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A Appendix

A.1 Approximating Bilateral Trade Imbalances

We can write the proportional bilateral imbalance between n and n' as:

$$\frac{M_{n'n} - M_{nn'}}{M_{n'n}^{\frac{1}{2}} M_{nn'}^{\frac{1}{2}}} = \sum_{s=1}^{S} \frac{M_{sn'n} - M_{snn'}}{M_{sn'n}^{\frac{1}{2}} M_{snn'}^{\frac{1}{2}}} \left(\frac{M_{sn'n} M_{snn'}}{M_{n'n} M_{nn'}} \right)^{\frac{1}{2}}. \tag{38}$$

Note from (1) that

$$\frac{M_{sn'n}}{M_{sn'n}^{\frac{1}{2}} M_{snn'}^{\frac{1}{2}}} = \left[\frac{(1 - NX_n/D_n)}{(1 - NX_{n'}/D_{n'})} \frac{d_{sn'} e_{sn}}{d_{sn} e_{sn'}} \left(\frac{\tau_{sn'n}}{\tau_{snn'}} \right)^{-\theta_s} \left(\frac{O_{sn} P_{sn'}}{O_{sn'} P_{sn}} \right)^{-\theta_s} \right]^{\frac{1}{2}} =$$

$$= e^{\frac{1}{2}\left[\ln\left(\frac{1-NX_n/D_n}{1-NX_{n'}/D_{n'}} \right) + \ln\left(\frac{d_{sn'} e_{sn}}{d_{sn} e_{sn'}} \right) - \theta_s \ln\left(\frac{\tau_{sn'n}}{\tau_{snn'}} \right) - \theta_s \ln\left(\frac{O_{sn} P_{sn'}}{O_{sn'} P_{sn}} \right) \right]}. \tag{39}$$

The first-order Taylor-series expansion of (39) centered at $\ln(1 - NX_n/D_n) = 0$ for all n, $\ln d_{sn} = \ln e_{sn} = \ln(D_s/D)$ for all s and n, and $\ln \tau_{sn'n}^{-\theta_s} = \ln \tau_{snn'}^{-\theta_s} = \ln \bar{\tau}_{sn'n}^{-\theta_s}$ for all s, n' and n yields[46]

$$\frac{M_{sn'n}}{M_{sn'n}^{\frac{1}{2}} M_{snn'}^{\frac{1}{2}}} \simeq \frac{1}{2} \left[\ln\left(\frac{1 - NX_n/D_n}{1 - NX_{n'}/D_{n'}} \right) + \ln\left(\frac{d_{sn'} e_{sn}}{d_{sn} e_{sn'}} \right) - \theta_s \ln\left(\frac{\tau_{sn'n}}{\tau_{snn'}} \right) - \theta_s \ln\left(\frac{O_{sn} P_{sn'}}{O_{sn'} P_{sn}} \right) \right], \tag{40}$$

and, hence,

$$\frac{M_{n'n} - M_{nn'}}{M_{n'n}^{\frac{1}{2}} M_{nn'}^{\frac{1}{2}}} \simeq \sum_{s=1}^{S} \left(\frac{M_{sn'n} M_{snn'}}{M_{n'n} M_{nn'}} \right)^{\frac{1}{2}} \left[\ln\left(\frac{1 - NX_n/D_n}{1 - NX_{n'}/D_{n'}} \right) + \ln\left(\frac{d_{sn'} e_{sn}}{d_{sn} e_{sn'}} \right) \right.$$

$$\left. -\theta_s \ln\left(\frac{\tau_{sn'n}}{\tau_{snn'}} \right) - \theta_s \ln\left(\frac{O_{sn} P_{sn'}}{O_{sn'} P_{sn}} \right) \right]. \tag{41}$$

A.2 Variance Decomposition for 1995-1999

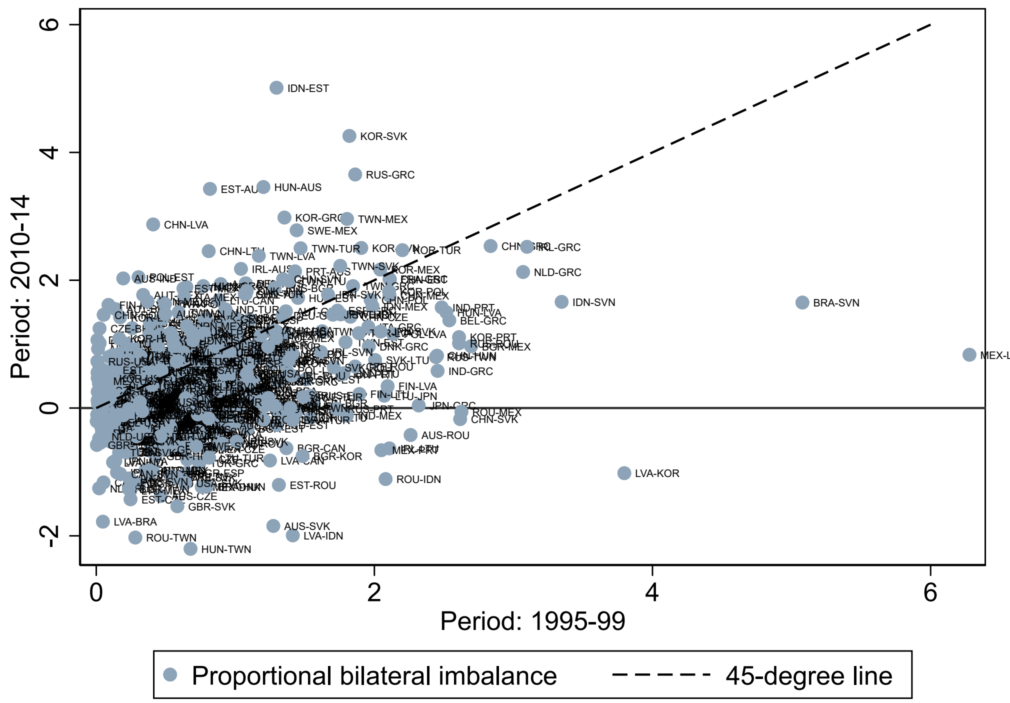
A.2.1 Data

To compile the data for 1995-1999 decomposition of the variation in bilateral imbalances, we proceed as described in Sections 2.1 and 2.2 – with one exception: we use the 2013 release of WIOD (whose data tables start in 1995), instead of the 2016 release (whose data tables start in 2000). The data allow

[46] Note from our definitions that

$$d_{sn} = \frac{D_s}{D} \quad \Leftrightarrow \quad \frac{D_{sn}}{D_s} = \frac{D_n}{D}, \quad e_{sn} = \frac{D_s}{D} \quad \Leftrightarrow \quad \frac{E_{sn}}{D_s} + e_{sn} \frac{NX_n}{D_n} \frac{D_n}{D_s} = \frac{D_n}{D}.$$

Figure A1: Proportional bilateral imbalances, 2010-14 versus 1995-99



"Proportional bilateral imbalance" refers to $(M_{n'nt} - M_{nn't}) / (M_{nnt} M_{n'n't})^{1/2}$, where $M_{n'nt}$ represents the total spending by economy n on goods and services from n' in period t. On the horizontal axis, all values are the average for the 2010-14 period. On the vertical axis, all values are the average for the 1995-1999 period. The 2010-14 data is based on WIOD (2016 release), the 1995-99 data on WIOD (2013 release). The chart covers 37 individual economies.

us to aggregate trade and spending values to the same 31 sectors as described in Section 2.2 (and shown in Table A2). However, in the 2013 release Croatia, Norway and Switzerland are not covered as individual countries but grouped with the "Rest of the World". For this reason, the 1995-1999 data only cover 37 individual economies and the Rest of the World, which yields $(38 \times 37/2 =)$ 703 distinct bilateral trade imbalances.

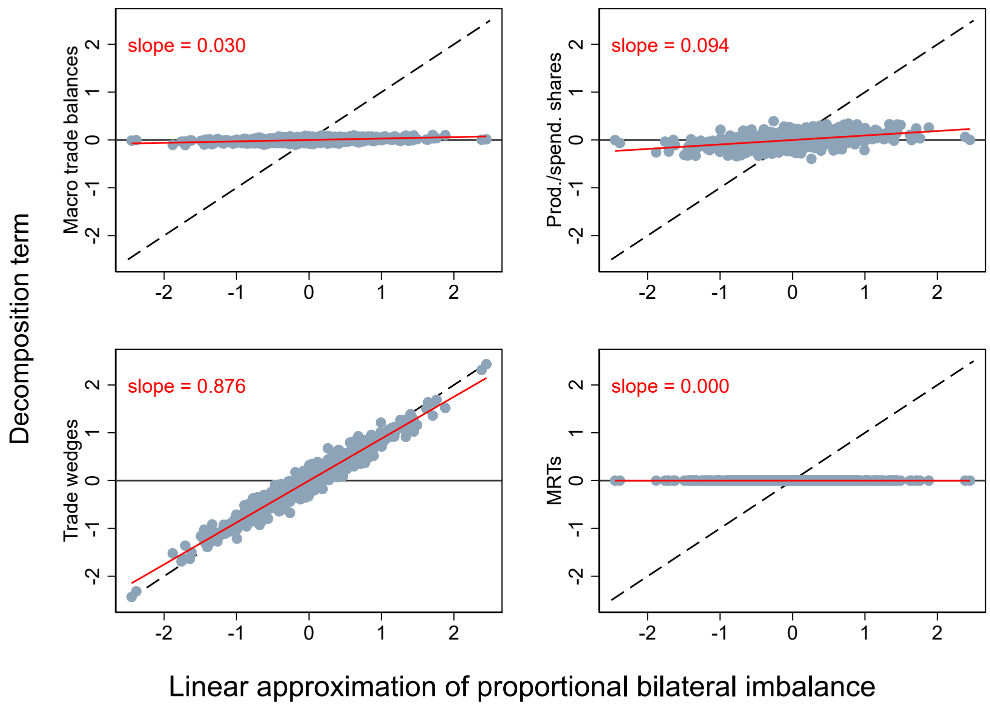
Figure A1 correlates the bilateral imbalances available in both periods with one another, using only the 703 surpluses for 1995-1999. The figure indicates that there is a fairly high degree of persistence: the correlation of the 1995-99 surplus with the 2010-14 value of the same trade balance is .36. Moreover, more than two thirds of the bilateral balances which were in surplus in 1995-1999 were still in surplus in 2010-14.

A.2.2 Variance Decomposition

Figure A2 is the analogue for the 1995-1999 period of Figure 4 in the main text. The quantitative results of the variance decomposition are remarkably similar.

Variation in economies' aggregate trade balances accounts for 3% of the

Figure A2: Variance decomposition for 1995-99



In each panel, the horizontal-axis variable is the first-order linear approximation of $(M_{n'n} - M_{nn'}) / (M_{n'n} M_{nn'})^{1/2}$ from equation (6), represents the total spending by economy n on output from n'. The vertical-axis variable is one each of the four right-hand-side terms in expression (6). The red line represents the line of best fit, whose respective slope is also printed in red. All data is based on WIOD (2013 release), averaged for the years 1995-99. The data covers 37 individual economies and the Rest of the World.

variation in bilateral trade imbalances. Differences in production and spending patterns ("triangular trade") account for 9% of the variation, and asymmetric trade wedges account for the remaining 88%.

A.3 Dynamic Model

A.3.1 Agents' Optimality

The utility maximisation problem of an agent born in t' can be written as

$$\max_{\{C_{nt}(t')\}_{t=t'}^{\infty}} \sum_{t=t'}^{\infty} \left(\frac{1-\xi}{1+\rho_n} \right)^{t-t'} \ln C_{nt}(t') \tag{42}$$

subject to

$$P_{nt}^{C} C_{nt}(t') + P_{nt}^{I} I_{nt}(t') + B_{nt+1}(t') = w_{nt} H_{nt} + \frac{r_{nt}}{1-\xi} K_{nt}(t') + \frac{R_t}{1-\xi} B_{nt}(t'), \tag{43}$$

$$K_{nt+1}(t') = I_{nt}(t') + (1-\delta) K_{nt}(t'), \tag{44}$$

$$K_{nt'}(t') = B_{nt'}(t') = 0, \tag{45}$$

where $I_{nt}(t')$ is the agent's investment in t; $B_{nt}(t')$ denotes bond holdings; $K_{nt}(t')$ denotes capital holdings; P^C_{nt} is the final-consumption price level; P^I_{nt} is the investment price level; w_{nt} is the wage rate; and r_{nt} is the rental rate of capital in n. The resulting Euler equation is

$$\frac{C_{nt+1}(t')}{C_{nt}(t')} = \frac{P^C_{nt}}{P^C_{nt+1}} \frac{R_{t+1}}{1+\rho_n}, \tag{46}$$

and the optimal portfolio requires

$$\frac{r_{nt+1} + P^I_{nt+1}(1-\delta)}{P^I_{nt}} = R_{t+1}. \tag{47}$$

A.3.2 Steady-State Optimal Savings

We can analytically characterise the steady-state consumption and savings decisions of an agent born in period t' as a function of their period-t asset and human wealth:

$$P_n C_{nt}(t') = \frac{\rho_n + \xi}{(1-\xi)(1+\rho_n)} R A_{nt}(t') + \frac{R(\rho_n+\xi)}{[R-\gamma(1-\xi)](1+\rho_n)} w_n H_{nt}, \tag{48}$$

$$A_{nt+1}(t') = \frac{1}{1+\rho_n} R A_{nt}(t') + \frac{[R-\gamma(1+\rho_n)](1-\xi)}{[R-\gamma(1-\xi)](1+\rho_n)} w_n H_{nt}. \tag{49}$$

Define $A_{nt} \equiv (1-\xi)^{-1} \sum_{t'=-\infty}^{t} \xi (1-\xi)^{t-t'} A_{nt}(t')$. Then,

$$a_{nt+1} = \frac{1-\xi}{\gamma} \left[\frac{R}{1+\rho_n} a_{nt} + \frac{R-\gamma(1+\rho_n)}{[R-\gamma(1-\xi)](1+\rho_n)} w_n \right], \tag{50}$$

where $a_{nt} \equiv A_{nt}/H_{nt}$. There is a stationary distribution of assets in steady state as long as $\frac{1-\xi}{1+\rho_n}\frac{R}{\gamma} < 1$. Under this condition,

$$A_{nt} = \frac{(1-\xi)[R-\gamma(1+\rho_n)](1-\alpha_n)}{[\gamma(1+\rho_n) - R(1-\xi)][R-\gamma(1-\xi)]} f_n K^{\alpha_n}_{nt} H^{1-\alpha_n}_{nt}, \tag{51}$$

$$P_n C_{nt} = \frac{\gamma\xi(\rho_n+\xi) R(1-\alpha_n)}{[\gamma(1+\rho_n) - R(1-\xi)][R-\gamma(1-\xi)]} f_n K^{\alpha_n}_{nt} H^{1-\alpha_n}_{nt}. \tag{52}$$

A.3.3 Steady-State Net Exports

In steady state,

$$K_{nt} = \frac{\alpha_n}{\eta_n P_n (R-1+\delta)} f_n K^{\alpha_n}_{nt} H^{1-\alpha_n}_{nt}. \tag{53}$$

This in turn implies

$$\eta_n P_n I_{nt} = \frac{\alpha_n (\gamma - 1 + \delta)}{R - 1 + \delta} f_n K_{nt}^{\alpha_n} H_{nt}^{1-\alpha_n}. \tag{54}$$

From the definition of GDP,

$$f_n K_{nt}^{\alpha_n} H_{nt}^{1-\alpha_n} = P_n C_{nt} + \eta_n P_n I_{nt} + NX_{nt}. \tag{55}$$

This, together with (52) and (54), gives us the steady-state trade balance-to-GDP ratio.

A.4 Exact-Hat Algebra

A.4.1 Key Outcomes and "Own Spending" Shares

In the spirit of Arkolakis et al. (2012), we can re-write a number of key conditions in terms of "own spending" shares. Specifically, from (20)-(28),

$$P_n = \frac{f_n}{Z_n} \prod_{s=1}^{S} v_{snn}^{\frac{1}{\theta_s} \frac{\sigma_{sn}}{1-\sum_s \sigma_{sn}\mu_{sn}}}, \tag{56}$$

$$p_{sn} = \frac{f_n}{z_{sn} Z_n^{\mu_{sn}}} \left(\prod_{s=1}^{S} v_{snn}^{\frac{1}{\theta_s} \frac{\sigma_{sn}}{1-\sum_s \sigma_{sn}\mu_{sn}}} \right)^{\mu_{sn}}, \tag{57}$$

$$v_{sn'n} = \left(\frac{\tau_{sn'n} p_{sn'}}{\tau_{snn} p_{sn}} \right)^{-\theta_s} v_{snn}, \tag{58}$$

$$R = \frac{\alpha_n}{\eta_n} \left(\prod_{s=1}^{S} v_{snn}^{-\frac{1}{\theta_s} \frac{\sigma_{sn}}{1-\sum_s \sigma_{sn}\mu_{sn}}} \right) Z_n k_n^{\alpha_n - 1} + 1 - \delta, \tag{59}$$

where $v_{sn'n} \equiv M_{sn'n} / \sum_{n'} M_{sn'n} = (\tau_{sn'n} p_{sn'})^{-\theta_s} \Big/ \sum_{n'} (\tau_{sn'n} p_{sn'})^{-\theta_s}$ is the economy-n' trade share in economy-n expenditure in sector s.

A.4.2 Changes in Trade Costs and Productivity

For any steady-state outcome x_n, define $\tilde{x}_n$ as the new outcome after a parameter change; and $\hat{x}_n \equiv \tilde{x}_n / x_n$. The only exogenous parameter changes we consider in this section are changes in $\{\tau_{sn'n}\}_{s,n' \neq n}$ and uniform changes in sectoral productivities , where $\hat{z}_{n'} = \hat{z}_{sn'}$ for all s, n.

Then:

$$\hat{v}_{sn'n} = \frac{\left[\frac{\hat{\tau}_{sn'n}\hat{f}_{n'}}{\hat{z}_{n'}^{1+\mu_{sn'}/\left(1-\sum_s \sigma_{sn'}\mu_{sn'}\right)}}\left(\prod_{s=1}^{S}\hat{v}_{sn'n'}^{\frac{1}{\theta_s}\frac{\sigma_{sn'}}{1-\sum_s \sigma_{sn'}\mu_{sn'}}}\right)^{\mu_{sn'}}\right]^{-\theta_s}}{\sum_{n'=1}^{N}\left[\frac{\hat{\tau}_{sn'n}\hat{f}_{n'}}{\hat{z}_{n'}^{1+\mu_{sn'}/\left(1-\sum_s \sigma_{sn'}\mu_{sn'}\right)}}\left(\prod_{s=1}^{S}\hat{v}_{sn'n'}^{\frac{1}{\theta_s}\frac{\sigma_{sn'}}{1-\sum_s \sigma_{sn'}\mu_{sn'}}}\right)^{\mu_{sn'}}\right]^{-\theta_s} v_{sn'n}}, \tag{60}$$

$$\hat{f}_n\hat{k}_n^{\alpha_n}h_n = \sum_{s=1}^{S}(1-\mu_{sn})\sum_{n'=1}^{N}\hat{v}_{snn'}v_{snn'}\sigma_{sn'}\left(\tilde{q}_{n'}-\tilde{nx}_{n'}\right)\hat{f}_{n'}\hat{k}_{n'}^{\alpha_{n'}}h_{n'}, \tag{61}$$

$$\tilde{q}_n\hat{f}_n\hat{k}_n^{\alpha_n}h_n = \sum_{s=1}^{S}\sum_{n'=1}^{N}\hat{v}_{snn'}v_{snn'}\sigma_{sn'}\left(\tilde{q}_{n'}-\tilde{nx}_{n'}\right)\hat{f}_{n'}\hat{k}_{n'}^{\alpha_{n'}}h_{n'}, \tag{62}$$

$$\tilde{nx}_n = 1 - \frac{\alpha_n\left(1-\frac{1-\delta}{\gamma}\right)}{\frac{\tilde{R}}{\gamma}-\frac{1-\delta}{\gamma}} - \frac{\xi\left(\rho_n+\xi\right)\frac{\tilde{R}}{\gamma}\left(1-\alpha_n\right)}{\left[1+\rho_n-\frac{\tilde{R}}{\gamma}\left(1-\xi\right)\right]\left[\frac{\tilde{R}}{\gamma}-\left(1-\xi\right)\right]}, \tag{63}$$

$$\sum_{n=1}^{N}\tilde{nx}_n\hat{f}_n\hat{k}_n^{\alpha_n}h_n = 0, \tag{64}$$

$$\frac{\tilde{R}-1+\delta}{R-1+\delta} = \hat{z}_n^{\frac{1}{1-\sum_s\sigma_{sn}\mu_{sn}}}\left(\prod_{s=1}^{S}\hat{v}_{snn}^{-\frac{1}{\theta_s}\frac{\sigma_{sn}}{1-\sum_s\sigma_{sn}\mu_{sn}}}\right)\hat{k}_n^{\alpha_n-1}, \tag{65}$$

$$\hat{y}_n = \left(\prod_{s=1}^{S}\hat{v}_{snn}^{-\frac{1}{\theta_s}\frac{\sigma_{sn}}{1-\sum_s\sigma_{sn}\mu_{sn}}}\right)\hat{z}_n^{\frac{1}{1-\sum_s\sigma_{sn}\mu_{sn}}}\hat{k}_n^{\alpha_n}, \tag{66}$$

$$\hat{c}_n = \frac{\gamma\xi\left(\rho_n+\xi\right)\tilde{R}\left(1-\alpha_n\right)}{\left[\gamma\left(1+\rho_n\right)-\tilde{R}\left(1-\xi\right)\right]\left[\tilde{R}-\gamma\left(1-\xi\right)\right]}\hat{y}_n, \tag{67}$$

where $nx_n = NX_{nt}/f_n k_n^{\alpha_n}H_{nt}$ denotes the economy-n aggregate net exports to GDP ratio, $h_n \equiv f_n k_n^{\alpha_n}H_{nt}/\sum_n\left(f_n k_n^{\alpha_n}H_{nt}\right)$ is the economy-n share in world nominal GDP, and $q_n \equiv \sum_s p_{sn}Q_{snt}/\left(f_n k_n^{\alpha_n}H_{nt}\right)$ is the economy-n gross-output-to-GDP ratio.

Equations (60)-(62) describe the exact-hat algebra for our model conditional on given changes in trade balances and per-worker capital stocks, $\{\tilde{nx}_n, \hat{k}_n\}_n$. If factor endowments and trade balances were taken as exogenous as in static trade models of the kind used, for example, in Dekle et al. (2007, 2008), this set of equations would be sufficient to perform counterfactuals exploring the trade impact of changes in trade wedges and productivities (as well as the exogenous factor endowments and trade balances). In this sense, they represent the "static block" of our exact hat algebra. Equations (63)-(65) reflect the endogeneity of trade balances and capital stocks – via asset-market clearing and portfolio optimality, respectively – in the steady

state of our dynamic model. They represent the "dynamic block" of our exact-hat algebra. Finally, equations (66) and (67) translate the exogenous and endogenous changes in the combined static and dynamic blocks into real-GDP and consumption changes.

A.4.3 Financial Autarky

We only consider the transition from our baseline assumption of perfectly integrated international asset markets (no barriers to international asset trade) to complete financial autarky (prohibitive barriers to international asset trade). The latter requires all net holdings of the international bond to be zero in equilibrium: $B_{nt} = 0$ for all n and t. Since economies differ in their production technologies and intertemporal preferences, each economy must have its "own" interest rate R_{nt} (instead of R_t) for this to be an equilibrium outcome.

Assuming an economy-specific interest rate R_{nt}, we can proceed as in Section A.3 to show that in steady state,

$$\frac{A_{nt}}{f_n K_{nt}^{\alpha_n} H_{nt}^{1-\alpha_n}} = \frac{(1-\xi)\left[R_n - \gamma(1+\rho_n)\right](1-\alpha_n)}{\left[\gamma(1+\rho_n) - R_n(1-\xi)\right]\left[R_n - \gamma(1-\xi)\right]}, \tag{68}$$

$$\frac{\eta_n P_n K_{nt}}{f_n K_{nt}^{\alpha_n} H_{nt}^{1-\alpha_n}} = \frac{\alpha_n}{R_n - 1 + \delta}. \tag{69}$$

Financial autarky requires $B_n = 0$, which implies $A_{nt} = \eta_n P_n K_{nt}$. Equating (68) and (69) yields a quadratic equation in permissible values of R_n.[47] This quadratic equation has only one positive root, which corresponds to the steady-state interest rate:

$$\frac{R_n}{\gamma} = (1+\rho_n)\left\{1 - \frac{1}{2}\left[1 - \frac{(1-\alpha_n)(1-\delta)}{\gamma(1+\rho_n)} - \alpha_n\left(\frac{1-\xi}{1+\rho_n} + \frac{\xi}{1-\xi}\right)\right] + \right.$$
$$\left. + \frac{1}{2}\sqrt{\left[1 - \frac{(1-\alpha_n)(1-\delta)}{\gamma(1+\rho_n)} - \alpha_n\left(\frac{1-\xi}{1+\rho_n} + \frac{\xi}{1-\xi}\right)\right]^2 + 4\alpha_n \frac{\xi}{1-\xi}\frac{\xi+\rho_n}{1+\rho_n}}\right\}. \tag{70}$$

It is straightforward to show that $B_{nt} = 0$ implies $NX_{nt} = 0$ for all n and t.

The exact-hat algebra required to compute outcomes in the new financial-autarky steady state is now summarised by the following system of equations:

[47] Note that $R_n \in \left[\gamma(1+\rho_n), \gamma(1+\rho_n)/(1-\xi)\right]$ is required for $A_{nt}/\left(f_n K_{nt}^{\alpha_n} H_{nt}^{1-\alpha_n}\right)$ to be positive and finite.

$$\hat{v}_{sn'n} = \frac{\left[\hat{f}_{n'}\left(\prod_{s=1}^{S}\hat{v}_{sn'n'}^{\frac{1}{\theta_s}\frac{\sigma_{sn'}}{1-\sum_s\sigma_{sn'}\mu_{sn'}}}\right)^{\mu_{sn'}}\right]^{-\theta_s}}{\sum_{n'=1}^{N}\left[\hat{f}_{n'}\left(\prod_{s=1}^{S}\hat{v}_{sn'n'}^{\frac{1}{\theta_s}\frac{\sigma_{sn'}}{1-\sum_s\sigma_{sn'}\mu_{sn'}}}\right)^{\mu_{sn'}}\right]^{-\theta_s} v_{sn'n}}, \tag{71}$$

$$\hat{f}_n\hat{k}_n^{\alpha_n}h_n = \sum_{s=1}^{S}(1-\mu_{sn})\sum_{n'=1}^{N}\hat{v}_{snn'}v_{snn'}\sigma_{sn'}\tilde{q}_{n'}\hat{f}_{n'}\hat{k}_{n'}^{\alpha_{n'}}h_{n'}, \tag{72}$$

$$\tilde{q}_n\hat{f}_n\hat{k}_n^{\alpha_n}h_n = \sum_{s=1}^{S}\sum_{n'=1}^{N}\hat{v}_{snn'}v_{snn'}\sigma_{sn'}\tilde{q}_{n'}\hat{f}_{n'}\hat{k}_{n'}^{\alpha_{n'}}h_{n'}, \tag{73}$$

$$\frac{R_n-1+\delta}{R-1+\delta} = \left(\prod_{s=1}^{S}\hat{v}_{snn}^{-\frac{1}{\theta_s}\frac{\sigma_{sn}}{1-\sum_s\sigma_{sn}\mu_{sn}}}\right)\hat{k}_n^{\alpha_n-1}, \tag{74}$$

$$\hat{y}_n = \left(\prod_{s=1}^{S}\hat{v}_{snn}^{-\frac{1}{\theta_s}\frac{\sigma_{sn}}{1-\sum_s\sigma_{sn}\mu_{sn}}}\right)\hat{k}_n^{\alpha_n}, \tag{75}$$

$$\hat{c}_n = \frac{\gamma\xi(\rho_n+\xi)R_n(1-\alpha_n)}{[\gamma(1+\rho_n)-R_n(1-\xi)][R_n-\gamma(1-\xi)]}\hat{y}_n, \tag{76}$$

where R_n is given in equation (70) and, from the reasoning above, $\tilde{nx}_n = 0$ for all n.

A.5 Additional Details on Counterfactuals

A.5.1 Bilateral Exposure and Global Trade-Wedge Symmetry

Beyond real GDP and consumption effects, one way in which counterfactual global trade-wedge may impact the global economy is by altering the relative dependence of economies on different trade partners. We refer to this as economies' bilateral "exposures". Specifically, we define the "exposure" of economy n to n' as the percent change in economy-n steady-state real GDP in response to a permanent 1 percent increase in the aggregate productivity of economy n', $\{\hat{z}_{n'}\}_{n'\neq n}$. We focus on permanent changes as our model is geared towards comparisons of steady states, but our findings may be indicative of possible business-cycle-frequency co-movements as well.

We compute the matrix of bilateral exposures, as defined above, for all economies in our data using the exact-hat algebra in equations (60)-(66). Figure A3 gives an overview of the results in matrix form. The matrix shows the row economy's GDP response to a 1 percent aggregate-productivity increase in the column economy. Diagonal elements showing economies' exposures to themselves are omitted, and the off-diagonal elements are colour-coded: darker shades of green indicate greater positive exposures (economy-n real GDP rises

Figure A3: Bilateral exposures

	AUS	AUT	BEL	BGR	BRA	CAN	CHE	CHN	CZE	DEU	DNK	ESP	EST	FIN	FRA	GBR	GRC	HRV	HUN	IDN	IND	IRL	ITA	JPN	KOR	LTU	LVA	MEX	NLD	NOR	POL	PRT	ROU	RUS	RoW	SVK	SVN	SWE	TUR	TWN	USA
AUS		.00	.01	.00	.00	.00	.01	.17	.00	.05	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.01	.01	.01	.03	.00	.00	.00	.02	.01	.00	.00	.00	.02	-.12	.00	.00	.01	.00	.02	-.06
AUT	.00		.01	.00	.00	.00	.02	.10	.01	.16	.00	.00	.00	.00	.01	.00	.00	.00	.01	.00	-.01	.01	.03	.00	.02	.00	.00	.00	.02	.01	.01	.00	.00	.01	-.13	.00	.00	.01	.00	.01	-.06
BEL	.00	.00		.00	.00	.00	.02	.09	.01	.04	.00	.00	.00	.00	.03	.01	.00	.00	.00	.00	-.01	.02	.01	.00	.02	.00	.00	.00	.05	.00	.00	.00	.00	.01	-.11	.00	.00	.01	.00	.01	-.07
BGR	.00	.02	.02		-.01	.00	.02	.14	.02	.11	.01	.00	.00	.00	.00	.00	.00	.00	.01	.00	-.02	.01	.02	.00	.03	.00	.00	.00	.03	.01	.01	.00	.01	.01	-.20	.01	.00	.01	.02	.01	-.10
BRA	.00	.00	.01	.00		.00	.01	.13	.00	.05	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	-.01	.01	.01	.00	.03	.00	.00	.00	.02	.01	.00	.00	.00	.02	-.17	.00	.00	.01	.00	.01	-.08
CAN	.00	.00	.00	.00	.00		.01	.11	.00	.05	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.01	.00	.02	.00	.00	.01	.01	.01	.00	.00	.00	.01	-.11	.00	.00	.01	.00	.01	.03
CHE	.00	.01	.01	.00	.00	.00		.07	.00	.08	.00	.00	.00	.00	.01	.01	.00	.00	.00	.00	.00	.01	.02	.00	.02	.00	.00	.00	.02	.01	.00	.00	.00	.01	-.04	.00	.00	.01	.00	.01	-.03
CHN	.00	.00	.01	.00	.00	.00	.01		.00	.06	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	-.01	.01	.01	.01	.03	.00	.00	.00	.02	.01	.00	.00	.00	.02	-.13	.00	.00	.01	.00	.02	-.06
CZE	.00	.02	.02	.00	.00	.00	.02	.14		.19	.01	.01	.00	.00	.02	.01	.00	.00	.02	.00	-.01	.01	.03	.00	.03	.00	.00	.00	.03	.01	.04	.00	.00	.03	-.17	.04	.00	.01	.01	.02	-.08
DEU	.00	.01	.01	.00	.00	.00	.02	.10	.01		.01	.01	.00	.00	.02	.01	.00	.00	.01	.00	.00	.01	.02	.00	.02	.00	.00	.00	.02	.01	.01	.00	.00	.01	-.11	.00	.00	.01	.01	.01	-.04
DNK	.00	.00	.01	.00	.00	.00	.01	.09	.01	.08		.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.01	.01	.00	.02	.00	.00	.00	.02	.02	.01	.00	.00	.01	-.03	.00	.00	.03	.00	.01	-.05
ESP	.00	.00	.01	.00	.00	.00	.01	.10	.01	.06	.00		.00	.00	.01	.00	.00	.00	.00	.00	-.01	.01	.01	.00	.02	.00	.00	.00	.02	.01	.00	.00	.00	.01	-.16	.00	.00	.01	.00	.01	-.08
EST	.00	.01	.01	.00	.00	.00	.01	.11	.01	.08	.01	.00		.06	.00	.00	.00	.00	.01	.00	-.01	.01	.01	.00	.02	.02	.03	.00	.03	.02	.03	.00	.00	.04	-.07	.00	.00	.06	.00	.01	-.06
FIN	.00	.00	.00	.00	.00	.00	.01	.10	.00	.06	.00	.00	.01		.00	.00	.00	.00	.00	.00	.01	.01	.01	.00	.02	.00	.00	.00	.01	.01	.00	.00	.00	.01	-.14	.00	.00	.01	.00	.01	-.06
FRA	.00	.00	.01	.00	.00	.00	.01	.09	.00	.07	.00	.01	.00	.00		.01	.00	.00	.00	.00	-.01	.01	.02	.00	.02	.00	.00	.00	.02	.01	.00	.00	.00	.01	-.11	.00	.00	.01	.00	.01	-.06
GBR	.00	.00	.01	.00	.00	.00	.01	.10	.00	.06	.00	.00	.00	.00	.01		.00	.00	.00	.00	.00	.02	.01	.00	.02	.00	.00	.00	.02	.01	.00	.00	.00	.01	-.09	.00	.00	.00	.00	.01	-.05
GRC	.00	.00	.00	-.01	-.01	.00	.02	.15	.01	.08	.00	-.01	.00	.00	-.01	.00		.00	.00	.00	-.02	.01	.00	.00	.03	.00	.00	.00	.02	.01	.00	.00	.00	.01	-.27	.00	.00	.01	-.01	.01	-.11
HRV	.00	.02	.01	.00	.00	.00	.01	.08	.01	.06	.00	.00	.00	.00	.00	.00	.00		.01	.00	.00	.01	.05	.00	.02	.00	.00	.00	.02	.01	.01	.00	.00	.01	.00	.00	.02	.01	.00	.01	-.05
HUN	.00	.01	.01	.00	.00	.00	.01	.11	.02	.16	.01	.01	.00	.00	.02	.01	.00	.00		.00	-.01	.01	.03	.00	.03	.00	.00	.01	.02	.01	.02	.00	.01	.01	-.11	.01	.01	.01	.01	.01	-.05
IDN	.01	.00	.01	.00	.00	.00	.02	.19	.00	.08	.01	.00	.00	.00	.00	.00	-.01	.00	.00		-.01	.01	.01	.01	.04	.00	.00	.00	.03	.02	.00	.00	.00	.02	-.22	.00	.00	.01	.00	.03	-.10
IND	.00	.00	.01	.00	-.01	.00	.01	.15	.00	.07	.01	.00	.00	.00	.00	.00	-.01	.00	.00	.01		.01	.00	.00	.03	.00	.00	.00	.02	.01	.00	.00	.00	.02	-.21	.00	.00	.01	.00	.02	-.10
IRL	.01	.01	.03	.00	.00	.01	.03	.15	.01	.10	.01	.02	.00	.00	.02	.10	.00	.00	.00	.00	.00		.03	.00	.03	.00	.00	.01	.04	.01	.01	.00	.00	.02	.04	.00	.00	.02	.00	.02	-.04
ITA	.00	.01	.01	.00	.00	.00	.02	.12	.01	.08	.00	.00	.00	.00	.01	.01	.00	.00	.00	.00	-.01	.01		.00	.03	.00	.00	.00	.02	.01	.01	.00	.00	.01	-.20	.00	.00	.01	.00	.01	-.08
JPN	.00	.00	.00	.00	.00	.00	.01	.10	.00	.05	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	-.01	.01	.00		.02	.00	.00	.00	.01	.01	.00	.00	.00	.01	-.15	.00	.00	.01	.00	.02	-.05
KOR	.00	.00	.00	.00	-.01	.00	.01	.15	.00	.07	.00	.00	.00	.00	.00	.00	-.01	.00	.00	.00	-.01	.01	.01	.02		.00	.00	.01	.02	.01	.00	.00	.00	.02	-.24	.00	.00	.01	.00	.01	-.08
LTU	.00	.01	.00	.00	-.01	-.01	.02	.16	.01	.08	.01	-.01	.02	-.01	-.02	-.03	-.01	.00	.01	.00	-.02	.01	.02	.00	.03		.04	.00	.02	.02	.00	.00	.00	.00	-.26	.00	.00	.01	.00	.02	-.16
LVA	.00	.01	.01	.00	.00	.00	.02	.12	.01	.08	.01	.00	.03	.02	.00	.01	.00	.00	.00	.00	-.01	.01	.01	.00	.03	.07		.00	.03	.02	.03	.00	.00	.04	-.03	.00	.00	.02	.00	.01	-.07
MEX	.01	.01	.01	.00	.00	.01	.02	.24	.01	.11	.01	.00	.00	.00	.00	.00	-.01	.00	.00	.01	-.01	.02	.01	.01	.05	.00	.00		.03	.02	.00	.00	.00	.03	[illegible]	.00	.00	.01	.00	.03	-.01
NLD	.00	.00	.03	.00	.00	.00	.01	.12	.01	.08	.00	.01	.00	.00	.01	.01	.00	.00	.00	.01	.00	.01	.02	.00	.02	.00	.00	.00		.01	.01	.00	.00	.01	-.08	.00	.00	.01	.00	.01	-.06
NOR	.00	.00	.01	.00	.00	.01	.01	.13	.01	.08	.02	.00	.00	.00	.00	.03	-.01	.00	.00	.00	-.01	.01	.01	.00	.03	.00	.00	.00	.04		.01	.00	.00	.02	-.16	.00	.00	.03	.00	.02	-.08
POL	.00	.01	.01	.00	.00	.00	.01	.12	.02	.10	.01	.01	.00	.00	.01	.01	.00	.00	.01	.00	-.01	.01	.02	.00	.03	.00	.00	.00	.02	.01		.00	.00	.02	-.15	.01	.00	.01	.01	.01	-.07
PRT	.00	.00	.01	.00	.00	.00	.01	.10	.00	.07	.00	.02	.00	.00	.01	.00	.00	.00	.00	.00	-.01	.01	.01	.00	.02	.00	.00	.00	.02	.01	.00		.00	.01	-.14	.00	.00	.01	.00	.01	-.08
ROU	.00	.01	.01	.00	-.01	.00	.02	.16	.01	.12	.01	.00	.00	.00	.01	.00	-.01	.00	.01	.00	-.01	.01	.04	.00	.04	.00	.00	.00	.03	.02	.01	.00		.02	-.22	.00	.00	.01	.01	.02	-.11
RUS	.00	.00	.00	.00	.00	.00	.01	.09	.01	.04	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.01	.02	.00	.00	.00	.01	.01	.01	.00	.00		-.05	.00	.00	.00	.00	.01	-.04
RoW	.00	.00	.01	.00	.00	.01	.02	.18	.00	.07	.01	.00	.00	.00	.00	.01	-.01	.00	.00	.01	.00	.01	.01	.01	.04	.00	.00	.01	.02	.01	.00	.00	.00	.02		.00	.00	.01	.00	.02	-.06
SVK	.00	.00	.01	.00	.00	.00	.01	.13	.07	.12	.01	.01	.00	.00	.03	.02	.00	.00	.02	.00	-.01	.01	.03	.00	.04	.00	.00	.00	.02	.01	.02	.00	.00	.02	-.07		.00	.01	.01	.02	-.07
SVN	.00	.04	.01	.00	.00	.00	.01	.08	.01	.11	.01	.01	.00	.00	.02	.00	.00	.02	.02	.00	.00	.01	.07	.00	.02	.00	.00	.00	.02	.01	.01	.00	.01	.01	-.02	.01		.01	.01	.01	-.04
SWE	.00	.01	.01	.00	.00	.00	.01	.11	.01	.08	.02	.00	.00	.01	.00	-.01	.00	.00	.00	.00	-.01	.01	.01	.00	.03	.00	.00	.00	.02	.02	.01	.00	.00	.01	-.16	.00	.00		.00	.01	-.07
TUR	.00	.01	.01	.00	-.01	.00	.02	.19	.01	.12	.01	.00	.00	.00	.01	.01	-.01	.00	.00	.01	-.01	.01	.02	.00	.04	.00	.00	.00	.03	.02	.01	.00	.00	.04	[illegible]	.00	.00	.01		.02	-.12
TWN	.01	.00	.00	.00	-.01	.00	.02	.18	.00	.08	.00	.00	.00	.00	.00	.00	-.01	.00	.00	.00	-.02	.01	.00	.05	.04	.00	.00	.00	.02	.01	.00	.00	.00	.02	-.18	.00	.00	.01	.00		-.08
USA	.00	.00	.00	.00	.00	.01	.01	.11	.00	.05	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	-.01	.01	.00	.00	.02	.00	.00	.01	.01	.01	.00	.00	.00	.01	-.15	.00	.00	.01	.00	.01	

Each cell shows the percentage change in the row economy's steady-state real GDP per capita in response to a 1 percent increase in the aggregate productivity of the column economy. See Section A.5.1 for details. Calibration on data from PWT (edition 9.0) and WIOD (2016 release), average for the years 2010-14.

in economy-n' aggregate productivity); darker shares of red indicate greater negative exposures (economy-n real GDP declines in economy-n' aggregate productivity).

As would be expected, most bilateral exposures are small in absolute value. However, productivity changes in the larger economies – notably, the U.S., China, and Germany – have economically significant effects on the real incomes of *all* economies. China in particular stands out, with the median country gaining .12 percent of real income for from a 1 percent increase in Chinese aggregate productivity. This reflects China's centrality in global value chains that has been widely noted elsewhere.[48]

By our measures, most economies' trade wedges in importing from China are lower than China's wedges in importing from them. As a result, for most economies global trade-wedge symmetry implies a trade liberalisation vis-à-vis trade partners *other than China*. We now explore to what extent this changes the patterns of bilateral exposure. We do so by using the exact-hat

[48]See, for example, Baldwin and Freeman (2021) for a recent discussion and evidence on China's centrality in global value chains.

Figure A4: Changes in bilateral exposures due to global trade-wedge symmetry

	AUS	AUT	BEL	BGR	BRA	CAN	CHE	CHN	CZE	DEU	DNK	ESP	EST	FIN	FRA	GBR	GRC	HRV	HUN	IDN	IND	IRL	ITA	JPN	KOR	LTU	LVA	MEX	NLD	NOR	POL	PRT	ROU	RUS	RoW	SVK	SVN	SWE	TUR	TWN	USA
AUS		.00	.00	.00	.00	.00	.00	-.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00
AUT	.00		.00	.00	.00	.00	.00	-.01	.00	-.02	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.02	.01	.00	.00	.00	.00	.00
BEL	.00	.00		.00	.00	.00	.00	-.01	.00	.01	.00	-.01	.00	.00	-.01	.00	.00	.00	.00	.00	.01	.00	.00	.00	-.01	.00	.00	.00	.01	.00	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00	-.01
BGR	.00	.00	.00		.00	.00	.00	-.01	.00	-.01	.00	.02	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	-.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.03	.00	.00	.00	-.01	.00	.00
BRA	.00	.00	.00	.00		.00	.00	-.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00	.00
CAN	.00	.00	.00	.00	.00		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.01
CHE	.00	.00	.00	.00	.00	.00		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00	.00
CHN	.00	.00	.00	.00	.00	.00	.00		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.03	.00	.00	.00	.00	.00	.00
CZE	.00	-.01	-.01	.00	.00	.00	.00	-.01		-.04	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	-.01	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00
DEU	.00	.00	.00	.00	.00	.00	.00	.00	.00		.00	.00	.00	.00	-.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00
DNK	.00	.00	.00	.00	.00	.00	.00	-.01	.00	.00		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.01	.00	.00	.01	.00	.00	.00
ESP	.00	.00	.00	.00	.00	.00	.00	-.01	.00	.00	.00		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.03	.00	.00	.00	.00	.00	.00
EST	.00	.00	.01	.00	.00	.00	.00	-.01	.00	.01	.00	.00		.01	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.01	.01	.02	.00	.00	.01	.00	.00	.00	.02	.00	.00	.01
FIN	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.01	.00	.00		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.03	.00	.00	.01	.00	.00	.00
FRA	.00	.00	.00	.00	.00	.00	.00	-.01	.00	.00	.00	.00	.00	.00		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00	.00
GBR	.00	.00	.00	.00	.00	.00	.00	-.01	.00	.00	.00	.00	.00	.00	.00		.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00
GRC	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.09	.00	.00	.00	.01	.00	.01
HRV	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00	.01
HUN	.00	.01	.00	.00	.00	.00	.00	-.02	.00	-.01	.00	.00	.00	.00	.00	.00	.00	.00		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
IDN	.00	.00	.00	.00	.00	.00	.00	-.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.04	.00	.00	.00	.00	.00	.00
IND	.00	.00	.00	.00	.00	.00	.00	-.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.05	.00	.00	.00	.00	.00	.00
IRL	.00	.00	.00	.00	.00	.00	.01	-.02	.00	.00	.00	.00	.00	.00	.00	.03	.00	.00	.00	.00	-.01		.00	.00	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00	-.02	.00	.00	.00	.00	.00	.09
ITA	.00	.00	.00	.00	.00	.00	.00	-.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.04	.00	.00	.00	.00	.00	.00
JPN	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00	.00
KOR	.00	.00	.00	.00	.00	.00	.00	-.01	.00	.00	.00	.00	.00	.00	.00	-.01	.00	.00	.00	.00	-.01	.00	.00	.00		.00	.00	.00	-.01	.00	.00	.00	.00	.00	.06	.00	.00	.00	.00	-.01	-.01
LTU	.00	.00	.00	.00	.00	-.01	.00	-.03	.00	-.01	.00	.00	.00	.00	-.01	.00	.00	.00	.00	.00	.00	.01	.00	.00	-.01		.00	-.01	-.01	.01	.02	.00	.00	.02	.05	-.01	.00	-.01	.00	.00	-.03
LVA	.00	.00	.00	.00	.00	.00	.00	-.01	.00	.01	.00	.00	.01	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01		.00	.01	.01	.02	.00	.00	.00	-.02	.00	.00	.01	.00	.00	.01
MEX	.00	.00	.00	.00	.00	.00	.00	-.02	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00		.00	.00	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00	-.04
NLD	.00	.00	.00	.00	-.01	.00	.00	-.01	.00	.02	.00	.00	.00	.00	-.01	.00	.00	.00	.00	.00	-.01	.01	.00	.00	-.01	.00	.00	-.01		.00	.00	.00	.00	.00	-.01	.00	.00	.00	.00	.00	-.02
NOR	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00		.00	.00	.00	.00	.02	.00	.00	.00	.00	.00	.00
POL	.00	.00	.00	.00	.00	.00	.00	-.01	.00	-.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		.00	.00	.01	.01	.00	.00	.00	.00	.00	.00
PRT	.00	.00	.00	.00	.00	.00	.00	-.01	.00	.00	.00	.02	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		.00	.00	.03	.00	.00	.00	.00	.00	.00
ROU	.00	.00	.00	.00	.00	.00	.00	-.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		.00	.02	.00	.00	.00	.00	.00	.00
RUS	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		.01	.00	.00	.00	.00	.00	.00
RoW	.00	.00	.00	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00		.00	.00	.00	.00	.00	.02
SVK	.00	-.01	-.01	.00	-.01	.00	.00	-.03	-.04	-.05	.00	-.01	.00	.00	-.02	-.02	.00	.00	-.02	.00	-.01	.00	-.03	-.01	-.02	.00	.00	.00	-.01	.00	-.02	.00	-.01	.00	[illegible]		.00	.00	-.01	-.01	-.02
SVN	.00	.01	.00	.00	.00	.00	.00	.00	.01	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	-.01	.01		.00	.00	.00	.00
SWE	.00	.00	.00	.00	.00	.00	.00	-.01	.00	-.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.02	.00	.00		.00	.00	.00
TUR	.00	.00	.00	.00	.00	.00	.00	-.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	-.01	.00	-.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.05	.00	.00	.00		.00	.00
TWN	.00	.00	.00	.00	.00	.00	.00	.06	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	-.01	.00	.00	.00	-.02	.00	.00	.00	.00	.00	.00	.00	.00	.00	.02	.00	.00	.00	.00		.00
USA	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00	

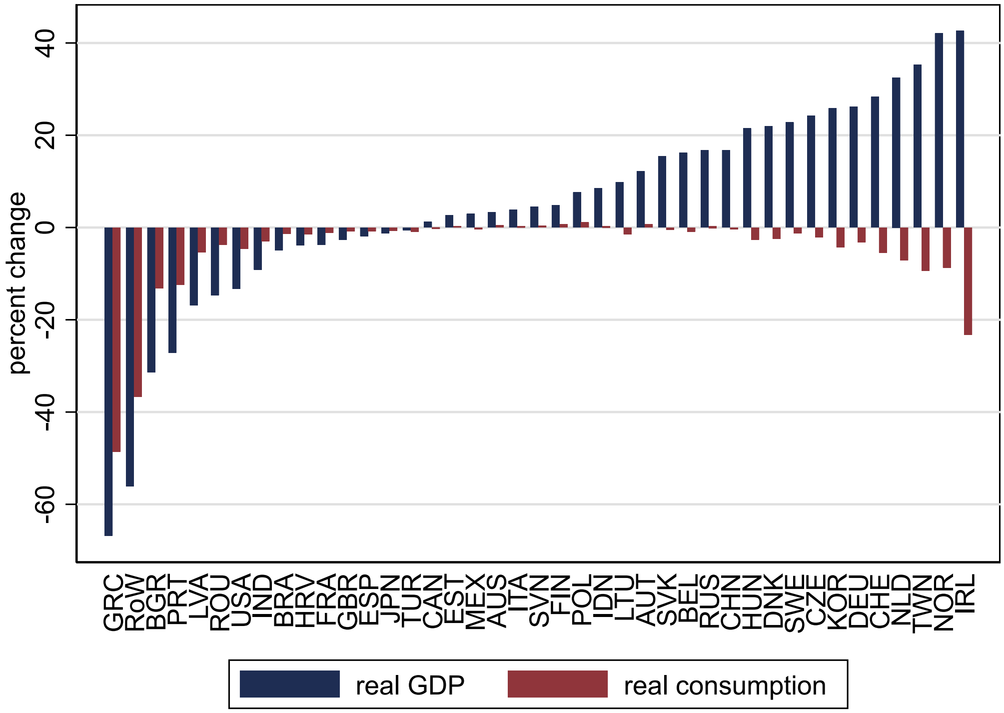
Each cell shows the percentage change in the row economy's "exposure" to the column economy. See Section A.5.1 for details. Calibration on data from PWT (edition 9.0) and WIOD (2016 release), average for the years 2010-14.

algebra in equations (60)-(66) to compute bilateral exposures for all economies *after* global trade wedges have been made symmetric. Figure A4 presents the *changes* in bilateral exposures relative to what is shown in Figure A3. Again, matrix elements are colour-coded: darker shades of green indicate greater positive changes; darker shades of red indicate greater negative changes. As expected the exposure to China declines for the large majority of economies, with a .01 percentage point decline for the median economy. By contrast, global trade-wedge symmetry increases almost all economies exposure to the Rest of the World.

While these changes are quantitatively small, they point to an intriguing possibility. In recent months, G7 policy makers have expressed a concern that the global economy's resilience to economic shocks may have been undermined by an over-reliance on China's manufacturing capacity in (some) global value chains.[49] Our results suggest that, in addition to China's size and comparative advantages, the current prominence of China in cross-border production networks may also be owed to a particular configuration of trade-wedge asym-

[49] See, for example, G7 Panel on Economic Resilience (2021).

Figure A5: Impact of financial autarky on real GDP and consumption



Percent change in real per-capita GDP and consumption relative to data in the financial-autarky steady state, as described in Section 3.4 and Appendix A.5.2. Calibration on data from PWT (edition 9.0) and WIOD (2016 release), average for the years 2010-14.

metries.

A.5.2 Financial Autarky

Figure A5 gives a graphical overview of the macroeconomic impact of financial autarky across economies. The real-GDP and real-consumption changes primarily reflect a dramatic relocation of capital. Economies with net negative international bond holdings under full financial integration (towards the left-hand side of Figure A5) see their capital stocks and real income levels shrink in financial autarky. Meanwhile, economies with net positive bond holdings under financial integration (towards the right-hand side of Figure A5) see their capital stocks and real incomes grow. However, both groups experience a decline in their real consumption levels. This is because the former lose the benefit of higher wages supported by externally financed capital investments, while the latter lose the benefit of higher foreign investment returns.

The disappearance of macro trade surpluses and deficits also prompts changes in real incomes via the "transfer effect": expenditure shifts towards the output of former trade-surplus economies, which causes a terms-of-trade in their favour, raising their real incomes, and lowering the real incomes of former trade-deficit economies. However, as found in Dekle et al. (2007,

2008), these effects are quantitatively small, and they are dwarfed for most economies by the impact of financial autarky on their capital stocks.

A.5.3 Sources and Concordances for U.S.-China Trade War Tariffs

We obtain data on tariff changes and import values at the 10-digit level of HS for the U.S. from Bown (2019). For China, we take data on tariff changes and import values at the 8-digit level of HS from Bown et al. (2019).[50] Using a concordance from HS to ISIC Rev. 4, we aggregate the tariff changes at the (roughly) 2-digit level of ISIC used in the WIOD (2016 release). We then aggregate further to obtain tariff changes for the coarser set of sectors used throughout this paper (see Section 3). The resulting changes in trade wedges, upon which we base our counterfactual, are shown in Table A4.

A.6 Eaton and Kortum (2002)

This section presents a version of the Eaton-Kortum (2002) model that delivers the same steady-state relationships as our benchmark Armington model. We maintain most of the assumptions made in Section 3, but replace the Armington side of the model, equations (17) and (18), with the assumption that the non-tradable sector-s input is assembled from tradable varieties according to the CES production function

$$X_{snt} = \left[\int_0^1 x_{snt}^{\frac{\chi_s - 1}{\chi_s}}(i)\,di\right]^{\frac{\chi_s}{\chi_s - 1}}, \tag{77}$$

where $\chi_s \geq 0$. x_{snt} represents the use of variety i in the production of the sector-s input by economy n. Varieties are produced with technology

$$Q_{snt}(i) = z_{sn}(i)\left[\frac{K_{snt}^{\alpha_n}(i)H_{snt}^{1-\alpha_n}(i)}{1-\mu_{sn}}\right]^{1-\mu_{sn}}\left[\frac{J_{snt}(i)}{\mu_{sn}}\right]^{\mu_{sn}}, \tag{78}$$

where $\alpha_n, \mu_{sn} \in (0,1)$. $K_{snt}(i)$, $H_{snt}(i)$, and $J_{snt}(i)$ respectively represent the capital, efficiency units of labour, and economy-n final good used in the production of variety i. Productivity shifter $z_{sn}(i)$ is the realisation of a random variable drawn independently for each i from a place-specific Fréchet probability distribution:

$$F_{sn}(Z) = Pr(z_{sn}(i) \leq Z) = e^{-\left(z_{sn}^{\beta_s}\right)Z^{-\beta_s}}, \tag{79}$$

where $z_{sn}^{\beta_s} \geq 0$ and $\beta_s > \chi_s - 1$.

[50] We would like to thank Chad Bown for making this data available.

Goods markets continue to be perfectly competitive, and international trade is subject to the same iceberg transport costs: $\kappa_{sn'n} \geq 1$ units of the economy-n', sector-s variety must be shipped for one unit to arrive in economy n. Production factors can move freely between activities within economies, but cannot move across borders.

Under these assumptions, the steady-state relationships in section 3.1.4 must be adjusted as follows:

$$P_n^C = P_n^J = \frac{P_n^I}{\eta_n} = \prod_{s=1}^{S} \Xi_s^{\sigma_{sn}} \left[\sum_{n'=1}^{N} \left(\kappa_{sn'n} p_{sn'}\right)^{-\beta_s} \right]^{-\frac{\sigma_{sn}}{\beta_s}} \equiv P_n, \tag{80}$$

$$p_{sn}(i) = \frac{1}{z_{sn}(i)} f_n^{1-\mu_{sn}} P_n^{\mu_{sn}}, \quad f_n \equiv \left(\frac{r_n}{\alpha_n}\right)^{\alpha_n} \left(\frac{w_n}{1-\alpha_n}\right)^{1-\alpha_n} \tag{81}$$

respectively replace equations (20) and (21), where $\Xi_s \equiv \{\Gamma\left[\left(\beta_s + 1 - \chi_s\right)/\beta_s\right]\}^{1/(1-\chi_s)}$, $\Gamma\left[\cdot\right]$ is the gamma function, and p_{sn} is still as defined in equation (21); and

$$M_{sn'nt} = \frac{\left(\kappa_{sn'n} p_{sn'}\right)^{-\beta_s}}{\sum_{n''=1}^{N} \left(\kappa_{sn''n} p_{sn''}\right)^{-\beta_s}} \sigma_{sn} \left(\sum_{s=1}^{S} p_{sn} Q_{snt} - NX_{nt} \right) \tag{82}$$

replaces equation (24).

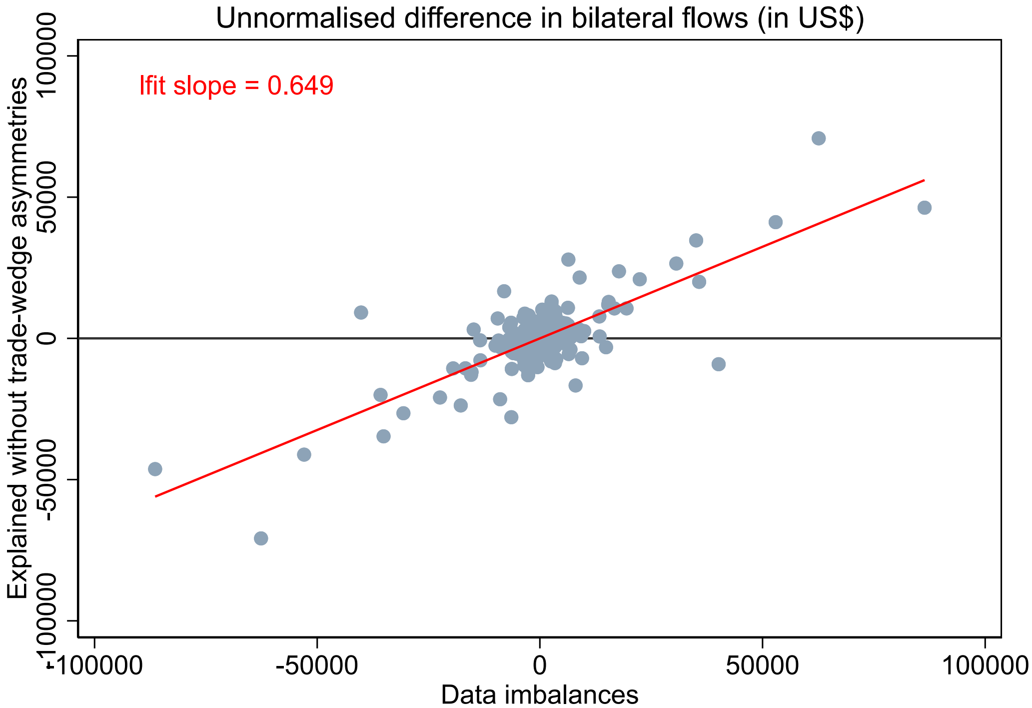
Re-defining $\kappa_{sn'n} \equiv \tau_{sn'n}$, $\beta_s \equiv \theta_s$ and $Z_n \equiv \prod_{s=1}^{S} \left[z_{sn}/\left(\Xi_s \tau_{snn}\right)\right]^{\sigma_{sn}/\left(1-\sum_s \sigma_{sn}\mu_{sn}\right)}$, it is easy to show that all key steady-state relationships remain the same, and we can proceed with the calibration and counterfactuals as described in Sections 3.2 and Appendix A.4.

A.7 Dollar-Value versus Proportional Bilateral Imbalances

In their pioneering analysis of bilateral trade balances, Davis and Weinstein (2002) investigate how much of the variation across country pairs in the US-dollar value of bilateral trade balances can be explained using a gravity equation under the assumption of symmetric trade barriers. They conclude that a large portion remains unexplained – and term this the "mystery of the excess trade balances". However, their gravity equation does not control for multilateral resistance either through appropriate fixed effects or a theory-consistent non-linear regression model.

Felbermayr and Yotov (2021) revisit the estimation of Davis and Weinstein (2002) in a recent paper, updating it to control for multilateral resistance. As they find that the resulting gravity-predicted trade flows can be used to explain variation in the dollar value of bilateral trade balances well, they argue that

Figure A6: Accounting for economy-pair variation in the simple differences of bilateral flows



"Unnormalised difference in bilateral trade flows" refers to $M_{n'n} - M_{nn'}$, where $M_{n'n}$ is the value (in million US$) of imports by economy n from n'. "Data imbalances" are the unnormalised differences observed in the data. "Explained..." are the unnormalised differences predicted on the basis of equations (83) and (84) in Appendix A7. All data is based on WIOD (2013 release), averaged for the years 1995-99. The data covers 37 individual economies and the Rest of the World.

this solves the "mystery".

By contrast, our analysis focuses on variation across trade-partner pairs in *proportional* bilateral balances (bilateral trade balances relative to the geometric average of bilateral trade flows). Our approach is fully structural, and takes account of multilateral resistance. We find that, with respect to proportional bilateral trade balances, the "mystery" remains: a large part of their variation cannot be explained unless we allow for black-box asymmetries in trade wedges. As we argue in Section 2.1.2, we consider this the most appropriate test of the ability of structural gravity to explain trade imbalances: an analysis of the variation in the unnormalised dollar value of bilateral trade balances conflates the (well-understood) ability of structural gravity to explain variation in average trade flows across trade-partner pairs with the (less well-studied) inability of gravity to account for variation in the proportional gap between bilateral flows.

To give a sense of the effect of conflating the two, we use PPML to estimate

a gravity regression of the form

$$M_{n'n} = e^{\{\Omega_{n'}+\Pi_n+\delta_{n'n}\}}\varepsilon_{n'n}, \tag{83}$$

where $\Omega_{n'}$ is an economy-n'-exporter dummy; Π_n is an economy-n-importer dummy; $\delta_{n'n} = \delta_{nn'}$ is a pair dummy; and $\varepsilon_{n'n} \neq \varepsilon_{nn'}$ is a mean-zero error.[51] As the left-hand-side variable, we use the 1995-1999 average value of bilateral trade flows from WIOD (2013 release) for 37 individual economies and the "Rest of the World" (= 1406 pairs). We use this data to facilitate comparison with Davis and Weinstein (2002), who use data for 1995. Based on our estimates, we then construct

$$\hat{M}_{n'n} = e^{\left\{\hat{\Omega}_{n'}+\hat{\Pi}_n+\hat{\delta}_{n'n}\right\}}, \tag{84}$$

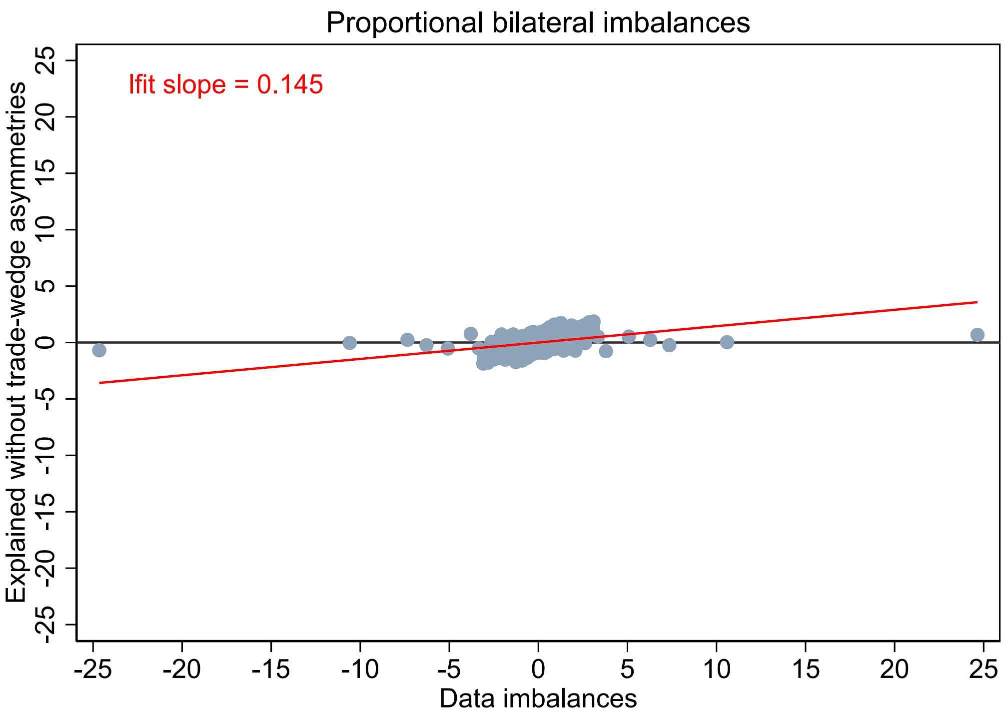
i.e. the gravity trade value exempting any trade-wedge asymmetries (the magnitude of which is captured by $\ln\hat{\varepsilon}_{n'n} - \ln\hat{\varepsilon}_{nn'}$).

Figure A6 plots $\hat{M}_{n'n} - \hat{M}_{nn'}$ against $M_{n'n} - M_{nn'}$. The figure is analogous to Figure 1 in Davis and Weinstein (2002). However, while they find that the coefficient of fitted on actual trade imbalances is .06, in Figure A6 this coefficient is .65. Based on an analysis of unnormalised dollar-value bilateral trade balances, one might thus be led to conclude that a structural gravity model can explain most of the variation in bilateral imbalances in the absence of asymmetric trade wedges.

By contrast, Figure A7 plots $(\hat{M}_{n'n} - \hat{M}_{nn'})/(\hat{M}_{n'n}^{1/2}\hat{M}_{nn'}^{1/2})$ against $(M_{n'n} - M_{nn'})/(M_{n'n}^{1/2}M_{nn'}^{1/2})$. The coefficient of fitted on actual trade imbalances is now only .15. This is quantitatively in line with the conclusion drawn in the present paper – that most of the variation in *proportional* bilateral imbalances must be attributed to asymmetric trade wedges. It also shows that most of the seeming "success" of structural gravity in Figure A6 is due to the well-documented success of estimations such as (83) in explaining the variation in the *average value* of bilateral trade flows across pairs of economies, rather than its ability to explain pairwise *imbalances* in these flows.

[51] This is a simplified version of the structural gravity model estimated by Felbermayr and Yotov (2021). The authors use PPML to estimate a non-linear model under the inclusion of theory-consistent mass variables and multilateral resistance terms. As Fally (2015) shows, this is equivalent to estimating a PPML gravity equation with a full set of importer and exporter fixed effects.

Figure A7: Accounting for economy-pair variation in proportional bilateral imbalances



"Proportional bilateral imbalances" refers to $(M_{n'n} - M_{nn'})/\left(M_{n'n}^{1/2} M_{nn'}^{1/2}\right)$, where $M_{n'n}$ is the value (in million US$) of imports by economy n from n'. "Data imbalances" are the proportional imbalances observed in the data. "Explained..." are the proportional imbalances predicted on the basis of equations (83) and (84) in Appendix A4. All data is based on WIOD (2013 release), average for the years 1995-99. The data covers 37 individual economies and the Rest of the World.

A.8 Appendix Tables

Table A1: Sample of economies

WIOD (2016)		Final data	
Economy	Code	Economy	Code
Australia	AUS	Australia	AUS
Austria	AUT	Austria	AUT
Belgium	BEL	Belgium	BEL
Brazil	BRA	Brazil	BRA
Bulgaria	BGR	Bulgaria	BGR
Canada	CAN	Canada	CAN
China	CHN	China	CHN
Croatia	HRV	Croatia	HRV
Cyprus	CYP	Rest of the World	RoW
Czech Republic	CZE	Czech Republic	CZE
Denmark	DNK	Denmark	DNK
Estonia	EST	Estonia	EST
Finland	FIN	Finland	FIN
France	FRA	France	FRA
Germany	DEU	Germany	DEU
Greece	GRC	Greece	GRC
Hungary	HUN	Hungary	HUN
India	IND	India	IND
Indonesia	IDN	Indonesia	IDN
Ireland	IRL	Ireland	IRL
Italy	ITA	Italy	ITA
Japan	JPN	Japan	JPN
Korea	KOR	Korea	KOR
Latvia	LVA	Latvia	LVA
Lithuania	LTU	Lithuania	LTU
Luxembourg	LUX	Rest of the World	RoW
Malta	MLT	Rest of the World	RoW
Mexico	MEX	Mexico	MEX
Netherlands	NLD	Netherlands	NLD
Norway	NOR	Norway	NOR
Poland	POL	Poland	POL
Portugal	PRT	Portugal	PRT
Rest of the World	RoW	Rest of the World	RoW
Romania	ROU	Romania	ROU
Russia	RUS	Russia	RUS
Slovakia	SVK	Slovakia	SVK
Slovenia	SVN	Slovenia	SVN
Spain	ESP	Spain	ESP
Sweden	SWE	Sweden	SWE
Switzerland	CHE	Switzerland	CHE
Taiwan, Prov. of China	TWN	Taiwan, Prov. of China	TWN
Turkey	TUR	Turkey	TUR
U.K.	GBR	U.K.	GBR
U.S.	USA	U.S.	USA

The "WIOD (2016)" column shows economies and regions as covered in the 2016 release of WIOD. The "Final data" column shows economies and regions as grouped for our analysis.

Table A2: Sector sample

WIOD (2016)		Final data
Sector	ISIC 2-dg.	New code
Crop and animal production...	1	1
Forestry and logging	2	1
Fishing and aquaculture	3	1
Mining and quarrying	5-9	2
Manufacture of food products,...	10-12	3
Manufacture of textiles,...	13-15	4
Manufacture of wood and...	16	5
Manufacture of paper and...	17	6
Printing and reproduction...	18	6
Manufacture of coke and...	19	7
Manufacture of chemicals...	20	8
Manufacture of basic pharma...	21	8
Manufacture of rubber and...	22	9
Manufacture of other non-metal...	23	10
Manufacture of basic metals	24	11
Manufacture of fabricated metal...	25	11
Manufacture of computer,...	26	13
Manufacture of electrical equip...	27	13
Manufacture of machinery and...	28	12
Manufacture of motor vehicles,...	29	14
Manufacture of other transport...	30	14
Manufacture of furniture; other...	31-32	15
Repair and installation...	33	15
Electricity, gas, steam and...	35	16
Water collection, treatment...	36	16
Sewerage; waste collection,...	37-39	16
Construction	41-43	17
Wholesale and retail...	45	18
Wholesale trade, except...	46	18
Retail trade, except of...	47	19
Land transport and...	49	21
Water transport	50	22
Air transport	51	23
Warehousing and support...	52	24
Postal and courier activities	53	25
Accommodation and food...	55-56	20
Publishing activities	58	6
Motion picture, video and...	59-60	6
Telecommunications	61	25
Computer programming,...	62-63	28
Financial service activities,...	64	26
Insurance, reinsurance and...	65	26
Activities auxiliary to financial...	66	26
Real estate activities	68	27
Legal and accounting activities;...	69-70	28
Architectural and engineering...	71	28
Scientific research and...	72	28
Advertising and market research	73	28
Other professional, scientific...	74-75	28
Administrative and support...	77-82	28
Public administration and...	84	31
Education	85	29
Human health and social work...	86-88	30
Other service activities	90-96	31
Activities of households...	97-98	28
Activities of extraterritorial...	99	31

The "WIOD (2016)" column shows sector names and codes as covered in the 2016 release of WIOD. The "Final data" column shows the new codes for the sector groups created for our analysis.

Table A3: Sector sample and trade elasticities

Final data		
New code	Sector	Trade elasticity
1	Agriculture, hunting, forestry and fishing	8.11
2	Mining and quarrying	15.72
3	Food, beverages and tobacco	2.55
4	Textiles and textile products; leather, leather apparel and footwear	5.56
5	Wood and products of wood and cork	10.83
6	Pulp, paper; paper, printing and publishing	9.07
7	Coke, refined petroleum and nuclear fuel	51.08
8	Chemicals and chemical products	4.75
9	Rubber and plastics	1.66
10	Other non-metallic, mineral products	2.76
11	Basic metals and fabricated metal	7.99
12	Electrical and optical equipment	10.60
13	Machinery, nec	1.52
14	Transport equipment	0.37
15	Manufacturing, nec; recycling	5
16	Electricity, gas and water supply	5
17	Construction	5
18	Wholesale trade, commission trade, including motor vehicles and motorcycles	5
19	Retail trade, except of motor vehicles and motorcycles	5
20	Hotels and restaurants	5
21	Inland transport	5
22	Water transport	5
23	Air transport	5
24	Other supporting and auxiliary transport activities; activities of travel agencies	5
25	Post and telecommunications	5
26	Financial intermediation	5
27	Real estate activities	5
28	Other business activities	5
29	Education	5
30	Health and social work	5
31	Public admin, defence, social security and other public services	5

"New code" shows the new codes for the sector groups created for our analysis. "Sector" shows the corresponding sector names. "Trade elasticity" shows the corresponding trade elasticities. Trade elasticities are based on Caliendo and Parro (2015), and Costinot and Rodríguez-Clare (2014).

Table A4: Trade-cost changes as a result of the USA-CHN trade war

Final data			
New code	Sector	$\hat{\kappa}_{s,CHN,USA}$	$\hat{\kappa}_{s,USA,CHN}$
1	Agriculture, hunting, forestry and fishing	1.16	1.25
2	Mining and quarrying	1.06	1.10
3	Food, beverages and tobacco	1.19	1.19
4	Textiles and textile products; leather, leather apparel and footwear	1.05	1.14
5	Wood and products of wood and cork	1.20	1.19
6	Pulp, paper; paper, printing and publishing	1.20	1.16
7	Coke, refined petroleum and nuclear fuel	1.18	1.25
8	Chemicals and chemical products	1.14	1.11
9	Rubber and plastics	1.13	1.08
10	Other non-metallic, mineral products	1.17	1.12
11	Basic metals and fabricated metal	1.18	1.19
12	Electrical and optical equipment	1.18	1.10
13	Machinery, nec	1.11	1.08
14	Transport equipment	1.23	1.00
15	Manufacturing, nec; recycling	1.10	1.06
16	Electricity, gas and water supply	1.23	1.06

"New code" shows the new codes for the sector groups created for our analysis. "Sector" shows the corresponding sector names. $\hat{\kappa}_{sn'n}$ shows the new iceberg cost for imports by economy n from n' in sector s in the trade-war scenario. $\hat{\kappa}_{sn'n} = 1$ for all s, $n'$and n not shown in the table. Iceberg-cost changes are based on data from Bown (2019) and Bown et al. (2019). See Appendix A.5.3 for more details.