-5}\log\widehat{\text{Imports}}$	-0.223	-0.271	-0.179	-0.359**	-0.383**	-0.285**
	(0.175)	(0.194)	(0.169)	(0.164)	(0.155)	(0.13)
$\Delta_{t-5,t-10}\log\text{Imports}$	-0.027	-0.05	-0.033	0.06	0.028	0.023
	(0.026)	(0.04)	(0.034)	(0.036)	(0.027)	(0.023)
Gravity Controls	Y	–	–	Y	–	–
Country pair f.e.	N	Y	Y	N	Y	Y
Country-year f.e.	Y	Y	Y	Y	Y	Y
Exchange rate regime	All	All	No Pegs	All	All	No pegs
Observations	14,810	14,810	14,478	8,909	8,909	8,643
First stage F-statistic	3.13	3.19	3.58	4.93	6.17	6.56

This table shows the instrumental variable regressions of volatility (Panel A) and unshared risk (Panel B) on the change in imports, instrumented using trade deals. Sample is restricted to base countries belonging to top 50% central countries, as defined by the centrality measure in equation (14). Columns (1) through (3) report the five-year change in volatility and columns (4) through (6) the 10-year change.

Controls include pre-trends, country-year fixed effects for both countries, gravity variables in Columns (1) and (4), and country pair fixed effects in columns (2), (3), (5), and (6). In columns (3) and (6) we remove pegged currencies.

We report standard errors clustered at the country-pair level in parentheses and the first-stage Cragg-Donald F-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent level, respectively.

Table A.9. Second Stage: Effect of Trade on Exchange Rate Risk.
Core Countries

	Panel A. Common Factor Regression, β					
	Five-year change			Ten-year change		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_{t,t-5}\log\widehat{\text{Imports}}$	-0.244	-0.125	-0.077	-0.508**	-0.537*	-0.445*
	(0.268)	(0.333)	(0.318)	(0.232)	(0.281)	(0.262)
$\Delta_{t-5,t-10}\log\text{Import}$	-0.031	-0.022	-0.013	0.082	0.038	0.034
	(0.038)	(0.064)	(0.06)	(0.051)	(0.04)	(0.038)
Gravity Controls	Y	–	–	Y	–	–
Country pair f.e.	N	Y	Y	N	Y	Y
Country-year f.e.	Y	Y	Y	Y	Y	Y
Exchange rate regime	All	All	No Pegs	All	All	No pegs
Observations	13854	13854	13562	8723	8723	8461
First stage F-statistic	3.23	2.63	2.97	5.91	6.19	6.58

	Panel B. Common Factor Regression, R^2					
	Five-year change			Ten-year change		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_{t,t-5}\log\widehat{\text{Imports}}$	-0.151	-0.125	-0.067	-0.161*	-0.217**	-0.169*
	(0.129)	(0.157)	(0.14)	(0.089)	(0.109)	(0.098)
$\Delta_{t-5,t-10}\log\text{Import}$	-0.022	-0.026	-0.015	0.027	0.016	0.014
	(0.019)	(0.031)	(0.027)	(0.018)	(0.016)	(0.014)
Gravity Controls	Y	–	–	Y	–	–
Country pair f.e.	N	Y	Y	N	Y	Y
Country-year f.e.	Y	Y	Y	Y	Y	Y
Exchange rate regime	All	All	No Pegs	All	All	No pegs
Observations	13,852	13,852	13,560	8,723	8,723	8,461
First stage F-statistic	3.25	2.64	2.98	5.91	6.19	6.58

This table shows the instrumental variable regressions of the slope coefficient (Panel A) and R-squared (Panel B) on the change in imports, instrumented using trade deals. Sample is restricted to base countries belonging to top 50% central countries, as defined by the centrality measure in equation (14). Columns (1) through (3) report the five-year change in volatility and columns (4) through (6) the 10-year change.

Controls include pre-trends, country-year fixed effects for both countries, gravity variables in Columns (1) and (4), and country pair fixed effects in columns (2), (3), (5), and (6). In columns (3) and (6) we remove pegged currencies.

We report standard errors clustered at the country-pair level in parentheses and the first-stage Cragg-Donald F-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent level, respectively.

B. Model Appendix

A. Financial Autarky

The current value Lagrangian for country j at a point in time is

$$\mathcal{L}_j = u(C_j) + \lambda_j^{RC}\left(\left(\sum_{i=1}^{N} q_{ij}^{\frac{\eta-1}{\eta}}\right)^{\frac{\eta}{\eta-1}} - C_j\right) + \lambda_j^{BC}\left(w_j L_j - \sum_{i=1}^{N} p_{ij} q_{ij}\right) \tag{A1}$$

The system of first-order conditions is

$$C_j: \qquad u'(C_j) = \lambda_j^{RC} \tag{A2}$$

$$q_{ij}: \qquad \lambda_j^{BC} p_{ij} = \lambda_j^{RC} C_j^{\frac{1}{\eta}} q_{ij}^{-\frac{1}{\eta}} \tag{A3}$$

Equation (A3) can be multiplied by q_{ij} and integrated to give the expression

$$\lambda_j^{RC}/\lambda_j^{BC} = \frac{\sum_{i=1}^{N} p_{ij} q_{ij}}{C_j} = \frac{w_j L_j}{C_j}, \tag{A4}$$

where the second equality follows from $\sum_{i=1}^{N} p_{ij} q_{ij} = w_j L_j$. Substituting (A4) into (A3) and integrating gives the CES demand equation in (20).

B. Complete Markets

The current value Lagrangian of the planner's problem is

$$\mathcal{L} = \sum_j \lambda_j u(C_j) + \lambda_j^{RC}\left(\left(\sum_{i=1}^{N} q_{ij}^{\frac{\eta-1}{\eta}}\right)^{\frac{\eta}{\eta-1}} - C_j\right) + \lambda_j^{GRC}\left(\sum_{j=1}^{N} \tau_{jk} q_{jk} - z_j l_{Tj}\right) \tag{A5}$$

The first-order conditions are

$$C_j: \qquad \lambda_j u'(C_j) = \lambda_j^{RC} \tag{A6}$$

$$q_{ij}: \qquad \lambda_i^{GRC} \tau_{ij} = \lambda_j^{RC} C_j^{\frac{1}{\eta}} q_{ij}^{-\frac{1}{\eta}} \quad . \tag{A7}$$

Comparing these conditions to autarky's, it is evident under the normalization $\lambda_j^{BC} = 1/\lambda_j$ that the equilibrium prices of j's tradable good, p_{jj}, are equal to the shadow values of j's global resource constraint, λ_j^{GRC}.