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ORIGINS OF INTERNATIONAL FACTOR STRUCTURES

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ABSTRACT

We show that exchange rate correlations tend to be explained by the global trade network while consumption correlations tend to be explained by productivity correlations. Sharing common trade linkages with other countries increases exchange rate correlations beyond bilateral linkages. We explain these findings using a model of the global trade network with market segmentation. Interdependent global production generates international comovements, while market segmentation disconnects the drivers of exchange rate correlations from the drivers of consumption correlations. Moreover, we show that the trade network generates common factors found in exchange rates. Our findings offer a trade-based account of the origins of international comovements and shed light on important frictions in international markets.

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Exchange rates and economic quantities exhibit substantial variation in their correlations across countries. For exchange rates, these correlations generate factor structures in comovements and differences in the risk characteristics of international asset prices. That said, the drivers of these correlations and the relation between those for quantities and those for asset prices are not particularly well understood. In this paper, we provide an account of these international comovements based upon the structure of the global trade network.

We begin with the insight that linkages in the global trade network transmit shocks across countries. These network linkages, along with the correlations of primitive shocks, give rise to varying degrees of comovements between countries. As a result, comovements in exchange rates and in economic quantities, specifically consumption growth, can be decomposed into components that are driven by the network structure and by the correlations of the underlying primitive shocks. We then show that exchange rate comovements and consumption comovements tend to be driven by different forces. Exchange rate comovements are better explained by countries' closeness in the trade network, while consumption comovements are better explained by correlations of primitive shocks. To explain this disconnect, we present a multi-country model with segmented financial markets that generates the observed empirical patterns. Our results provide new evidence on the drivers of international asset price correlations and shed light on the nature of the frictions which are important in international financial markets.

The international finance literature has been focusing on the disconnect between consumption growth and exchange rate movements for a given country-pair. In particular, Backus and Smith (1993) document that countries' consumption growth differences and their exchange rate movements are only weakly correlated in the data—many textbook models would predict a perfect correlation. In contrast, our results present a disconnect between cross-sectional variations in exchange rate correlations vis-à-vis cross-sectional variations in consumption or productivity correlations. Furthermore, because our measure of trade network closeness is constructed only using trade data, our findings also demonstrate a rare link between quantities—the structure of the trade network—and international asset prices. While consumption or productivity correlations do not explain large fractions of the cross-sectional variations in asset price correlations, the trade network structure, as summarized by trade network closeness, is able to do so.

To document the drivers of correlations in exchange rates and consumption growth, we construct a number of measures of closeness based on the trade data. Our closeness measures capture the similarity between a pair of countries' trade linkages. Consider the U.S. and Germany for example. They can be close in the trade network because they trade a lot directly with each other, or because they both trade a lot with common trade partners like China. Our full closeness measure is simply the dot product between the vector of the bilateral trade shares of the U.S. with respect to all countries and the vector of the bilateral trade shares of Germany with respect to all countries. We decompose this full closeness measure into a direct component and an indirect component. The direct component measures bilateral connections between the U.S. and Germany while the indirect component measures their trade connections to other countries, which, for example, is increasing if they both trade more with China. We measure trade network closeness for trade in both intermediate goods and final consumption goods.

With these measures of trade network closeness, we document a number of facts about the drivers of international comovements. First, we show that trade network closeness has a much stronger explanatory power for exchange rate comovements, while correlations of total factor productivity (TFP) shocks drive international consumption growth comovements. These results provide evidence of a new form of disconnect between economic fundamentals and asset prices. Specifically, when accounting for exchange rate correlations, the regression R^2 is around 25% for trade network closeness and around 10% for TFP correlations. In contrast, when accounting for consumption correlations, the R^2 is around 7% for trade network closeness and around 28% for TFP correlations. We also demonstrate that the differences in R^2 are significant using a bootstrap exercise, further strengthening the evidence on the disconnect which we uncover.

Second, both components of trade network closeness explain exchange rate correlations. Specifically, we find that both the direct component, capturing bilateral trade connections, and the indirect component, capturing trade with shared third countries, are important explanatory variables for countries' exchange rate correlations. We also show that both trade network closeness in consumption goods and intermediate goods are able to explain exchange rate correlations.

Third, we show that our measures of trade network closeness remain significant for explaining exchange rate correlations even when controlling for bilateral trade intensity[1] and bilateral distance, which is often a key driver of international comovements in (usually two-country) models. This result highlights the importance of understanding full structure of the trade network as measured by the direct and indirect components. The latter indirect components can only be understood in the context of models and empirical measures with more than two countries.

Fourth, we exploit the panel dimension of our data by measuring trade network closeness using non-overlapping time periods. We show that changes in trade network closeness are related to changes in exchange rate correlations, providing further evidence on the relation between trade network closeness and exchange rate correlations. By exploiting the time-series variation, we are also able to control for country-pair and time fixed effects. The country-pair fixed effects rule out any time invariant bilateral characteristics—such as distance—which might drive both exchange rate correlations and trade network closeness.

Having documented the close relation between trade network closeness and exchange rate correlations, along with the disconnect between the drivers of exchange rate correlations and consumption correlations, we next present a model to explain our findings. Our model contains multiple countries which are populated by a group of active households and a group of inactive households. Each country produces a distinct tradable good which is used by all other countries for production of their own goods, as well as for final consumption. This interdependent production and consumption structure gives rise to the international trade network and to heterogeneity across countries. Each country's output is exposed to a productivity shock which is specific to that country and is potentially correlated with other countries' productivity shocks. We consider these productivity shocks to be supply shocks.

While active households in each country have access to complete financial markets, inactive

[1]Bilateral trade intensity is constructed as total pair-wise trade divided by total pair-wise GDP.

households do not. Instead, the inactive households receive a transfer from the active households. The size of this transfer is determined by a country-specific transfer shock. Using this transfer, the inactive households purchase their consumption bundles. We show in the paper that this transfer shock can be interpreted as a demand shock which impacts the total demand for a good. Market clearing for each country's good states that the output of that good equals the sum of total usage for production, total usage for active households' consumption, and total demand for inactive households' consumption. When inactive households consume more of a good due to larger transfer shocks, the good's quantity available to active households declines and affects their marginal utilities.

Exchange rates are determined by the relative marginal utilities of active household's across countries, which are themselves driven by the active households' consumption. In contrast, aggregate consumption is determined by the consumption of active and inactive households. This difference between aggregate and active household consumption is what allows the model to generate the disconnect between the cross-sectional drivers of exchange rate and consumption correlations, which we discuss shortly.

Comovements in exchange rates and consumption arise in two ways. First, even when the primitive shocks are uncorrelated, the trade network will propagate both productivity (supply) and transfer (demand) shocks across countries. Productivity shocks propagate through the network by impacting the output of a particular good and therefore the output of other goods that use that good for production. Transfer shocks propagate through the network by impacting the market clearing for a particular good and, in equilibrium, shifting the allocations between active and inactive households within and across countries. Second, comovements in asset prices and consumption can also arise if the productivity and transfer shocks are correlated across countries. As a result, consumption and asset prices are determined by the interaction between the structure of the global trade network, the correlations of productivity shocks, and the correlations of transfer shocks. Countries have more correlated economic quantities and asset prices if they have more correlated primitive shocks and if they are closer in the trade network.

Consistent with our empirical findings, our model shows that the dot product of countries' consumption and intermediate goods trade shares is a key predictor of international comovements. Futhermore, the model predicts that a specific combination of consumption and intermediate shares should predict international asset price correlations, which we verify in the data. Finally, the model predicts that a country's average closeness relative to other countries in the trade network determines the variance of its exchange rate, which we also confirm in the data.

To understand the source of the disconnect between the drivers of exchange rate correlations and consumption correlations, we calibrate and estimate our model. We begin by disciplining the heterogeneity across countries by directly using the observed trade network and correlations of productivity shocks. We next estimate the remaining model parameters using both standard exchange rate moments from the literature and the additional moments found in our paper. Using a parsimonious specification for the unobserved model parameters, the estimated model is able to match the disconnect which we observe in the data. With the calibrated model we are then able to study a number of model variants which illuminate the mechanism which drives our disconnect.

In particular, we show that the market segmentation in our model plays a key role of disentangling the aggregate consumption and exchange rate dynamics. Not only does it resolve the Backus and Smith (1993) puzzle in the time series for a country pair, it also generates the disconnect between international comovements that we document in this paper. On the one hand, supply shocks determine the overall resources of the active and inactive households combined in each country, which are closely related to the country-level consumption growth. On the other hand, the trade network propagates both supply and demand shocks to determine the active households' marginal utilities, which are closely related to the exchange rate behavior.

Given the importance of trade network closeness for exchange rate correlations, in the final section of the paper, we study how comovement that arises from the structure of the global trade network is related to currency factors such as carry and dollar (Lustig, Roussanov and Verdelhan, 2011, 2014; Richmond, 2019; Verdelhan, 2018). Given that network closeness explains a substantial fraction of correlations in exchange rates, we investigate if the common factors in exchange rates also manifest themselves as common factors implied by our trade network closeness measure. To do so, we extract the principal components from the covariance matrix implied by trade network closeness. We then show that: (1) countries' loadings on these principal components are closely related to their loadings on the common exchange rate factors, and (2) the common factors embedded in these principal components are also closely correlated with the common exchange rate factors. These findings show the structure of the global trade network helps to explain the origin of common factors in exchange rate.

Overall, our findings provide a trade-based account for the origins of exchange rate correlations, consumption correlations, and common factors in currency markets. Furthermore, by showing that the disconnect between the cross-sectional drivers of quantity and asset price correlations can be explained by a segmented-market model, we provide new evidence on the types of frictions that are important in international financial markets.

Related Literature Our paper contributes to the literature on exchange rate determination. Some recent work includes Gabaix and Maggiori (2015) which highlights the role of capital flows in imperfect financial markets, Farhi and Gabaix (2015) which highlights the role of rare disasters, Colacito and Croce (2011) which highlights the role of long-run risk, Maggiori (2017) which highlights the role of asymmetric financial development, and Itskhoki and Mukhin (2019) which highlights the role of noise traders and risk-averse intermediaries. Pavlova and Rigobon (2007) study the role of demand shocks in a two-country model. We contribute to this literature by showing how exchange rate behavior is related to the structure of the global trade network and that segmented markets within a country can explain the novel disconnect in comovements which we uncover.

Our paper relates to the literature in international finance on comovements and common factors. Lustig, Roussanov and Verdelhan (2011) and Verdelhan (2018) show that exchange rate movements are driven by a few common factors. Lustig and Richmond (2019) show that the exchange rate factor structure is related to bilateral measures of physical, cultural, and institutional distance. Hassan et al. (2021) study how trade deals affect the factor structure in exchange rates and present a model of international trade to explain their findings. This literature also studies how currency risk premia relates to economic fundamentals. In particular, Hassan (2013) studies the effect of country size, Ready, Roussanov and Ward (2017) the effect trade composition between final and commodity goods, Corte, Riddiough and Sarno (2016) studies the effect of external imbalances, and Jiang (2018) studies the relation to government fiscal conditions. Korsaye, Trojani and Vedolin (2020) provide a model-free estimation of exchange rate factors. Hassan et al. (2021) study how trade agreements impact changes in currency risk and present a model to explain these findings.

Our paper is closest to Richmond (2019), which shows how countries' trade network centralities, a measure of their overall positions in the global trade network, are related to their currency risk premia and to their exposure to a global factor in consumption growth. In comparison, our paper documents a quantitative disconnect between the drivers of exchange rate comovements and the drivers of consumption comovements. This disconnect points to a role for market segmentation in explaining international correlations. Both papers highlight the structure of the global trade network as an important source of global comovements. Using our model, we demonstrate how segmentation interacts with the global trade network to generate the measured differences in the drivers of comovements in asset prices and quantities.

Our model builds on earlier segmented-market models of exchange rate determination (Alvarez, Atkeson and Kehoe, 2002, 2009) by considering a multi-country setting with both consumption and production linkages. Our specific setup of segmented markets is most closely related to that of Hassan (2013). Lustig and Verdelhan (2019) show that incompleteness in international financial markets is unlikely to explain key puzzles in exchange rates. Our paper contributes to this literature by studying how segmented markets interacts with the structure of global trade to generate comovements across countries.

Our full model is a segmented markets version of classic international business cycle models (Backus, Kehoe and Kydland, 1992; Colacito et al., 2018). Our model is also related to network and granularity models such as Long Jr and Plosser (1983); Gabaix (2011); Foerster, Sarte and Watson (2011); Acemoglu et al. (2012); Chaney (2014); Acemoglu, Akcigit and Kerr (2016); Baqaee and Farhi (2017, 2018), as well as to the literature that connects asset pricing with input-output linkages across firms such as Herskovic et al. (2016); Herskovic (2018); Gofman, Segal and Wu (2018). We adapt the network model to an international context, and show that international comovements align with predictions from a network model with segmented markets. In a related paper, Huo, Levchenko and Pandalai-Nayar (2018) build a production model with a trade network, and show how the distribution of international GDP comovements would change if technology and non-technology shocks are turned off. In comparison, our work proposes a trade-based closeness measure and studies how it explains bilateral business cycle and exchange rate correlations.

Our work is also related to the literature in international macroeconomics on the comovements in international business cycles. Gregory and Head (1999); Kose, Otrok and Whiteman (2003); Imbs (2004); Calderon, Chong and Stein (2007); Burstein, Kurz and Tesar (2008); Rose and Spiegel (2009) find trade, specialization, and financial integration are relevant for determining comovements in in international business cycles. Bayoumi and Eichengreen (1998); Devereux and Lane (2003) show that trade links and common economic shocks also affect bilateral exchange rate volatility. Stockman and Tesar (1990); Tesar (1993) study comovements in two-country international business cycle models and highlight the role of correlated shocks. Forbes and Rigobon (2002); Bekaert, Hodrick and Zhang (2009) study comovements in international equity returns. Lu and Luo (2019) study how monetary policy affects comovements. Our work structurally relates these comovements to the input-output linkages in the international trade network.

Moreover, the literature on optimal currency areas since Friedman (1953) and Mundell (1961) suggests that countries with correlated business cycles should form currency unions. This is because, on net, countries with more correlated business cycles benefit more from lower transaction costs in international trade. Frankel and Rose (1998) show that countries that trade more tend to have more correlated business cycles. Our paper provides a network-based explanation for the relationship between trade and business cycle correlations and connects these findings to asset prices and factor structures in exchange rates.

1 Reduced-Form Evidence on International Correlations

Our goal is to understand the fundamental sources of comovements in asset prices and quantities across countries. These comovements can arise due to correlated shocks or due to propagation of these shocks through international trade linkages. Countries that have closer trade linkages or more correlated shocks could potentially have higher comovements in quantities and asset prices. To this end, we begin by documenting how cross-country correlations of asset prices and quantities are related to various components of the international trade network and to cross-country correlations of productivity shocks.

We first provide details of the data which we use. Next, we define various measures of trade network closeness. Finally, we show how the measures of trade network closeness and productivity shocks correlations are related to correlations in asset prices and quantities.

1.1 Data Sources

We construct our trade data using global input output tables from two sources. We start with data from Johnson and Noguera (2012) which covers 40 countries from 1974 to 2009. We extend the sample through 2014 using the World Input Output Tables from World Input-Output Database (Timmer et al. (2015)). The combined input output tables contain data on imports of intermediate and consumption goods and a measure of gross output in dollars. We use annual consumption data from the World Bank's World Development Indicators (WDI) to construct consumption growth in local currency units. Data on Total Factor Productivity (TFP) are from annual the Penn World Table (Feenstra, Inklaar and Timmer, 2015). We construct TFP correlations using log TFP growth and consumption correlations using log consumption growth in local currency units. Data on aggregate trade (for calculation of bilateral trade intensity) and distance is from CEPII.

Spot exchange rate data are monthly from Global Financial Data from January 1974 to December 2014. Following Verdelhan (2018) and Lustig and Richmond (2019), we define the currency base factor of country i as the average log exchange rate change with respect to all foreign countries:

$$\Delta \bar{e}_{it} = \frac{1}{N} \sum_{j} \Delta e_{ijt}, \tag{1}$$

where e_{ijt} is the log exchange rate in units of currency j per unit of currency i at time t. This currency base factor measures the average appreciation of exchange rate in country i relative to all other countries. A positive value means an appreciation of country i's currency relative to other currencies. For example, if the base country i is the U.S., then the base factor is effectively the movement in the equal-weighted dollar index.

Our combined dataset runs from 1974 to 2014. We consider two samples of countries when presenting results. Our primary sample contains 19 developed countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, and United States. For robustness, in the Appendix we study a second sample which additionally includes 10 emerging countries: Brazil, China, Greece, Hungary, India, Indonesia, Mexico, Poland, South Korea, and Turkey.

1.2 Measuring Trade Network Closeness

We are interested in measuring countries' closeness in the global trade network. Broadly speaking, countries are closer in the global trade network if they share a more similar set of trade linkages, either bilaterally or with other countries. We also distinguish between closeness in trade in intermediate and consumption goods.

We first measure countries' import shares using data from the World Input-Output Tables (WIOT). By employing WIOT data, we are also able to distinguish imports for intermediate usage from imports for final consumption. For two countries i and j at time t, we define w_{ijt} as the dollar-value of imports of intermediate goods from country j by country i relative to the dollar-value gross output of country i. We define v_{ijt} as the dollar-value imports of final consumption goods from country j by country i relative to the dollar-value of gross consumption by country i. We refer to the matrix W_t with elements w_{ijt} as the production weight matrix and the matrix V_t with elements v_{ijt} as the consumption weight matrix. Each row of these matrices contains the import shares in production and consumption goods for each country i at time t.

For all measures of closeness we study two time windows: full-sample and rolling window. For our primary results we construct closeness measures using averages of the W_t and V_t matrices over the full sample from 1974 to 2014. We label these time-invariant matrices as W and V with elements w_{ij} and v_{ij}, and use them to explain the comovements of asset prices and quantities over our full sample window. We also construct time-varying measures of closeness to examine how they align with the time-series variation in the comovements of asset prices and quantities. To do so, we compute 10-year rolling averages of W_t and V_t and use these as inputs to measure time-varying closeness. For exposition in the following, we use the time-invariant matrices to describe the construction of our closeness measures.

Using the matrices of bilateral trade weights, we construct measures of trade network closeness for each country pair. Our measures of trade network closeness between two countries i and j are based upon the dot product between components of their vectors of bilateral trade shares in consumption and intermediate goods. We define full consumption (denoted with V) closeness between countries i and j as:

$$\mathcal{C}^{V-Full}(i,j) = \{V \cdot V'\}_{ij} = \sum_{k=1}^{N} v_{ik} v_{jk}.$$

Countries have higher consumption closeness when they have more similar profiles of consumption trade shares. This definition of closeness is motivated by cosine similarity. We use just the dot product rather scaling by the norms of the vectors so that we can decompose the closeness measure into bilateral and network components. As a result, the matrix of the full consumption closeness values is given by $V \cdot V'$, with each element being the closeness between a pair of countries.

We decompose our measure of closeness into two components which we refer to as bilateral and network closeness. Bilateral consumption closeness is defined as:

$$\mathcal{C}^{V-Bilateral}(i,j) = v_{ii}v_{ji} + v_{ij}v_{jj}.$$

This bilateral component of the full closeness measure captures the closeness of countries due to the direct trades in consumption goods between the country pair. The second component of the full closeness measure, which we refer to as network consumption closeness, is given by:

$$\mathcal{C}^{V-Network}(i,j) = \sum_{k\neq i,j} v_{ik}v_{jk}.$$

Network consumption closeness captures the similarity of the two countries' consumption shares due to their common linkages to other countries. For example, if two countries trade more with each other, they will have higher bilateral closeness. In comparison, if they both trade more with a third country, they will have higher network closeness. By construction, full consumption closeness is equal to the sum of bilateral and network closeness:

$$\mathcal{C}^{V-Full}(i,j) = \mathcal{C}^{V-Bilateral}(i,j) + \mathcal{C}^{V-Network}(i,j).$$

We similarly define the measures of trade closeness in intermediate (denoted with W) goods: $C^{W-Full}(i,j) = \sum_{k=1}^{N} w_{ik}w_{jk}$, $C^{W-Bilateral}(i,j) = w_{ii}w_{ji} + w_{ij}w_{jj}$, and $C^{W-Network}(i,j) = \sum_{k\neq i,j} w_{ik}w_{jk}$. These production closeness measures simply replace the matrix V in the above expressions with the production weight matrix W.

1.3 International Comovements in the Cross-Section

We now turn to studying the relation between our measures of trade network closeness, correlations of productivity growth, and international comovements of quantities and of exchange rates. Specifically, we run regressions of the correlations of consumption growth and correlations of currency base factors, which we refer to as exchange rate correlations, on various bilateral explanatory variables:

$$corr\left(\Delta\bar{e}_{it}, \Delta\bar{e}_{jt}\right) = \alpha + \beta' x_{ij} + \varepsilon_{ij}, \quad (2)$$

$$corr(\Delta\bar{c}_{it}, \Delta\bar{c}_{jt}) = \alpha + \beta' x_{ij} + \varepsilon_{ij}. \quad (3)$$

The bilateral explanatory variables x_{ij} include measures of trade network closeness, productivity (TFP) growth correlations, bilateral trade intensity, and distance. We standardize each of these variables to simplify the interpretation of the coefficients. For all bilateral regressions we only select the set of unique country pairs. That is, our sample contains the pair (i, j), but does not include (j, i), (i, i), and (j, j). For the main paper we focus on the sample of 19 developed countries and present results for the developed and emerging sample in the Appendix.

We first focus on the explanatory power of trade network closeness versus the explanatory power of TFP correlations. In particular, we find that exchange rate correlations tend to be explained by trade network closeness while consumption correlations tend to be explained by TFP correlations. Table (1) presents regressions of exchange rate correlations (top panel) and consumption correlations (bottom panel) on measures of trade network closeness and TFP correlations. Beginning with the top panel, models 1–6 all use trade network closeness and show that countries which have higher trade network closeness have higher currency base factor correlations. The R-squared in models 1–6 range from 18% to 31%. Model 7 shows that countries which have a higher TFP correlation do tend to have higher exchange rate base factor correlations, but the R-squared of 11% in this regression is substantially lower than models 1–6. These patterns in explanatory power for trade network closeness and TFP correlations reverse when studying consumption correlations in the bottom panel. When explaining consumption correlations, the R-squared with trade network closeness ranges from 6–9% for models 1–6, while the R-squared for the model with TFP correlations is 28%.

To further demonstrate that exchange rate correlations tend to be explained by trade network closeness while consumption correlations tend to be explained by TFP correlations, we study the boostrapped distribution of the R-squareds in the previous regressions. For each iteration of the bootstrap, we randomly sample the years of data with replacement in order to build a bootstrapped sample of the same length as our original data. For this resampled data we compute our trade network closeness measures, TFP correlations, exchange rate correlations, and consumption growth correlations. We then compute the regression's R-squareds at each iteration and repeat this 10,000 times. This approach preserves the cross-sectional correlations induced by the network or particular shock realizations within a given year.

We present the bootstrapped distribution of the R-squareds in Figure (1). The top panel presents the R-squared for exchange rate correlations and the bottom panel for consumption correlations. We include the R-squared from models 3 ($V - Full$), 6 ($W - Full$), and 7 (TFP Correlation) in Table (1). The top panel shows that when explaining exchange rate correlations the R-squared for the trade network closeness models is signifcantly higher than the TFP correlation model: the 95% confidence interval for the difference in R-squared between using $V - Full$ closeness and TFP correlations is .058 to .224 (.031 to .201 for $W - Full$ minus TFP correlations). In contrast, the bottom panel shows that when explaining consumption correlations the R-squared for TFP correlation mode is signifcantly higher than the the trade network closeness models: the 95% confidence interval for the difference between using TFP correlations and $V - Full$ closeness for consumption corrlations is .044 to .327 (.036 to .317 for TFP correlation R-squared minus $W - Full$ R-squared).

Both the bilateral and the network closeness measures matter for explaining exchange rate correlations. Returning to the first panel of Table (1), model 1 shows that bilateral consumption closeness explains a substantial share of exchange rate correlations. In model 2, we add network consumption closeness and show that both the bilateral and the network measures explain exchange rate correlations. The bottom row presents the p-value of a likelihood-ratio test between the nested models 1 and 2 and shows that including consumption network closeness significantly increases the goodness-of-fit. Model 3 presents a univariate regression with full consumption network closeness, which is also significant. Given that full network closeness is the sum of bilateral and network closeness, the difference in the R-squared in model 2 versus 3 arises due to allowing different loadings on network closeness in model 2. Models 4–6 replicate models 1–3, but use production network closeness instead. The marginal explanatory power of production network closeness is somewhat higher than that of the consumption network closeness, though these measures are themselves highly correlated. Overall, these results demonstrate that the structure of the trade network matters for exchange rate correlations over and above direct bilateral trade linkages.

Adding Controls. We next consider the explanatory power of our trade network closeness measures for exchange rate correlations when controlling for other variables. We first introduce bilateral trade intensity as an alternative measure of trade linkages. Bilateral trade intensity (BTI) is calculated as total bilateral trade between a pair of countries divided by the sum of their GDPs. BTI therefore combines trade in consumption and production goods into one measure and also uses a different functional form than our trade network closeness measures. The results are presented in Table (2). Model 1 shows that BTI itself explains a similar amount of exchange rate correlations to our network closeness measures. Models 2 and 3 introduce bilateral and network consumption closeness and show that our measures of network closeness remain significant when controlling for BTI. Model 4 shows that full consumption network closeness also is a significant determinant of exchange rate correlations when controlling for BTI. Finally, models 4–7 show that production based closeness measures also remain significant when controlling for BTI. Overall, we conclude that our measures of trade network closeness are key determinants of exchange rate correlations, even controlling for BTI. Furthermore, we prefer our measures of network closeness as they allow us to cleanly separate bilateral and network connections as well as consumption from production closeness.

We also introduce bilateral log distance as a control in Table (3). Models 1–3 explain exchange rate correlations and models 4–6 explain consumption correlations. Models 1 and 2 show that while distance is a significant determinant for exchange rate correlations, our measures of consumption and production network closeness remain significant in multivariate specifications. Model 3 shows how distance affects exchange rate correlations controlling for TFP correlations, which are insignificant in this specification. Interestingly, models 4–6 show that distance does not explain consumption correlations and that TFP correlations (model 6) still remain the most powerful explanatory variable for consumption correlations.

Explaining Time-Series Variation in Correlations. Our previous results demonstrate the relation of cross-country correlations of exchange rates and consumption growth to trade network closeness and TFP correlations over the full-sample from 1974 to 2014. While these correlations do have a stable component, there also exists time-series variation in the correlations. We now study whether the time-series variation in correlations is related to the time-series variations in trade network closeness and TFP correlations.

Consistent with our prior findings, we find that the time-series variation in our measures of trade network closeness also explains the time-series variation in exchange rate correlations, while the time-series variation in TFP correlations explains the time-series variation in consumption correlations. To show this, we estimate regressions using conditional exchange rate and consumption correlations:

$$corr_t\left(\Delta\overline{e}_{it}, \Delta\overline{e}_{jt}\right) = \delta_{ij} + \delta_t + \beta' x_{ijt} + \varepsilon_{ijt}, \tag{4}$$

$$corr_t(\Delta\overline{c}_{it}, \Delta\overline{c}_{jt}) = \delta_{ij} + \delta_t + \beta' x_{ijt} + \varepsilon_{ijt}. \tag{5}$$

These regressions include year fixed effects, δ_t, and country-pair fixed effects, δ_{ij}.[2] By including country-pair fixed effects, we also control for bilateral time-invariant characteristics, such as distance. The results are presented in Table (4). Models 1 and 2 show that the time-series variation in both consumption and production closeness explain time-series variation in exchange rate correlations. Model 3 shows that the time-series variation in TFP correlations do not appear to be

[2] We compute all inputs in these regressions using 10-year non-overlapping windows. Specifically, we use data from 1975—1984, 1985—1994, 1995—2004, and 2005—2014 to calculate FX, consumption, and TFP correlations along with our measures of trade network closeness.

significantly related to changes in exchange rate correlations. Models 4–6 show that the opposite is true for consumption correlations—changes in TFP correlations explain changes in consumption correlations, while changes in trade network closeness have insignificant explanatory power.[3]

Developed and Emerging Sample. We also study a larger sample of developed and emerging countries and find similar results to our developed sample. We present these results in Appendix B. In Table (A1) we study the unconditional relation among these variables and find similar results: (1) trade network closeness tends to explain exchange rate correlations while TFP correlations tend to explain consumption correlations and (2) network closeness explains exchange rate correlations over and above bilateral closeness for both consumption and production based measures. Table (A2) presents results including gravity controls and shows thats our measures of trade network closeness remain significant. Finally, Table (A3) provides evidence that time-series variation in trade network closeness explains time-series variation in exchange rate correlations, while time-series variation TFP correlations explains time-series variation in consumption correlations.

2 A Network Model of International Comovements

To explain the empirical findings in the previous section, we now present a general equilibrium model of international trade and asset prices. The model allows us to shine light on a number of the findings. First, we show how the structure of the global trade network interacts with primitive shocks to give rise to international comovements in asset prices and quantities. Second, we demonstrate why both bilateral and network closeness measures are important for understanding these comovements. Finally, we explain the source of the disconnect between what explains exchange rate correlations and consumption correlations.

We start with a general model, and then consider special cases that generate tractable results to

[3]Our findings here relate to the work of Gavazzoni and Santacreu (2020), who study how innovation diffuses across countries through trade as well as through common increases in productivity. Interpreted broadly, our findings here suggest that common changes in productivity (TFP) across countries tends to affect their consumption comovements. On the other hand, changes in trade that may occur due to innovation diffusion appear to affect asset prices.

further develop intuition for a number of our empirical findings. Then, in Section (3), we calibrate the model to quantitatively match the empirical patterns we uncovered in Section (1).

2.1 Model Set-Up

Time is discrete and infinite, indexed by $t = \{1, 2, \ldots\}$. There is no storage technology that allows agents to transfer goods across periods. There are N countries, each popluated by a unit mass of households and indexed by $i \in \{1, \ldots, N\}$. Each household is one of two types: active (with share ψ) and inactive (with share $1 - \psi$).

There are two types of goods: intermediate and final consumption goods. Each country has a distinct intermediate good which is used for production of other intermediate goods. Production of intermediate goods is undertaken by the active households in each country. Consumption goods are assembled as a basket of intermediate goods. We first turn to the production of intermediate goods.

Active Households: Intermediate Goods and Production. Active households in each country produce a distinct intermediate tradable good using labor and tradable intermediate goods from different countries. Each active household in country i has an identical Cobb-Douglas production function of the form

$$\overline{X}_{it} = A_{it} L_{it}^{\theta_i} \left(\prod_{j=1}^{N} X_{ijt}^{w_{ij}} \right),$$

where A_{it} is the productivity level, L_{it} is the labor input, and X_{ijt} is the quantity of the intermediate goods produced by country j that are used as production inputs in country i. The parameter θ_i measures the contribution of country i's labor, and the parameters w_{ij} measure the contribution of each country j's input. We assume that

$$\theta_i + \sum_{j=1}^{N} w_{ij} = 1 \text{ and } \theta_i, w_{ij} > 0,$$

so that the production function has constant returns to scale. We collect the intermediate goods production paramters w_{ij} into a matrix W.

Notably, we do not model any exogenous endowment processes. The quantity of intermediate goods produced by each country is endogenously determined by the labor input, the quantity of intermediate good inputs, and the level of productivity.

Active Households: Final Consumption Goods and Preferences. Active households in country i assemble their final consumption good from different countries' intermediate goods. Let $\overline{C}_{it}$ denote the active households' quantity of the final consumption good, which is derived from a Cobb-Douglas production function:

$$\overline{C}_{it} = \prod_{j=1}^{N} C_{ijt}^{v_{ij}}, \tag{6}$$

where C_{ijt} is the quantity of the intermediate goods produced by country j used as the production inputs by i. The parameters satisfy

$$\sum_{j=1}^{N} v_{ij} = 1 \text{ and } v_{ij} > 0.$$

We collect the final goods' production paramters v_{ij} into a matrix V. Along with the intermediate goods' production weights W, the matrix V will be a key source of international comovements in the model.

The active households have $\log$ preferences over their aggregate consumption, and discount future utility at rate β. The utility function is

$$\sum_{t=1}^{\infty} \exp(-\beta t) \log \overline{C}_{it}.$$

The active households also have access to complete financial markets, where they can trade contingent claims with the active households in any country.

Inactive Households. Within each country, inactive households have identical preferences to the active households. We denote quantities chosen by the inactive households with hats. Inactive households final consumption is denoted by $\hat{\overline{C}}_{it}$, which is also aggregated over their consumption of each country's intermediate good: $\hat{\overline{C}}_{it} = \prod_{j=1}^{N} \hat{C}_{ijt}^{v_{ij}}$.

In contrast to the active households, who can produce intermediate goods and have access to complete financial markets, we assume that the inactive households do not produce and cannot trade any financial assets. Instead, they receive a stochastic transfer $p_{it}e^{\mu_{it}}$ from the active households, where p_{it} is the price index of a unit of the final consumption bundle in country i at time t in a common numeraire, and μ_{it} is the size of the transfer shock. They can use this transfer to purchase any intermediate goods.[4]

Inactive households maximize their utility subject to the intra-period budget constraint:

$$p_{it}\hat{\overline{C}}_{it} \quad \leq \quad p_{it}e^{\mu_{it}}.$$

Market Clearing. We study the competitive equilibrium defined in the usual fashion: All households maximize their utilities taking prices as given and market clearing conditions for each good and labor are satisfied. Since the share of active households is $0 < \psi \leq 1$, the aggregate output of country i's intermediate good is $\psi\overline{X_i}$. Adding across production inputs and active and inactive households' consumption demand, the market clearing condition for country i's intermediate good is

$$\psi\overline{X_i} \quad = \quad \psi\sum_{j=1}^{N}(C_{ji} + X_{ji}) + (1-\psi)\sum_{j=1}^{N}\hat{C}_{ji}.$$

On the left-hand side, we have the total output of country i's intermediate good by active households. On the right-hand side, we have the demand for this good from each country's active and inactive households. Note that the households import this intermediate good not only for producing

[4]Hassan (2013) motivates this set-up by assuming the inactive households cede their claims to the active households in exchange for a nominal bond with a stochastic real payoff, effectively becoming hand-to-mouth.

their own intermediate good, but also for producing their final consumption good.

Let q_i denote the market price of intermediate good i in a common numeraire. For notational convenience, we use D_i to denote the demand for country i's intermediate good from the inactive households in all countries, which is given by

$$D_i = q_i \left(\frac{1}{\psi} - 1\right) \sum_{j=1}^{N} \hat{C}_{ji}. \tag{7}$$

With this definition, the market clearing condition can be written as

$$q_i \overline{X}_i = q_i \sum_{j=1}^{N} (C_{ji} + X_{ji}) + D_i. \tag{8}$$

This equation describes the market for country i's intermediate good from the perspective of active households. The left-hand side denotes the value of the total supply of this good in the common numeraire, and the right-hand side denotes the value of the production- and consumption-based demand for this good from the active households, plus the demand from the inactive households, D_i. The term D_i therefore takes a certain amount of the good away from what is available to the active households and will in equilibrium increase the price of this good. As a result, we can think about the stochastic variable D_i as a demand shock to country i's intermediate goods. We emphasize that this demand shock originates from the consumption of inactve households that is funded by the transfers μ_i.

Labor supply is fixed. The market clearing condition for country i's labor is

$$L_{it} = \overline{L}_i.$$

Primitive Shocks. There are two sources of exogenous shocks in the model: supply shocks that affect productivity and demand shocks that affect the resource constraint. We assume the log productivity level, a_{it}, and the log transfer shock, μ_{it}, in each country follow a random walk with a normal innovation:

$$
\begin{aligned}
a_{it+1} &= a_{it} + \varepsilon_{it+1}^{S}, \\
\mu_{it+1} &= \mu_{it} + \varepsilon_{it+1}^{\mu},
\end{aligned}
$$

where ε_{it+1}^{S} denotes a normal supply shock and ε_{it+1}^{μ} denotes a normal transfer shock in country i. For the convenience of presentation, we also express the law of motion for the demand from inactive households, D_{it}, as

$$
D_{it+1} = D_{it} + \varepsilon_{it+1}^{D},
$$

where ε_{it+1}^{D} is determined by the inactive households' consumption via Eq. (7), which is in turn driven by the transfers $\exp(\mu)$ whose shocks are log-normal.[5] All of the shocks are i.i.d. across time, but they can be correlated across countries.

2.2 Trade Network and Shock Transmission

We next characterize the equilibrium of the model and show how the structure of global production transmits shocks across countries. We use lower case letters to represent the logs of their uppercase counterparts. A variable with its country subscript omitted is a vector. For example, $\bar{c}_t$ is the vector where each element is $\bar{c}_{it} = \log \overline{C}_{it}$. A capitalized parameter with two country indices omitted is a matrix. For example, W is the matrix with each element being w_{ij}.

Since the active households have access to the complete markets, their competitive equilibrium can be characterized by the solution to a social planner's problem. Within period t, the social planner's Lagrangian is

$$
\sum_{i=1}^{N} \lambda_i \left(\sum_{j=1}^{N} v_{ij} \log C_{ij} \right) + \varphi_i \left(A_i L_i^{\theta} \left(\prod_{j=1}^{N} X_{ij}^{w_{ij}} \right) - \sum_{j=1}^{N} (C_{ji} + X_{ji}) - D_i \right) + \chi_i (\bar{L}_i - L_i),
$$

[5] The demand shock ε_{it+1}^{D} cannot be unbounded in our setting. In the next section, we provide a parameterization where we constrain the size of the shock to ensure that markets clear.

where λ_i is the Pareto weight that the social planner assigns to country i. This Pareto weight is determined by the initial level of wealth held by each country's active households.

A key variable that emerges from the model is a function of trade network parameters for intermediate usages, W, and consumption, V. We define the network profile matrix as:

$$H \equiv V(I - W)^{-1}.$$

Solving the planner's Lagrangian, we derive the the following lemma to characterize the real quantities in equilibrium.

Lemma 1 (Equilibrium Consumption)**.** *In equilibrium, the vector of each country's active households' log consumption is*

$$\bar{c} = \kappa^c + H(a - \theta \log(H'\lambda + (I - W')^{-1}D)), \tag{9}$$

for some vector of constants κ^c.

This lemma shows that the structure of the global trade network, summarized by the network profile matrix $H = V(I - W)^{-1}$, plays an important role in transmitting both the supply shocks (a) and the demand shocks (D). The network profile matrix combines the production trade network W and the consumption trade network V. The term $(I - W)^{-1}$ is commonly known as the Leontief inverse, which summarizes the transmission of the productivity shocks. Notice that $(I - W)^{-1} = I + W + W^2 + W^3 + \ldots$, where W reflects the transmission from the exporting country to the importing country, and W^k for $k > 1$ reflects the transmission of shocks due to higher order linkages.

Taking a first-order approximation, we can express the active households' log consumption growth as a linear function of the supply shocks ε^S and the demand shocks ε^D:

$$\Delta\bar{c} \approx H\left(\varepsilon^S - \frac{\theta}{H'\lambda}(I - W')^{-1}\varepsilon^D\right), \tag{10}$$

where $\frac{1}{H'\lambda}$ is a diagonal matrix whose element (i,i) is $\frac{1}{\{H'\lambda\}_i}$. This expression shows that each country's active household consumption growth is driven by a combination of demand and supply shocks of, potentially, all other countries globally. The specific combination of shocks that a country is exposed to is primarily determined by the structure of global trade linkages summarized by the network profile matrix H. This common exposure to country-level shocks that arises due to trade linkages gives rise to international comovements, which we study in the next section.

2.3 Characterizing Consumption and FX Comovements

We are interested in characterizing international comovements in consumption growth and exchange rates. Let $Var[z]$ denote the variance-covariance matrix for a vector of stochastic variables z. We define a general measure of *closeness* between two countries i and j as

$$\mathcal{C}(i,j) \equiv \left\{ H \cdot Var\left[\varepsilon^S - \frac{\theta}{H'\lambda}(I - W')^{-1}\varepsilon^D\right] \cdot H' \right\}_{ij}, \tag{11}$$

which measures the pairwise similarity of the shocks which drive countries' quantities. Indeed, this measure is directly related the covariance of *active* household's consumption growth (Equation (10)), as shown by the following proposition:

Proposition 1 (Active Households' Consumption Growth)**.** *Closer countries have more correlated active household consumption growth:*

$$cov\left(\Delta\bar{c}_{it}, \Delta\bar{c}_{jt}\right) = \mathcal{C}(i,j).$$

This proposition shows that the covariance of active household consumption growth across countries depends on two components: (1) the factor structure of the supply shocks (ε^S) and demand shocks (ε^D) through the middle variance-covariance matrix in Equation (11); and (2) the structure of the trade network (H) that propagates demand and supply shocks. In the following section, we present a number of special cases to understand how the various components of closeness drive international comovements.

Now that we have characterized the correlations of active households' consumption growth, we can also characterize exchange rate comovements. We define the bilateral log real exchange rate between countries i and j, e_{ijt}, as the log price of country j's consumption bundle per unit of country i's consumption bundle. An increase in e_{ijt} implies an appreciation of country i's real exchange rate relative to country j's. Since markets are complete for the active households, the bilateral exchange rate movement is determined by the difference in the growth rates of marginal utilities of the active households in the two countries, which is driven by the active households' consumption growth differential:

$$\Delta e_{ijt} = \Delta \bar{c}_{jt} - \Delta \bar{c}_{it}.$$

We define each country's *currency base factor*, $\Delta \bar{e}_{it}$, as the equal-weighted average log real exchange rate change against all countries, including itself:

$$\Delta \bar{e}_{it} = \frac{1}{N} \sum_{j=1}^{N} \Delta e_{ijt}.$$

This is the model equivalent of Equation (1). With these definitions, we obtain the following proposition which relates closeness to the behavior of exchange rates:

Proposition 2 (Exchange Rate Movements)**.** *(a) Closer countries have more correlated currency base factors and less volatile bilateral real exchange rate movements:*

$$\begin{aligned} cov\left(\Delta \bar{e}_{it}, \Delta \bar{e}_{jt}\right) &= \mathcal{C}(i,j) - \overline{\mathcal{C}}(i) - \overline{\mathcal{C}}(j) + \kappa^e, \\ var(\Delta e_{ijt}) &= -2\mathcal{C}(i,j) + \mathcal{C}(i,i) + \mathcal{C}(j,j), \end{aligned}$$

where κ^e is a constant:

$$\kappa^e = \frac{1}{N^2} \sum_{k=1}^{N} \sum_{\ell=1}^{N} \mathcal{C}(k,\ell),$$

and $\overline{\mathcal{C}}(i)$ is the average closeness between country i and all countries:

$$\overline{\mathcal{C}}(i) \quad = \quad \frac{1}{N}\sum_{j=1}^{N}\mathcal{C}(i,j).$$

(b) The variance of country i's currency base factor is

$$var\left(\Delta\overline{e}_{it}\right) \quad = \quad -2\overline{\mathcal{C}}(i)+\mathcal{C}(i,i)+\kappa^{e}.$$

Fixing its closeness to itself $\mathcal{C}(i,i)$, the country's currency base factor is less volatile if it has a higher average closeness.

Propositions 1 and 2 show that our closeness measure, $\mathcal{C}$, is a key driver of exchange rate and active household consumption growth correlations. A key empirical finding in Section (1.3) was that exchange rate correlations tend to be explained by measures of trade network closeness, while consumption correlations tend to be explained by supply (TFP) shock correlations. The key to explaining this disconnect theoretically turns out to be the market segmentation due to the presence of inactive households. More precisely, the aggregate consumption in a country can be expressed as the population-weighted average of the consumption of active and inactive households:

$$\overline{C}_{i}^{aggregate} \quad = \quad \psi\overline{C}_{i}+(1-\psi)\hat{\overline{C}}_{i}.$$

The inactive households in our model allow us to disentangle aggregate consumption correlations across countries from exchange rate correlations. To the see impact of inactive households on exchange rates and consumption we consider a positive transfer shock μ_{it} in country i. This shock transfers resources from country i's active households to its inactive households.

First, consider the impact of this transfer shocks on the real exchange rate. With home bias in consumption, consumption of active households in country i will still be disproportionally affected by this shock, even though risks are perfectly shared among active households. This decline in active households' consumption raises their marginal utility and the price of that country's consumption bundle, leading to a real appreciation of country i's currency.

Second, consider the impact of this transfer shock on this country's aggregate consumption. While the transfer shock lowers active household's consumption, it increases inactive household's consumption. Since the active and inactive households in this country have the same preferences and therefore pick the same consumption basket, if we fix the terms of trade, the transfer shock will not affect the aggregate consumption level in the country. This can be thought of as the first-order effect. Of course, the terms of trade do move in response to transfer shocks and generate second-order effects. On balance, the equilibrium effect of a given transfer shock on the aggregate consumption level in country i depends on the size of the shock as well as a number of model parameters. That said, a given transfer shock does not necessarily give rise to a strong association between the exchange rate movement and the aggregate consumption growth.

In Section (3), we calibrate the model to precisely show how the model generates the disconnect between the drivers of exchange rate and consumption correlations. Before turning to the calibration, we next present special cases from the model to explain a number of our empirical findings.

2.4 Revisiting the Empirical Findings Through the Lens of Model

Our model provides a clear interpretation of our empirical findings in Section (1). We first note that the parameters in the production matrix W and the consumption matrix V have a direct mapping to the trade shares which we use to construct closeness in Section (3). Lemma 2 in Appendix A.2.2 provides the detail. As a result, we can interpret our model-based closeness measures as the theoretical counterparts to our empirical closeness measures.

Propositions 1 and 2 show that the correlation structure in the active households' consumption and hence exchange rate movements are related to the closeness measure in Equation (11), which was defined as,

$$\mathcal{C}(i,j) \equiv \left\{ H \cdot Var\left[\varepsilon^S - \frac{\theta}{H'\lambda}(I - W')^{-1}\varepsilon^D\right] \cdot H' \right\}_{ij}.$$

In this closeness measure, the correlation structure in the productivity shocks ε^S interacts non-linearly with the network linkages, summarized by the network profile matrix H, and the correlation structure in the demand shocks, ε^D. To isolate their respective contributions to the correlation structure in exchange rates, we define the model's trade-based full closeness measure as:

$$\mathcal{C}^{H-Full}(i,j) \quad = \quad \{HH'\}_{ij} = \{V(I-W)^{-1}V'(I-W')^{-1}\}_{ij}, \tag{12}$$

which we refer to as network closeness. This is a special case of the general closeness measure when supply and demand shocks in each country are jointly i.i.d. with unit variance, i.e., $Var\left[\varepsilon^S - \frac{\theta}{H'\lambda}(I-W')^{-1}\varepsilon^D\right] = I$. In this case, closeness is determined solely by the dot product between the vector representing country i's network profile, H_i, and the vector representing country j's network profile, H_j. This closeness measure summarizes two countries' similarity in their trade linkages in both intermediate goods and final consumption goods. In particular, this similarity is high if these two countries both have large quantities of bilateral trade with third countries k, i.e., $H_{ik}, H_{jk} \gg 0$. In other words, two countries' closeness is not just determined by their bilateral trade, but also by who they share as common trade partners.

We can obtain the model-based counterparts to our empirical measures of closeness from Section (1) by studying special cases of the $\mathcal{C}^{H-Full}$ closeness. First, assuming that production has complete home bias towards home intermediate goods (i.e., $W = (1-\theta)I$) and substituting in Equation (12), we obtain the analog to full consumption closeness:

$$\mathcal{C}^{V-Full} = (1-\theta)^2 VV'.$$

Next, if the final consumption has perfect home bias towards home goods (i.e., $V = I$), we obtain the analog to full production closeness:

$$\mathcal{C}^{W-Full} = WW'.$$

Our empirical findings in Section (1) showed that consumption closeness, $\mathcal{C}^{V-Full}$, and production closeness, $\mathcal{C}^{W-Full}$, both capture significant variations in exchange rate correlations. Our model implies that the network closeness, $\mathcal{C}^{H-Full}$, aggregates information from the trade linkages for both final consumption and intermediate goods. To test the relation between the model-implied measure of trade network closeness and international correlations, we construct the empirical analog to $\mathcal{C}^{H-Full}$. We then regress currency base factor correlations and consumption correlations on this closeness measure:

$$corr(\Delta\overline{e}_{it}, \Delta\overline{e}_{jt}) \text{ or } corr(\Delta\overline{c}_{it}^{aggregate}, \Delta\overline{c}_{jt}^{aggregate}) = \alpha + \beta\mathcal{C}^{H-Full}(i,j) + \varepsilon_{i,j}.$$

We report the results of these regressions in columns (1) and (3) of Table (5). For comparison, we include the regressions on TFP correlations in columns (2) and (4), as in Table (1). This is also a special case of the closeness measure if there are no demand shocks (i.e., $\varepsilon^D = 0$) and the countries do not trade with each other (i.e., $V = I$ and $W = (1-\theta)I$). Consistent with our empirical results in Section (1), trade network linkages explain more variation in exchange rate correlations, while TFP correlations explain more variation in consumption correlations. Furthermore, our model-based measure of trade network closeness has similar explanatory power to the reduced form measures of trade network closeness which we studied in Section (1).

Implications for FX Variance. Beyond implications for bilateral correlations, our model also has implications for the variance of each country's currency base factor. Each country's currency base factor variance describes its volatility with respect to the average of foreign currencies. It is economically meaningful as it measures the systematic variation of a currency from the perspective of residents of each country (Lustig and Richmond, 2019).

Proposition 2(b) shows that currency base factor variances are proportional to each country's average closeness. As further validation of our model, we study how the observed currency base factor variances relate to average closeness computed from the model-implied trade network closeness measure. In particular, using our H-full closeness matrix we compute $-2\overline{\mathcal{C}}(i) + \mathcal{C}(i,i)$, which is the model implied currency base factor variance for a given closeness measure.

In Figure (2) we plot currency base factor variances in the data versus this model implied measure. We standardize both the model implied and empirical measure, so that we do not have to take a stand on the volatility of the shocks in the model implied measure. As the figure illustrates, average network closeness explains actual currency base factor variances in a way that is consistent with Proposition 2(b). This suggests that the variance of a country's currency base factor is closely related to where a country is positioned in the global trade network relative to others. This pattern is not obvious when we consider standard currency risk factors. For example, both Japan and Australia have high base factor variances, yet the Japanese Yen is a funding currency in the carry trade whereas the Australian Dollar is an investment currency. Our measure of network closeness, on the other hand, correctly predicts both currencies have high base factor variances. This result relates currency base factor variances to the underlying structure of the global trade network, further reinforcing the importance of the structure of the global trade network for explaining international asset price behavior.

3 Model Estimation

Having shown how our model generates the relation between trade network closeness and international comovements, we now turn to understanding further properties of our model. Our goal is to show that our model can reproduce a number of key moments in the data, taking the observed heterogeneity in the trade network and TFP correlations into account. In particular, we first discipline the model parameters using the observed network of trade linkages and other observable moments. Then, we estimate the remaining unobservable parameters of the model to match key moments in international markets. Finally, by shutting down different channels in the estimated model, we show the key mechanisms through which the model generates the disconnect between the drivers of exchange rate and consumption comovements.

3.1 Calibration Choices

We calibrate and estimate the model on our sample of 19 developed countries. We start by disciplining the model's trade network to match the network observed in the data. Using Lemma 2 in Section (A.2.2), we derive a simple mapping from the observed trade quantities to the network parameters. Lemma 2 shows that the production matrix W, the consumption matrix V, and the labor share θ can be directly mapped to observed input shares of intermediate and final consumption goods and the shares of value-added.[6] We compute the implied W, V, and θ from the yearly WIOT data and take averages over time as in Section (1).

We assume that the supply shocks and the transfer shocks are normally distributed. We use the observed variance-covariance matrix of log TFP growth from the Penn World Tables to discipline the distribution of the supply shocks. We impose a simple and parsimonious structure by considering a stationary economy in which the expected TFP level, the expected transfer level, and the share of inactive households are constant and identical across countries. Then, without loss of generality, we normalize the expected TFP level to 1 and estimate values for the expected level of transfer shocks and the share of inactive households in the next subsection.

3.2 Estimation Procedure

The remaining parameters of the model are the level of the transfer shocks ($\bar{\mu}$), the share of active households (ψ), and the variance-covariance matrix of the transfer shocks. We assume that this variance-covariance matrix is governed by two parameters:

$$\mu_{it} - \bar{\mu} \quad = \quad \kappa_1 \varepsilon_{it}^{S} + \kappa_2 \varepsilon_{it}^{\mu}.$$

The first parameter κ_1 describes the loading of each country's transfer shock on its own productivity shock. If $\kappa_1 > 0$, then, each country's transfer shock is positively correlated with its supply shock.

[6] As specified by Lemma 2, we use gross import shares when measuring the components of W and V, where the shares are relative to total imports. To focus on heterogeneity that arises due to the structure of the trade network, we normalize W and θ so that θ_i is equal across countries.

The second parameter κ_2 describes transfer shocks' idiosyncratic volatilities. The innovations ε_{it}^{μ} are i.i.d. across periods and across countries. Since κ_2 is identical across countries, each country's transfer shock has the same level of idiosyncratic volatility.

In this way, taking the observed trade network and TFP shock correlations as given, we use 4 parameters ($\bar{\mu}$, ψ, κ_1, and κ_2) to describe this model. To estimate these parameters, we minimize the sum of the squared errors of 8 moments, whose empirical values are reported in Column (1) of Table (6)(a). First, to target exchange rate behavior, we include the average volatility of currency base factors' and their average pair-wise correlation. In our sample, the average volatility, $std(\Delta\bar{e}_{it})$, is about 6% per annum, and the average pairwise correlation between currency base factors, $corr(\Delta\bar{e}_{it}, \Delta\bar{e}_{jt})$, is -0.03.

Second, to target consumption behavior and its relation to exchange rates, we include the average pairwise correlation of each country's log consumption growth, and the average Backus-Smith correlation (Backus and Smith, 1993). The Backus-Smith correlation is defined as the correlation between the bilateral log exchange rate movement and the relative log consumption growth differential between the U.S. and each foreign country. In our sample, the average pairwise consumption correlation, $corr(\Delta\bar{c}_{it}^{aggregate}, \Delta\bar{c}_{jt}^{aggregate})$, is about 0.3, and the average Backus-Smith correlation, $corr(\Delta e_{ijt}, \Delta\bar{c}_{jt}^{aggregate} - \Delta\bar{c}_{it}^{aggregate})$, is -0.15.

Lastly, to target the new cross-sectional patterns uncovered in our paper, we include the four R-squareds values from the regressions of exchange rate correlations and consumption correlations on network closeness and TFP correlations in Table (5)

We search for parameters that minimize the sum of squared errors of these moments. As algebraic solutions of these moments are not available, we use a Monte-Carlo method whereby we sample the productivity and transfer shock distribution for 10,000 points and solve the model at each point for a given parameter set. We then compute the model-implied moments from this distribution.

3.3 Estimation Results

Column (2) in Table (6)(b) reports the estimated parameter values for our baseline model. The steady-state size of transfer shocks from active households to inactive households is $\exp(\bar{\mu}) = 0.38$, and the inactive households account for $1 - \psi = 16\%$ of the population. This is a non-trivial amount of transfer, since the steady-state size of production per active household is 0.28 on average.

Moreover, the transfer shocks have a positive loading on productivity shocks, i.e., $\kappa_1 > 0$, which means that the demand shock in a country tends to be high when the supply shock is high in the same country. According to Eq. (10), this positive correlation suggests that the demand and supply shocks tend offset each other in their effects on the active households' consumption growth and hence on exchange rates. The demand shocks also have a non-trivial orthogonal component, i.e., $\kappa_2 = 4\%$. In comparison, the standard deviation of the productivity shocks is only 2% on average.

Column (2) in Table (6)(a) reports the simulated moments from this baseline model. The model closely matches the average volatility of currency base factors, the average consumption growth correlation, and the average Backus-Smith coefficient. One untargeted moment that our model does not match as well is the volatility of consumption growth, which is 4.7% in the model and about 2% in the data. The log preferences in our model require volatile consumption to match the exchange rate volatility. It is possible to lower consumption volatility by considering a CRRA preference with a higher risk aversion, but doing so sacrifices the tractability of the model.

Importantly, the model also matches the new empirical findings in this paper. TFP correlations have a higher explanatory power for consumption correlations, while network closeness has a higher explanatory power for exchange rate correlations. Specifically, for explaining consumption correlations, TFP correlations have an R^2 of 25% in the model and a similar R^2 of 27% in the data, while network closeness only has an R^2 of 1% in the model and a similar R^2 of 7% in the data. For explaining exchange rate correlations, TFP correlations have an R^2 of 16% in the model and a similar R^2 of 11% in the data, while network closeness only has an R^2 of 42% in the model and an R^2 of 25% in the data.

Overall, these results suggest that, even with a simple specification of parameters and taking the observed structure of the trade network and TFP correlations into account, our model can generate the relevant patterns of exchange rate movements in relation to consumption growth, productivity correlations, and trade linkages. In the baseline model, we replicate the empirical result that network closeness is closely related to exchange rate correlations, whereas TFP correlations are closely related to consumption correlations.

3.4 Inspecting the Mechanism

We now turn to inspecting the mechanism through which our model generates the disconnect in the determinants of exchange rate and consumption correlations. Specifically, we consider alternative models by varying parameter values and comparing the equilibrium exchange rate and consumption behaviors in these models with our baseline model. We consider three alternatives: (1) a model variant with complete markets; (2) a model variant in which each country's demand and supply shocks are independent; and (3) a model variant with uncorrelated supply shocks across countries. Each of these variants shines light on the determinants of the drivers of exchange rate and consumption correlations.

Model Variant 1: Complete Markets. First, we consider a complete-market variant of the model by setting the share of inactive households $(1 - \psi)$ to 0 for all countries. We keep other parameter values the same, including the parameters governing production and the trade network.

Column (3) in Table (6)(a) reports the simulated moments from this complete-market model. In this specification, since there is no transfer from the active households to the inactive households, the demand shocks are completely muted. As a result, the equilibrium exchange rate has a much lower volatility of 3%, since it is entirely driven by the supply shocks and the network propagation. Moreover, this model gives rise to the classic Backus-Smith puzzle, generating a positive and perfect correlation between exchange rate movements and consumption growth differentials.

Lastly, in the absence of market segmentation, TFP correlations explain a large portion of both currency (70%) and consumption correlations (98%), whereas network closeness explains very little of either (10% of currency correlations and 8% of consumption correlations).

This complete-markets variant sheds light on how market segmentation disconnects the drivers of consumption growth and exchange rate correlations. Without the transfer (demand) shocks within a country, consumption growth and exchange rate correlations are tightly interconnected. As discussed in Section (2.3), the inactive households and their demand shocks disentangle the aggregate consumption growth from the exchange rate, which is driven by the active households' consumption growth. This mechanism allows us to not only untie the comovement between the consumption growth and the exchange rate movement in each country's time series, which resolves the Backus-Smith puzzle, but also disconnect the cross-country correlation structures in consumption growth and exchange rates from the cross-country correlation structure in the TFP shocks.

Furthermore, by Eq. (10), reproduced below,

$$\Delta\bar{c} \approx H\left(\varepsilon^S - \frac{\theta}{H'\lambda}(I - W')^{-1}\varepsilon^D\right),$$

the trade linkages, as summarized by the H matrix, propagate both the supply (TFP) shocks ε^S and the demand shocks ε^D. The presence of the demand shock propagation also increases the importance of the trade network for explaining exchange rate correlations, which is absent in this model without inactive households and demand shocks.

Model Variant 2: Independent Demand and Supply Shocks. Next, we set the parameter $\kappa_1 = 0$, so that the transfer shock that represents demand fluctuations in each country, reproduced below,

$$\mu_{it} - \bar{\mu} = \kappa_1\varepsilon^S_{it} + \kappa_2\varepsilon^\mu_{it},$$

is uncorrelated with the supply-side TFP shock (ε^S_{it}) in the same country. We keep other parameter values the same.

Column (4) in Table (6)(a) reports the simulated moments from this model variant. Again, inspection of Eq. (10) shines light on the model's mechanism. In particular, a positive supply (TFP) shock (ε^S) in a country raises its active households' consumption, which lowers their marginal utility and depreciates the local currency. By contrast, a positive demand shock (ε^D) in a country lowers its active households' consumption, which raises their marginal utility and appreciates the local currency. In the baseline model, the demand shocks load positively on the supply shocks (i.e., $\kappa_1 > 0$), which partially offsets the variations in the exchange rate movements induced by the supply and demand shocks. When we remove this positive loading, the shocks are magnified, resulting in a higher exchange rate volatility of 9%.

In this model variant, TFP correlations explain more variation in exchange rate correlations (29% versus 16% in the data) and less variation in consumption correlations (0% versus 25% in the data). To understand this result, we note that the demand shocks determine how much consumption inactive households receive. If $\kappa_1 > 0$, then, when a country experiences a positive supply (TFP) shock, its output and active household consumption increases. Since the demand shock is positively correlated with the supply shock, it implies a higher transfer to the country's inactive households, whose consumption also rises. In this way, the country-level aggregate consumption loads positively on the TFP shock. In comparison, if $\kappa_1 = 0$, then, the inactive household's consumption only loads on the independent demand shocks, weakening the loading of the country-level aggregate consumption on the TFP shock and leading to a weaker relation between supply shock correlations and consumption growth correlations.

Model Variant 3: Uncorrelated Supply/Productivity Shocks. Lastly, we shut down the contribution of the supply shock correlations to international comovements by setting the productivity shocks to be uncorrelated: $\{Var[\varepsilon_t^S]\}_{i,j} = 0$ for all $i \neq j$. We keep other parameters the same, including the variances of the productivity shocks.

Column (5) in Table (6)(a) reports the simulated moments from this model variant. As expected, now the TFP correlations are 0 for all country pairs, and they do not explain any variations in bilateral consumption and exchange rate correlations. In comparison, as network closeness ($\mathcal{C}^{H-Full}$) captures how the demand and supply shocks are propagated to determine the active households' consumption, it remains a strong predictor of the bilateral exchange rate correlations. We also find that, in this model variant, the trade network's explanatory power for the cross-country correlations of the aggregate consumption remains low, because the inactive households' consumption is directly driven by the transfer shocks with relatively small propagation through the trade network. To see this, notice that the inactive households' aggregate consumption is directly determined by the transfer shocks via $\hat{\overline{C}}_{it} = e^{\mu_{it}}$, so that the effects of the trade network are only second-order through goods' prices. Given that the inactive households' consumption account for a large fraction of the aggregate consumption, the trade network's explanatory power for the cross-country correlations of the aggregate consumption remains quite low for all the model variants we consider.

In summary, these model variants help us understand the roles played by the model's key ingredients. First, the market segmentation introduced by the presence of inactive households allows us to disentangle the aggregate consumption in each country from the exchange rate behavior. This mechanism resolves both the Backus and Smith (1993) puzzle and the disconnect between international consumption and exchange rate comovements that we document in this paper. Second, the demand shock in a country is positively correlated with the supply shock in the same country, which partially offsets their effects on the exchange rate volatility. At the same time, the idiosyncratic volatility in the demand shock is propagated through the trade network to determine the active households' consumption, which magnifies the contribution of the trade network to the international correlations in exchange rates. Finally, the supply shocks remain a key determinant of aggregate consumption as well as international correlations in aggregate consumption growth. In contrast, the trade network plays a quantitatively smaller role in explaining the aggregate consumption correlation, since the demand shocks directly affect the inactive households' consumption and only minimally propagate through the trade network.

4 Implications for International Factor Structures

The previous sections establish a link between the structure of the trade network and exchange rate correlations across countries. A salient fact about exchange rate correlations is that a large fraction of these correlations can be explained by a small number of common factors (Lustig, Roussanov and Verdelhan, 2011; Verdelhan, 2018). To investigate the origin of this factor structure, we next investigate if it is related to our network closeness measure. We find that the same factor structure that is present in the trade network also relates to the common factors found in exchange rates. In doing so, we provide an economic interpretation of the origin of the common factors in exchange rates.

We begin by presenting a simple 4-country specification of our model which illustrates how the trade network can give rise to common factors. We then show emprically that the factor structure embedded in the global trade network is related to the the factor structure which drives standard currency risk factors.

4.1 A Simple Example of a Common Global Factor

Since it is not possible to analytically characterize the factor structure embedded in trade network for arbitrary networks V and W, we illustrate how factor structures arise in a special case. In the next subsection, we build on the intuition of this subsection to test the implications in the data. In this example, we assume the home bias in consumption tends to 1 in the limit:

$$V \rightarrow I,$$

and that the combined supply and demand shocks are i.i.d. across countries, $Var\left[\varepsilon^S - \frac{\theta}{H'\lambda}(I - W')^{-1}\varepsilon^D\right] = Var[\varepsilon] = I$. These simplifying assumptions allow us to focus on the production trade network W.

We consider the following 4-country production network:

$$W = (1-\theta)\begin{bmatrix} 1 & 0 & 0 & 0 \\ \gamma_2 & 1-\gamma_2 & 0 & 0 \\ \gamma_3 & 0 & 1-\gamma_3 & 0 \\ \gamma_4 & 0 & 0 & 1-\gamma_4 \end{bmatrix}.$$

In this network, the first country is the central country and exports to all other countries. Other countries, which we refer to as peripheral, do not export. The labor share is fixed at $1-\theta$ for all countries, but each peripheral country has a different import share from country 1 given by γ_2, γ_3, and γ_4.

Then, the consumption growth of households of each country can be characterized as having a factor structure. By Lemma 1,

$$\Delta\bar{c}_{t+1} = (I-W)^{-1}\varepsilon_{t+1} = \begin{bmatrix} m_{11} & 0 & 0 & 0 \\ m_{21} & m_{22} & 0 & 0 \\ m_{31} & 0 & m_{33} & 0 \\ m_{41} & 0 & 0 & m_{44} \end{bmatrix}\begin{bmatrix} \varepsilon^{(1)}_{t+1} \\ \varepsilon^{(2)}_{t+1} \\ \varepsilon^{(3)}_{t+1} \\ \varepsilon^{(4)}_{t+1} \end{bmatrix},$$

where the m's are functions of θ and the γ's. They satisfy $m_{11} > m_{i1} > 0$ and $m_{ii} > 0$ for $i = 2, 3, 4$. This formula shows that the central country's productivity shock $\varepsilon^{(1)}_{t+1}$ becomes the common factor in the cross-section of countries. All other (peripheral) countries' consumption load on this common factor, and have no further pairwise comovements beyond that induced by their exposure to the common factor. The shocks $\varepsilon^{(2)}_{t+1}$, $\varepsilon^{(3)}_{t+1}$, and $\varepsilon^{(4)}_{t+1}$ are idiosyncratic in the sense that only one country is exposed to each of them.

The bilateral exchange rate changes also load on these shocks:

$$
\begin{aligned}
\Delta e_{1,2,t+1} &= (m_{21} - m_{11})\varepsilon_{t+1}^{(1)} + m_{22}\varepsilon_{t+1}^{(2)}, \\
\Delta e_{1,3,t+1} &= (m_{31} - m_{11})\varepsilon_{t+1}^{(1)} + m_{33}\varepsilon_{t+1}^{(3)}, \\
\Delta e_{2,3,t+1} &= (m_{31} - m_{21})\varepsilon_{t+1}^{(1)} + m_{33}\varepsilon_{t+1}^{(3)} - m_{22}\varepsilon_{t+1}^{(2)},
\end{aligned}
$$

and the central country's shock $\varepsilon_{t+1}^{(1)}$ becomes the common factor in the cross-section of exchange rates, even for the bilateral pair between countries 2 and 3 that does not involve the central country. Since the loadings $(m_{21} - m_{11})$, $(m_{31} - m_{11})$, and $(m_{31} - m_{21})$ can be different depending on the values of the γ's, these currencies have different loadings on the common factor.

This expression demonstrates how our general equilibrium model produces exchange rate dynamics like those found in factor models of exchange rates such as Lustig, Roussanov and Verdelhan (2011). In these factor models, the exchange rate change between two countries can be expressed as

$$
\Delta e_{ijt+1} = (\delta^i - \delta^j)f_{t+1} + \eta_{t+1}^i - \eta_{t+1}^j,
$$

where f_{t+1} represents one or multiple common factors and η_{t+1}^i and η_{t+1}^j represent idiosyncratic shocks. In particular, our example offers a mechanism that generates the common factor f_{t+1} through network propagation of independent shocks across countries. This example could also be generalized to allow for multiple factors once we impose a richer dependence structure in the consumption and production networks.

Furthermore, the currency base factors can be expressed as the sum of the loading on the common factor $\varepsilon_{t+1}^{(1)}$, the average of peripheral countries' consumption shocks, and, for peripheral countries, an idiosyncratic component:

$$
\begin{aligned}
\Delta\overline{e}_{1,t+1} &= \left(\frac{m_{11}+m_{21}+m_{31}+m_{41}}{4} - m_{11}\right)\varepsilon_{t+1}^{(1)} + \frac{m_{22}\varepsilon_{t+1}^{(2)} + m_{33}\varepsilon_{t+1}^{(3)} + m_{44}\varepsilon_{t+1}^{(4)}}{4}, \\
\Delta\overline{e}_{2,t+1} &= \left(\frac{m_{11}+m_{21}+m_{31}+m_{41}}{4} - m_{21}\right)\varepsilon_{t+1}^{(1)} + \frac{m_{22}\varepsilon_{t+1}^{(2)} + m_{33}\varepsilon_{t+1}^{(3)} + m_{44}\varepsilon_{t+1}^{(4)}}{4} - m_{22}\varepsilon_{t+1}^{(2)}.
\end{aligned}
$$

The currency base factors offer a simple way to compare different currencies' strengths and volatilities. In particular, when the common factor $\varepsilon_{t+1}^{(1)}$ is negative, the central country's base factor $\Delta\overline{e}_{1,t+1}$ experiences the greatest appreciation, and a peripheral country i's base factor $\Delta\overline{e}_{it+1}$ appreciates more if its exposure m_{i1} is higher. A peripheral country i's base factor is more volatile if its exposure to the common factor m_{i1} is more different from the average exposure $(m_{11}+m_{21}+m_{31}+m_{41})/4$ and if its loading m_{ii} on its own idiosyncratic shock is higher.

This example demonstrates how common factors in exchange rates can arise through the structure of the trade network. While this example is intentionally stylized to provide analytical solutions, the intuition is more general. In particular, the structure of the network can give rise to common factors when countries tend to be exposed to similar sets of shocks. In our general model with dense input-output linkages in W and V, there are no truly idiosyncratic shocks, but some shocks are more important for the variation of quantities and asset prices. Therefore, we next apply principal component analysis to extract the common factors embedded in the structure of the trade network which contribute to a large proportion of the variation. We then relate these common factors to the factor structure of exchange rate movements.

4.2 The Trade Network Origins of Common Currency Factors

Proposition 2 shows that the closeness matrix explains exchange rate comovements. A direct implication is that the prinicipal components of this matrix capture common comovements in exchange rates. Accordingly, to study the common exchange rate factors, we apply an eigenvector decomposition to the closeness matrix. We show that the common variations embedded in our network closeness measure are closely related to common currency risk factors such as dollar and carry

(Lustig, Roussanov and Verdelhan, 2011; Verdelhan, 2018).

Specifically, for any covariance matrix $\mathcal{C}$, we can apply the eigenvalue decomposition:

$$\mathcal{C} = U(\mathcal{C})\Lambda(\mathcal{C})U(\mathcal{C})',$$

where $U(\mathcal{C})$ is an orthogonal matrix, and $\Lambda(\mathcal{C}) = diag(\lambda_1(\mathcal{C}), \ldots, \lambda_N(\mathcal{C}))$ is diagonal. The scalars $\lambda_k(\mathcal{C})$ are the eigenvalues of the matrix $\mathcal{C}$. The matrix $U(\mathcal{C})$ contains the corresponding eigenvectors. We order these eigenvectors $U_k(\mathcal{C})$ in descending order by their associated eigenvalues $\lambda_k(\mathcal{C})$. The eigenvalue decomposition is equivalent to applying a principal component analysis, which extracts the common variations in the shocks that underlie the covariance matrix $\mathcal{C}$. For example, the first eigenvector $U_1(\mathcal{C})$ contains the loadings of each shock in constructing the first principal component, and $\lambda_1 / \sum_{k=1}^{N} \lambda_k$ is the fraction of variance explained by the first principal component.

To study the common factors which are embedded in the structure of the global trade network, we note that our measures of closeness are themselves covariance matrices. Indeed, Proposition 1 and equation (11) show that closeness is the covariance matrix of active households consumption growth. Therefore, we apply this eigenvalue decomposition to our model's network closeness matrix in (12).

This eigenvalue decomposition allows us to study the relation between the common factors implied by closeness and common currency factors studied in the literature. To do so, we first note that the change in the value of a currency portfolio can be expressed as a linear combination of currency base factors[7], because the currency base factors themselves are simply linear combinations of log exchange rate movements. For example, the dollar factor is closely related to the U.S. dollar's base factor, and the carry factor (Lustig, Roussanov and Verdelhan, 2011, 2014) is closely related to the high-interest-rate currencies' base factors minus the low-interest-rate currencies' base factors.

[7]This follows directly from application of triangular arbitrage on log exchange rate changes. For useful discussions of the spanning properties of currency base factors see Appendix A of Lustig and Richmond (2019) and Aloosh and Bekaert (2019).

To study the relation between factor loadings in the trade network and in currencies, we run the following cross-sectional regressions:

$$\beta_i = \alpha + \gamma_1 U_{1,i}(\mathcal{C}) + \gamma_2 U_{2,i}(\mathcal{C}) + \gamma_3 U_{3,i}(\mathcal{C}) + \varepsilon_i, \tag{13}$$

where β_i is the loading of country i's currency base factor on the dollar, carry (HML), and unconditional carry (UHML) factors, and $U_{k,i}$ for $k = 1, 2, 3$ are country i's loadings in the principal components of network closeness closeness. The purpose of these regressions is to see whether a linear combination of the loadings on the common factors in network closeness is able to explain a currency's loading on the common factors in exchange rates.

Table (7) reports the results. We focus on the R^2 in these regressions since there is no a priori reason that specific principal components extracted from network closeness would explain currency factor loadings. The R^2 tells us how much of the cross-sectional variation in currency factor loadings is explained by common factor loadings in the global trade network. We see that for all three currency factors, the R^2's are high, ranging from 30–58$\%$. This suggests that countries' loadings on the common factors embedded in the trade network are similar to their currencies' loadings on the common risk factors that drive exchange rates. This relation is especially strong for risk factors which tend to represent unconditional exposures such as dollar and unconditional carry. Overall, these findings suggest that the structure of the international trade network may help to explain the origins of common factors in exchange rate markets.

We can also study the time-series relation between closeness-based factors and standard currency factors. We construct the closeness-based currency factors as linear combinations of the currency base factors with weights from the eigenvalue decomposition: $U_{k,i}(\mathcal{C})'\Delta\overline{e}_{t+1}$ for each PC indexed by $k = 1, 2, 3$. We then run a time series regression of the currency factors on these three closeness factors:

$$factor_t = \alpha + \gamma_1(U_{1,i}(\mathcal{C})'\Delta\overline{e}_{t+1}) + \gamma_2(U_{2,i}(\mathcal{C})'\Delta\overline{e}_{t+1}) + \gamma_3(U_{3,i}(\mathcal{C})'\Delta\overline{e}_{t+1}) + \varepsilon_t, \tag{14}$$

The results of running these regressions are in Table (8). We find that the closeness-based factors covary substantially with the currency factors, especially for dollar and unconditional carry. These findings echo the regressions in Table (7) and show that the factor structure that is embedded in the global trade network is closely related to the factor structure which is observed in exchange rates.

5 Conclusion

In this paper, we show that exchange rate comovements tend to be explained by the structure of the global trade network while consumption correlations tend to be explained by TFP correlations. Motivated by these findings, we present a multi-country model with segmented markets which replicates our new empirical findings. Furthermore, we show that the structure of the trade network generates common factors in exchange rates, as found in the data. These results provide new evidence on the key drivers of international asset price correlations and shed light on the types of frictions which are important in international financial markets.

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Table 1: Explaining Correlations of FX and Consumption

	Base Factor Correlations						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
V Bilateral	0.158***	0.111***					
	(0.022)	(0.028)					
V Network		0.074**					
		(0.028)					
V Full			0.162***				
			(0.022)				
W Bilateral				0.140***	0.145***		
				(0.023)	(0.021)		
W Network					0.117***		
					(0.021)		
W Full						0.152***	
						(0.023)	
TFP Correlation							0.111***
							(0.024)
Observations	171	171	171	171	171	171	171
R^2	0.229	0.258	0.240	0.180	0.305	0.213	0.113
LR-Test (p-value)		0.01			< .001		

	Consumption Correlations						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
V Bilateral	0.049***	0.041**					
	(0.015)	(0.020)					
V Network		0.013					
		(0.020)					
V Full			0.050***				
			(0.015)				
W Bilateral				0.051***	0.052***		
				(0.015)	(0.015)		
W Network					0.033**		
					(0.015)		
W Full						0.054***	
						(0.015)	
TFP Correlation							0.106***
							(0.013)
Observations	171	171	171	171	171	171	171
R^2	0.059	0.062	0.061	0.064	0.091	0.072	0.275
LR-Test (p-value)		0.515			0.024		

Note: Regressions of currency base factor correlations (Equation (2)) and bilateral consumption growth correlations (Equation (3)) on trade network closeness measures and total factor productivity (TFP) correlations. Bilateral regressions include the set of unique country pairs for 19 developed countries. Consumption growth is annual in local currency units. Currency base factors are the average appreciation of a currency vs all other currencies. The closeness measures are defined in Section 1.2. The sample is from 1974 to 2014.

Table 2: Explaining Correlations of FX and Consumption including Bilateral Trade Intensity

	FX Base Factor Correlations						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bilateral Trade Intensity	0.150***	0.095***	0.117***	0.091***	0.115***	0.134***	0.102***
	(0.020)	(0.028)	(0.021)	(0.027)	(0.027)	(0.020)	(0.027)
V Bilateral		0.086***					
		(0.030)					
V Network			0.096***				
			(0.023)				
V Full				0.094***			
				(0.029)			
W Bilateral					0.058**		
					(0.029)		
W Network						0.077***	
						(0.022)	
W Full							0.077**
							(0.030)
Observations	171	171	171	171	171	171	171
R^2	0.244	0.280	0.317	0.288	0.262	0.296	0.273

Note: Regressions of currency base factor correlations (Equation (2)) and bilateral consumption growth correlations (Equation (3)) on trade network closeness measures and total factor productivity (TFP) correlations, including bilateral trade intensity as a control. Bilateral regressions include the set of unique country pairs for 19 developed countries. Consumption growth is annual in local currency units. Currency base factors are the average appreciation of a currency vs all other currencies. The closeness measures are defined in Section 1.2. The sample is from 1974 to 2014.

Table 3: Explaining Correlations of FX and Consumption including Distance

	Base Factor Correlations			Consumption Correlations		
	(1)	(2)	(3)	(4)	(5)	(6)
Log Distance	-0.163***	-0.170***	-0.191***	-0.021	-0.018	0.006
	(0.022)	(0.023)	(0.022)	(0.017)	(0.017)	(0.015)
V Full	0.083***			0.040**		
	(0.022)			(0.017)		
W Full		0.070***			0.046***	
		(0.023)			(0.017)	
TFP Correlation			0.030			0.108***
			(0.022)			(0.015)
Observations	171	171	171	171	171	171
R^2	0.422	0.407	0.381	0.069	0.078	0.276

Note: Regressions of currency base factor correlations (Equation (2)) and bilateral consumption growth correlations (Equation (3)) on trade network closeness measures and total factor productivity (TFP) correlations, including distance as a control. Bilateral regressions include the set of unique country pairs for 19 developed countries. Consumption growth is annual in local currency units. Currency base factors are the average appreciation of a currency vs all other currencies. The closeness measures are defined in Section 1.2. The sample is from 1974 to 2014.

Table 4: Explaining Correlations of FX and Consumption Time Series

	FX Correlations			Consumption Correlations		
	(1)	(2)	(3)	(4)	(5)	(6)
V Full	0.374***			-0.040		
	(0.058)			(0.066)		
W Full		0.285***			0.019	
		(0.084)			(0.056)	
TFP Correlation			0.008			0.157***
			(0.011)			(0.018)
Observations	414	414	414	684	684	684
Within R^2	0.151	0.097	0.002	0.001	0.000	0.134
Country-Pair fixed effects	✓	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓	✓

Note: Panel regressions of time-series of currency base factor correlations (Equation (4)) and bilateral consumption growth correlations (Equation (5)) on the time-series of trade network closeness measures and total factor productivity (TFP) correlations. All input values are computed using 10-year non-overlapping windows. Observations are for 4 non-overlapping windows of data for the set of unique country pairs among 19 developed countries. Regressions include country-pair and time fixed effects. Consumption growth is annual in local currency units. Currency base factors are the average appreciation of a currency vs all other currencies. The closeness measures are defined in Section 1.2. The sample is from 1974 to 2014.

Table 5: Explaining Correlations of FX and Consumption Using Model Implied Closeness (Developed)

	Base Factor Correlations		Consumption Correlations	
	(1)	(2)	(3)	(4)
H Full	0.159***		0.052***	
	(0.022)		(0.015)	
TFP Correlation		0.111***		0.106***
		(0.024)		(0.013)
Observations	171	171	171	171
R^2	0.233	0.113	0.066	0.275

Note: Regressions of currency base factor correlations (Equation (2)) and bilateral consumption growth correlations (Equation (3)) on trade network closeness measures and total factor productivity (TFP) correlations. Trade network closeness (H Full) is computed as in Equation (12). Bilateral regressions include the set of unique country pairs for 19 developed countries. Consumption growth is annual in local currency units. Currency base factors are the average appreciation of a currency vs all other currencies. The closeness measures are defined in Section 1.2. The sample is from 1974 to 2014.

Table 6: Model Estimation

Panel (a) Moments

	(1) Data	(2) Baseline	(3) Complete-Market	(4) Independent Demand	(5) Uncorrelated Supply
Average Base Factor Volatility	0.06	0.06	0.03	0.09	0.06
Average Base Factor Correlation	-0.03	-0.05	-0.05	-0.05	-0.05
Average Consumption Growth Correlation	0.28	0.18	0.28	0.33	0.03
Average Backus-Smith Coefficient	-0.15	-0.12	1.00	-0.32	-0.05
R^2 of Currency Correlation on TFP Correlations	0.11	0.16	0.70	0.29	0.00
R^2 of Consumption Correlation on TFP Correlations	0.27	0.25	0.98	0.00	0.00
R^2 of Currency Correlation on Network Closeness	0.25	0.42	0.10	0.36	0.40
R^2 of Consumption Correlation on Network Closeness	0.07	0.01	0.08	0.13	0.05

Panel (b) Parameter Values

	(1) Symbol	(2) Baseline Model	(3) Complete-Market	(4) Independent Demand	(5) Uncorrelated Supply
Log Transfer Shock Size	$\bar{\mu}$	-0.97	-0.97	-0.97	-0.97
Share of Active Households	ψ	0.84	1.00	0.84	0.84
Demand Shocks' Loadings on Productivity Shocks	κ_1	1.41	1.41	0.00	1.41
Demand Shocks' Loadings on Idiosyncratic Shocks	κ_2	0.04	0.04	0.04	0.04

Note: Model calibration and estimation table. Panel (a) presents moments from the data and 5 model variants. Panel (b) presents parameters from the 5 model variants. Model parameters and estimation are detailed in Section (3).

Table 7: Cross-Sectional Regressions of Currency Factor Loadings on Closeness-Based Principal Component Loadings

	Dollar	Carry (HML)	Unconditional Carry (UHML)
	(1)	(2)	(3)
Closeness PC 1	0.895	0.579^{**}	2.398^{***}
	(0.616)	(0.241)	(0.674)
Closeness PC 2	-0.662	1.070^{**}	3.419^{**}
	(0.984)	(0.386)	(1.258)
Closeness PC 3	-1.044^{**}	-0.131	-0.388
	(0.450)	(0.176)	(0.536)
Observations	29	29	18
R^2	0.325	0.301	0.577

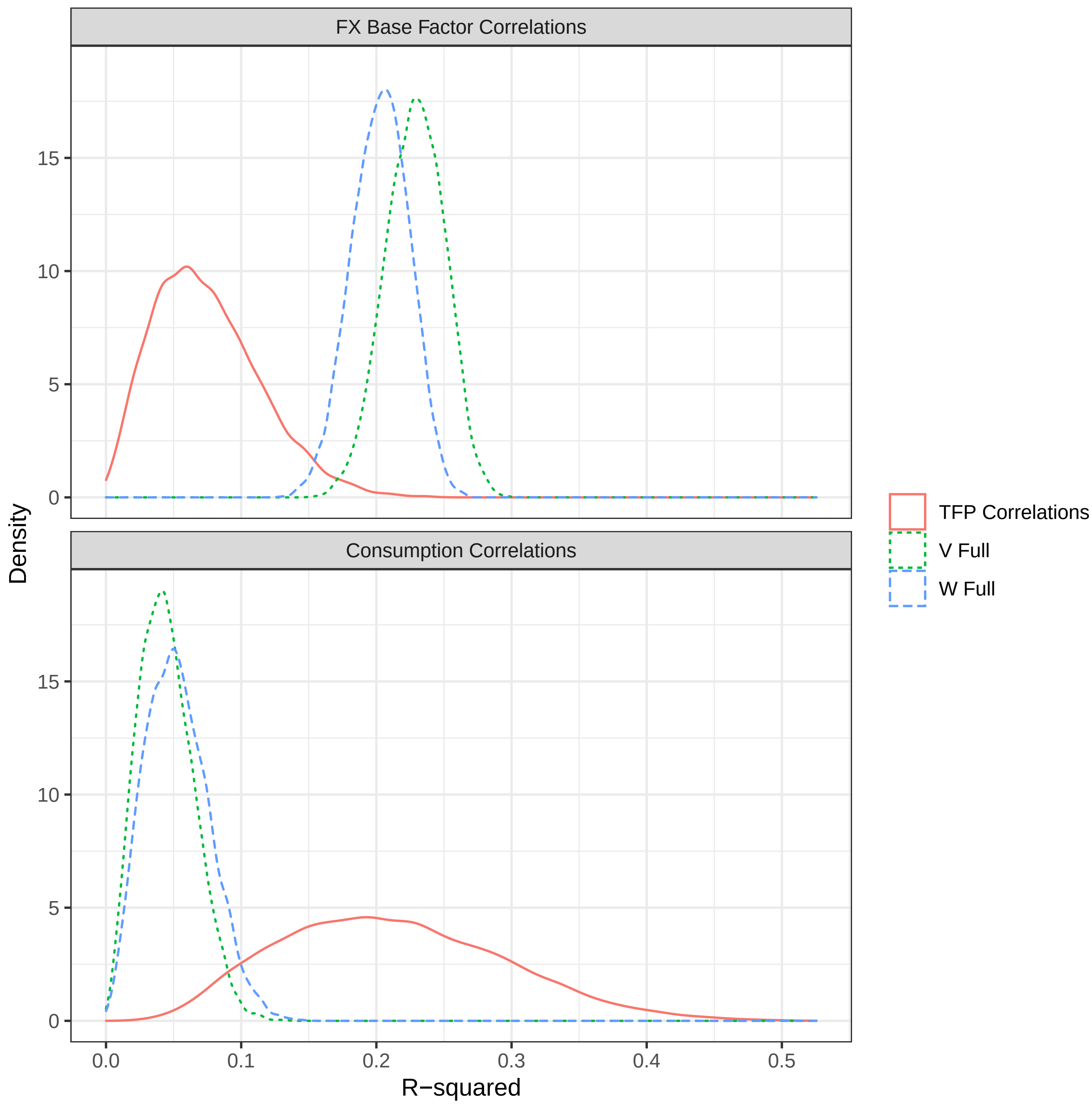
Note: Regression Equation (13) of actual loadings of currency base factors on the dollar, carry (HML), and unconditional carry (UHML) factors on their loadings on the first three principal components implied by trade network closeness. Actual loadings are estimated from regressions of currency i's base factor $\Delta\bar{e}_i$ on the dollar, carry, and unconditional carry factors. Data are from 19 developed countries from 1974 to 2014.

Table 8: Time-Series Regressions of Currency Factors on Closeness-Based Common Factors

	Dollar	Carry (HML)	Unconditional Carry (UHML)
	(1)	(2)	(3)
Closeness PC 1	0.306^{***}	0.276^{***}	0.550^{***}
	(0.033)	(0.051)	(0.047)
Closeness PC 2	-0.081	0.582^{***}	0.988^{***}
	(0.051)	(0.078)	(0.105)
Closeness PC 3	-0.123^{***}	-0.055	0.049
	(0.022)	(0.034)	(0.039)
Observations	398	398	180
R^2	0.416	0.156	0.646

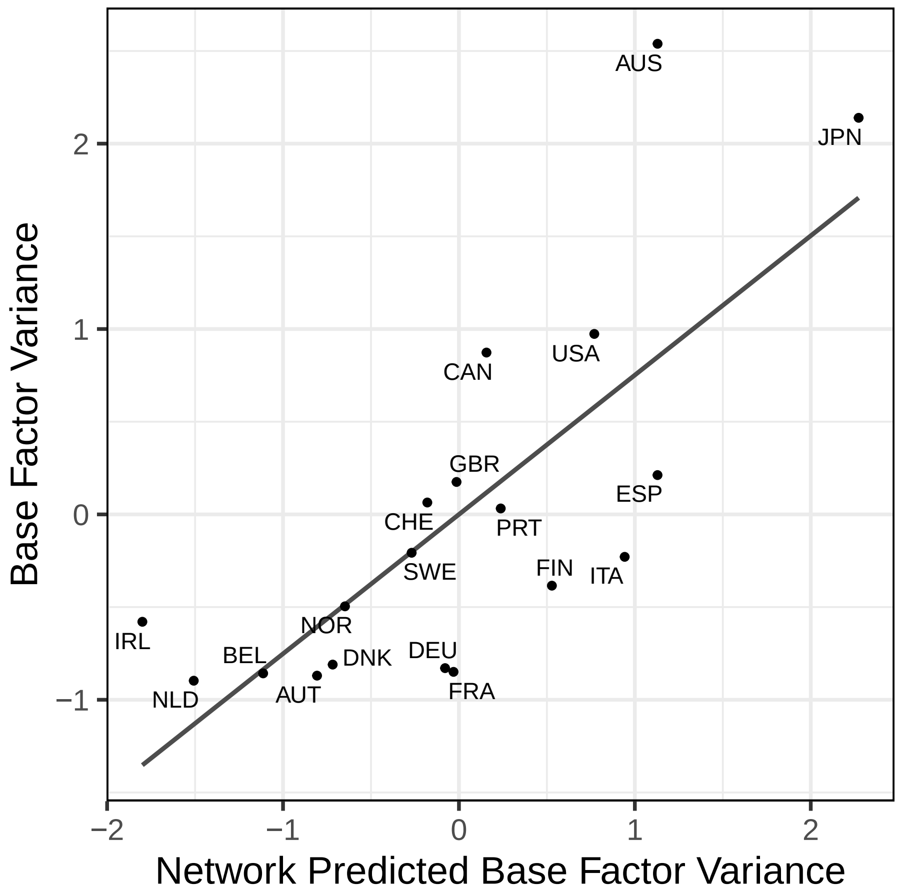
Note: Regression Equation (14) of dollar, carry (HML), and unconditional carry (UHML) currency factors on trade network closeness based factors. Trade network closeness based factors are constructed as linear combinations of currency base factors where the weights are from principal components of trade network closeness. Data are from 19 developed countries from 1974 to 2014.

Figure 1: Bootstrap distribution of R-squared



Note: Density plot of distribution of R-squared from regressions of base factor correlations (Equation (2)) and bilateral consumption growth correlations (Equation (3)) on trade network closeness measures and total factor productivity (TFP) correlations. Bilateral regressions include the set of unique country pairs for 19 developed countries. Consumption growth is annual in local currency units. Currency base factors are the average appreciation of a currency vs all other currencies. The closeness measures are defined in Section 1.2. The sample is from 1974 to 2014.

Figure 2: Base Factor Variance versus Implied from Network



Note: Plot of actual currency base factor variances versus those implied by network closeness. Currency base factors are the average appreciation of each currency against all other currencies in the sample. The closeness measures are defined in Section 1.2. The sample is 19 developed countries from 1974 to 2014.

A Proof Appendix

Whenever possible, we omit time subscripts because there is no storage technology and therefore the model can be solved period by period.

A.1 Inactive Households

Inactive households maximize their utility subject to the intra-period budget constraint:

$$p_i \overline{\hat{C}}_i = \sum_{j=1}^{N} q_j \hat{C}_{ij} \leq p_i e^{\mu_i} \tag{A1}$$

Households take prices as given. To afford one unit of final consumption, the within-period optimization is

$$\max_{\hat{C}_{ij}} \quad \log\left(\prod_{j=1}^{N} \hat{C}_{ij}^{v_{ij}}\right) - \hat{\chi}_i \left(\sum_{j=1}^{N} q_j \hat{C}_{ij} - p_i e^{\mu_i}\right). \tag{A2}$$

The first-order conditions imply

$$\hat{C}_{ij} \quad = \quad v_{ij}/(\hat{\chi}_i q_j) \tag{A3}$$

Using $\overline{\hat{C}}_i = \prod_{j=1}^{N} \hat{C}_{ij}^{v_{ij}}$ and $\sum_{j=1}^{N} q_j \hat{C}_{ij} = p_i e^{\mu_i}$, we obtain

$$\hat{\chi}_i \quad = \quad \frac{1}{\overline{\hat{C}}_i} \prod_{j=1}^{N} (v_{ij}/q_j)^{v_{ij}} \tag{A4}$$

$$\hat{C}_{ij} \quad = \quad \frac{v_{ij}/q_j}{\prod_{k=1}^{N} (v_{ik}/q_k)^{v_{ik}}} \overline{\hat{C}}_i \tag{A5}$$

and hence the price index of the inactive households' consumption bundle in country i is

$$p_i \quad = \quad \prod_{j=1}^{N} \left(\frac{q_j}{v_{ij}}\right)^{v_{ij}} \tag{A6}$$

Given prices, the solution for the inactive households' consumption is:

$$\hat{C}_{ij} = \frac{v_{ij}}{q_j} p_i \hat{\overline{C}}_i \tag{A7}$$

which implies

$$\frac{q_j \hat{C}_{ij}}{q_k \hat{C}_{ik}} = \frac{v_{ij}}{v_{ik}}.$$

A.2 Active Households

A.2.1 Lemma 1

The social planner's Lagrangian is

$$\sum_{i=1}^{N} \lambda_i \left(\sum_{j=1}^{N} v_{ij} \log C_{ij} \right) + \varphi_i \left(A_i L_i^{\theta} \left(\prod_{j=1}^{N} X_{ij}^{w_{ij}} \right) - \sum_{j=1}^{N} (C_{ji} + X_{ji}) - D_i \right) + \chi_i (\bar{L}_i - L_i) \tag{A8}$$

which implies the following first-order conditions:

$$\text{w.r.t. } C_{ji}: \quad \lambda_j v_{ji} C_{ji}^{-1} = \varphi_i \tag{A9}$$

$$\text{w.r.t. } X_{ji}: \quad \varphi_j \overline{X}_j w_{ji} X_{ji}^{-1} = \varphi_i \tag{A10}$$

$$\text{w.r.t. } L_i: \quad \varphi_i \overline{X}_i \theta L_i^{-1} = \chi_i \tag{A11}$$

Substitute into the market clearing condition:

$$\varphi_i \overline{X}_i - D_i = \sum_{j=1}^{N} \left(\lambda_j v_{ji} + \varphi_j \overline{X}_j w_{ji} \right). \tag{A12}$$

Define $\Gamma_i = \varphi_i \overline{X}_i$. It can be interpreted as the value of country i's total output, because, as will be shown in Lemma 2, the Lagrangian multiplier φ_i can be interpreted as the price of country

i's intermediate goods in a common numeraire. The market clearing condition becomes

$$\begin{aligned}
\Gamma_i - D_i &= \sum_{j=1}^{N} (\lambda_j v_{ji} + \Gamma_j w_{ji}) && \text{(A13)}\\
\Gamma - D &= V'\lambda + W'\Gamma && \text{(A14)}\\
\Gamma &= (I - W')^{-1}(V'\lambda + D) = H'\lambda + (I - W')^{-1}D. && \text{(A15)}
\end{aligned}$$

Then, the log production is

$$\begin{aligned}
\log \overline{X}_i &= a_i + \theta \ell_i + \sum_{j=1}^{N} w_{ij} \log \left(\frac{\varphi_i \overline{X}_i}{\varphi_j} w_{ij} \right) && \text{(A16)}\\
&= a_i + \theta \ell_i + \sum_{j=1}^{N} w_{ij} \log \left(\frac{\Gamma_i}{\Gamma_j / \overline{X}_j} w_{ij} \right) && \text{(A17)}\\
\overline{x} &= \kappa^x + a + (1 - \theta) \log \Gamma + W(\overline{x} - \log \Gamma) && \text{(A18)}\\
&= (I - W)^{-1}(\kappa^x + a - \theta \log \Gamma) + \log \Gamma && \text{(A19)}
\end{aligned}$$

where $\kappa^x = \theta \ell_i + \sum_{j=1}^{N} w_{ij} \log w_{ij}$ is a vector of constants.

Define $H = V(I - W)^{-1}$. The log consumption of active households is

$$\begin{aligned}
\overline{c}_i &= \sum_{j=1}^{N} v_{ij} \log \left(\frac{\lambda_i v_{ij}}{\Gamma_j} \overline{X}_j \right) && \text{(A20)}\\
\overline{c} &= \sum_{j=1}^{N} v_{ij} \log (\lambda_i v_{ij}) + V\overline{x} - V \log \Gamma && \text{(A21)}\\
&= \sum_{j=1}^{N} v_{ij} \log (\lambda_i v_{ij}) + H(\kappa^x + a - \theta \log \Gamma) && \text{(A22)}\\
&= \kappa^c + H(a - \theta \log(H'\lambda + (I - W')^{-1}D)) && \text{(A23)}
\end{aligned}$$

Let $L = (I - W')^{-1}$. Since

$$\frac{\partial \{\log(H'\lambda + LD)\}_i}{\partial D} = \frac{\partial \log(\{H'\lambda\}_i + L_i D)}{\partial D} = \frac{1}{\{H'\lambda\}_i + L_i D} L \qquad \text{(A24)}$$

we can apply a first-order approximation at $D=0$, and obtain

$$\{\log(\overline{\Gamma}+LD)\}_i \approx \log\{H'\lambda\}_i + \frac{1}{\{H'\lambda\}_i}LD \tag{A25}$$

We define $\frac{\theta}{H'\lambda}$ as a diagonal matrix whose element (i,i) is $\frac{\theta}{\{H'\lambda\}_i}$. Then,

$$\overline{c} = \kappa^c + H\left(a - \frac{\theta}{H'\lambda}(I-W')^{-1}D\right) \tag{A26}$$

We can also characterize the intermediate goods' log prices by

$$\begin{aligned} \log\varphi &= \log\Gamma - \overline{x} && \text{(A27)}\\ &= (I-W)^{-1}(-\kappa^x - a + \theta\log\Gamma) && \text{(A28)}\\ &= (I-W)^{-1}(-\kappa^x - a + \theta\log(\overline{\Gamma}+(I-W')^{-1}D)) && \text{(A29)} \end{aligned}$$

If the Leontief inverse $(I-W)^{-1}$ is approximately diagonal, holding demand shock constant, a higher productivity a_i means a lower good price φ_i. Holding productivity shock constant, a positive demand shock D_i means a higher good price φ_i.

A.2.2 Lemma 2

Here we derive a simple mapping from the observed trade quantities to the network parameters. This will allow us to map observed trade flows in the data to the underlying model parameters. Let q_{jt} denote the price of the tradable good in country j in a common numeraire. Then, $q_{jt}X_{ijt}$ is the total value of inputs of intermediate goods from country j used in country i's production, and $q_{jt}C_{ijt}$ is the total value of inputs of consumption goods from country j consumed in country i.

Lemma 2 (Input-Output Network)**.** *(a) Input shares of intermediate goods reflect matrix W:*

$$\frac{q_{jt}X_{ijt}}{q_{kt}X_{ikt}} = \frac{w_{ij}}{w_{ik}}.$$

(b) Input shares of final consumption goods reflect matrix V:

$$\frac{q_{jt}C_{ijt}}{q_{kt}C_{ikt}} = \frac{q_{jt}\hat{C}_{ijt}}{q_{kt}\hat{C}_{ikt}} = \frac{v_{ij}}{v_{ik}}.$$

(c) The share of value-added, defined as the total output minus the input cost as a fraction of total output, reflects the labor share θ_i:

$$\frac{q_{it}\overline{X}_{it} - \sum_{j=1}^{N} q_{jt}X_{ijt}}{q_{it}\overline{X}_{it}} = \theta_i.$$

Proof of lemma 2. We return from the social planner's solution to the competitive equilibrium. The optimization of country i's active households is

$$\sum_{t=1}^{\infty} \exp(-\beta t) \sum_{j=1}^{N} v_{ij} \log C_{ijt}. \tag{A30}$$

Since the active households have access to the complete markets, they can pick any consumption path that satisfies the infinite-horizon budget constraint:

$$W_0 + \sum_{t=1}^{\infty} q_{it}A_{it}L_{it}^{\theta_i}\left(\prod_{j=1}^{N} X_{ijt}^{w_{ij}}\right) - \sum_{t=1}^{\infty}\left(\sum_{j=1}^{N} q_{jt}(C_{ijt} + X_{ijt}) + p_{it}e^{\mu_{it}}\right) = 0, \tag{A31}$$

where W_0 is the initial transfer that is consistent with the Pareto weights λ_i. The Lagrangian is

$$\sum_{t=1}^{\infty} \exp(-\beta t) \sum_{j=1}^{N} v_{ij} \log C_{ijt} + \tag{A32}$$

$$M_i\left(W_0 + \sum_{t=1}^{\infty} q_{it}A_{it}L_{it}^{\theta_i}\left(\prod_{j=1}^{N} X_{ijt}^{w_{ij}}\right) - \sum_{t=1}^{\infty}\left(\sum_{j=1}^{N} q_{jt}(C_{ijt} + X_{ijt}) + p_{it}e^{\mu_{it}}\right)\right) + \tag{A33}$$

$$\sum_{t=1}^{\infty} N_{it}(\bar{L}_i - L_{it}) \tag{A34}$$

The FOC's w.r.t. C_{ijt} and X_{ijt} are

$$\exp(-\beta t)v_{ij} = M_i q_{jt} C_{ijt} \tag{A35}$$

$$q_{it}\overline{X}_{it} w_{ij} = q_{jt} X_{ijt} \tag{A36}$$

Comparing with Eq. (A9) and Eq. (A10), reproduced below (switching i and j subscripts),

$$\lambda_i v_{ij} = \varphi_{jt} C_{ijt} \tag{A37}$$

$$\varphi_{it}\overline{X}_{it} w_{ij} = \varphi_{jt} X_{ijt} \tag{A38}$$

we obtain $q_{it}/\varphi_{it} = q_{jt}/\varphi_{jt} = \exp(-\beta t)\xi$ for some constant ξ. Since q_{it} can be denoted in any numeraire, without loss of generality, we can set the constant $\xi = 1$, so that good i at time t has a time-0 state price of $q_{it} = \exp(-\beta t)\varphi_{it}$.

Lemma 2(a) and 2(b) directly follow from Eq. (A9) and Eq. (A10).

Lemma 2(c) follows from $\theta_i + \sum_j w_{ij} = 1$, which implies

$$q_{it}\overline{X}_{it}(1-\theta_i) = q_{it}\overline{X}_{it}\sum_j w_{ij} = \sum_j q_{jt} X_{ijt}. \tag{A39}$$

A.2.3 Lemma 3

Let p_{it} denote the price of country i's consumption basket. The household maximizes

$$p_{it}\left(\prod_{j=1}^{N} C_{ijt}^{v_{ij}}\right) - \sum_{j=1}^{N} q_{jt} C_{ijt} \tag{A40}$$

The zero-profit condition implies

$$p_{it} = \frac{\sum_{j=1}^{N} q_{jt} C_{ijt}}{\overline{C}_{it}} = \exp(-\beta t)\frac{\sum_{j=1}^{N} \varphi_{jt} C_{ijt}}{\overline{C}_{it}} \tag{A41}$$

Then, the log real exchange rate between countries i and j is

$$
\begin{aligned}
e_{ijt} &= \log \frac{p_{it}}{p_{jt}} && \text{(A42)}\\
&= \log \frac{\sum_{k=1}^{N} q_{kt} C_{ikt}}{\sum_{k=1}^{N} q_{kt} C_{jkt}} && \text{(A43)}\\
&= \log \frac{\sum_{k=1}^{N} \lambda_i v_{ik}}{\sum_{k=1}^{N} \lambda_j v_{jk}} + \overline{c}_{jt} - \overline{c}_{it} && \text{(A44)}
\end{aligned}
$$

Then the change in the currency base factor is

$$
\Delta \overline{e}_{it+1} = \frac{1}{N} \sum_{j=1}^{N} \Delta \overline{c}_{jt+1} - \Delta \overline{c}_{it+1}. \quad \text{(A45)}
$$

A.2.4 Proposition 1 and 2

The covariance of consumption growth follows directly from Lemma 1:

$$
cov(\Delta \overline{c}_{it}, \Delta \overline{c}_{jt}) = \mathcal{C}(i,j).
$$

The moments of exchange rates follow from the covariance of consumption growth. In particular, the covariance between the changes in currency base factors is

$$
\begin{aligned}
cov(\Delta \overline{e}_{it+1}, \Delta \overline{e}_{jt+1}) &= cov\left(\frac{1}{N} \sum_{k=1}^{N} \Delta \overline{c}_{kt+1} - \Delta \overline{c}_{it+1}, \frac{1}{N} \sum_{k=1}^{N} \Delta \overline{c}_{kt+1} - \Delta \overline{c}_{jt+1} \right) && \text{(A46)}\\
&= \mathcal{C}(i,j) - \overline{\mathcal{C}}(i) - \overline{\mathcal{C}}(j) + \kappa^e. && \text{(A47)}
\end{aligned}
$$

A.3 Equilibrium Solution

We can simplify the equation system into $3N$ equations and $3N$ unknowns. The unknowns are the intermediate goods' prices φ_i, active households' consumption $\overline{C}_i$ and production $\overline{X}_i$. The equations are the market clearing equations, the definitions of production, and the definitions of final consumption, with other variables substituted out.

$$\psi \overline{X}_i \varphi_i = \sum_{j=1}^{N} \psi w_{ji} \overline{X}_j \varphi_j + \sum_{j=1}^{N} v_{ji} \prod_{k=1}^{N} \left(\frac{\varphi_k}{v_{jk}} \right)^{v_{jk}} (\psi \overline{C}_j + (1-\psi) \exp(\mu_j)) \tag{A48}$$

$$\overline{X}_i^{\theta} = A_i \overline{L}_i^{\theta} \prod_{j=1}^{N} (\varphi_i w_{ij} / \varphi_j)^{w_{ij}} \tag{A49}$$

$$\overline{C}_i = \prod_{j=1}^{N} (v_{ij}/\varphi_j)^{v_{ij}} \tag{A50}$$

The first equation follows from

$$\psi \varphi_i \overline{X}_i = \sum_{j=1}^{N} \left(\psi \varphi_j \overline{X}_j w_{ji} \right) + \sum_{j=1}^{N} \left(\varphi_i \psi C_{ji} + \varphi_i (1-\psi) \hat{C}_{ji} \right) \tag{A51}$$

$$= \sum_{j=1}^{N} \left(\psi \varphi_j \overline{X}_j w_{ji} \right) + \sum_{j=1}^{N} \left(\psi v_{ji} \prod_{k=1}^{N} \left(\frac{\varphi_k}{v_{jk}} \right)^{v_{jk}} \overline{C}_j + (1-\psi) v_{ji} \prod_{k=1}^{N} \left(\frac{\varphi_k}{v_{jk}} \right)^{v_{jk}} \hat{\overline{C}}_j \right) \tag{A52}$$

$$= \sum_{j=1}^{N} \left(\psi \varphi_j \overline{X}_j w_{ji} \right) + \sum_{j=1}^{N} v_{ji} \prod_{k=1}^{N} \left(\frac{\varphi_k}{v_{jk}} \right)^{v_{jk}} \left(\psi \overline{C}_j + (1-\psi) \hat{\overline{C}}_j \right) \tag{A53}$$

which follows from

$$\varphi_i \hat{C}_{ji} = v_{ji} p_j \hat{\overline{C}}_j = v_{ji} \prod_{k=1}^{N} \left(\frac{\varphi_k}{v_{jk}} \right)^{v_{jk}} \hat{\overline{C}}_j \tag{A54}$$

The second equation follows from

$$\overline{X}_i = A_i \overline{L}_i^{\theta_i} \left(\prod_{j=1}^{N} X_{ij}^{w_{ij}} \right) \tag{A55}$$

$$= A_i \overline{L}_i^{\theta_i} \left(\prod_{j=1}^{N} (\varphi_i / \varphi_j \overline{X}_i w_{ij})^{w_{ij}} \right) \tag{A56}$$

$$\overline{X}_i^{\theta} = A_i \overline{L}_i^{\theta_i} \prod_{j=1}^{N} (\varphi_i / \varphi_j w_{ij})^{w_{ij}} \tag{A57}$$

The third equation follows from

$$\overline{C}_i = \prod_{j=1}^{N} C_{ij}^{v_{ij}} = \prod_{j=1}^{N} (\lambda_i v_{ij}/\varphi_j)^{v_{ij}} \tag{A58}$$

and $\lambda_i = 1$.

We solve this equation system numerically.

B Empirical Appendix

Table A1: Explaining Correlations of FX and Consumption (Developed and Emerging)

	Base Factor Correlations						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
V Bilateral	0.148***	0.083***					
	(0.014)	(0.017)					
V Network		0.103***					
		(0.017)					
V Full			0.154***				
			(0.014)				
W Bilateral				0.127***	0.123***		
				(0.014)	(0.013)		
W Network					0.112***		
					(0.013)		
W Full						0.139***	
						(0.014)	
TFP Correlation							0.125***
							(0.014)
Observations	406	406	406	406	406	406	406
R^2	0.222	0.288	0.240	0.163	0.289	0.198	0.159
LR-Test (p-value)		< .001			< .001		

	Consumption Correlations						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
V Bilateral	0.060***	0.025*					
	(0.012)	(0.015)					
V Network		0.056***					
		(0.015)					
V Full			0.064***				
			(0.012)				
W Bilateral				0.053***	0.051***		
				(0.012)	(0.012)		
W Network					0.047***		
					(0.012)		
W Full						0.058***	
						(0.012)	
TFP Correlation							0.131***
							(0.010)
Observations	406	406	406	406	406	406	406
R^2	0.062	0.095	0.069	0.047	0.086	0.058	0.295
LR-Test (p-value)		< .001			< .001		

Note: Regressions of currency base factor correlations (Equation (2)) and bilateral consumption growth correlations (Equation (3)) on trade network closeness measures and total factor productivity (TFP) correlations. Bilateral regressions include the set of unique country pairs for 29 developed and emerging countries. Consumption growth is annual in local currency units. Currency base factors are the average appreciation of a currency vs all other currencies. The closeness measures are defined in Section 1.2. The sample is from 1974 to 2014.

Table A2: Explaining Correlations of FX and Consumption including Distance (Developed and Emerging)

	Base Factor Correlations			Consumption Correlations		
	(1)	(2)	(3)	(4)	(5)	(6)
Log Distance	-0.150***	-0.159***	-0.161***	-0.042***	-0.045***	-0.020**
	(0.012)	(0.012)	(0.011)	(0.012)	(0.012)	(0.009)
V Full	0.065***			0.039***		
	(0.013)			(0.013)		
W Full		0.047***			0.032**	
		(0.014)			(0.013)	
TFP Correlation			0.058***			0.123***
			(0.012)			(0.011)
Observations	406	406	406	406	406	406
R^2	0.459	0.444	0.457	0.098	0.092	0.303

Note: Regressions of currency base factor correlations (Equation (2)) and bilateral consumption growth correlations (Equation (3)) on trade network closeness measures and total factor productivity (TFP) correlations, including distance as a control. Bilateral regressions include the set of unique country pairs for 29 developed and emerging countries. Consumption growth is annual in local currency units. Currency base factors are the average appreciation of a currency vs all other currencies. The closeness measures are defined in Section 1.2. The sample is from 1974 to 2014.

Table A3: Explaining Correlations of FX and Consumption Time Series (Developed and Emerging)

	FX Correlations			Consumption Correlations		
	(1)	(2)	(3)	(4)	(5)	(6)
V Full	0.107**			0.059		
	(0.047)			(0.048)		
W Full		0.101**			0.080*	
		(0.041)			(0.042)	
TFP Correlation			-0.002			0.198***
			(0.008)			(0.014)
Observations	1,136	1,136	1,136	1,357	1,357	1,357
Within R^2	0.018	0.024	0.000	0.002	0.005	0.208
Country-Pair fixed effects	✓	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓	✓

Note: Panel regressions of time-series of currency base factor correlations (Equation (4)) and bilateral consumption growth correlations (Equation (5)) on the time-series of trade network closeness measures and total factor productivity (TFP) correlations. All input values are computed using 10-year non-overlapping windows. Observations are for 4 non-overlapping windows of data for the set of unique country pairs among 29 developed and emerging countries. Regressions include country-pair and time fixed effects. Consumption growth is annual in local currency units. Currency base factors are the average appreciation of a currency vs all other currencies. The closeness measures are defined in Section 1.2. The sample is from 1974 to 2014.