A Online Appendix

A.1 Properties of World Relative Demand

Proposition 1 *(1.1) If $g_1 > g_2$, then all else being equal the world relative demand of final good 2-to-1 is positively related to borrower country 2's wealth share S_2 in the world, i.e. $\frac{\partial RD}{\partial S_2} > 0$. (1.2) In other words, if the sum of the two countries' home goods expenditure shares is strictly larger than 1, i.e., $\frac{c_{11}}{GDP_1+b_1-qb_1'} + \frac{c_{22}p_2}{GDP_2+b_2-qb_2'} > 1$, then all else being equal $\frac{\partial RD}{\partial S_2} > 0$.*

Proof:

(1.1) From Eq. 22 I calculate:

$$\frac{\partial RD}{\partial S_2} = \frac{g_1 g_2 (g_1 - g_2)}{(g_1 g_2 - p_2 g_2 - S_2 p_2 g_1 + S_2 p_2 g_2)^2}. \tag{24}$$

Because $g_1 > 0$ and $g_2 > 0$, when $g_1 > g_2$, $\frac{\partial RD}{\partial S_2} > 0$.

(1.2) From Eq. 21 and budget constraints, I derive creditor country 1's degree of home bias $\frac{c_{11}}{GDP_1+b_1-qb_1'} = 1 - \frac{p_2}{g_1}$ and borrower country 2's degree of home bias $\frac{c_{22}p_2}{GDP_2+b_2-qb_2'} = \frac{p_2}{g_2}$. Then, we have $g_1 > g_2 \iff \frac{p_2}{g_2} > \frac{p_2}{g_1} \iff \frac{c_{22}p_2}{GDP_2+b_2-qb_2'} > 1 - \frac{c_{11}}{GDP_1+b_1-qb_1'} \iff \frac{c_{22}p_2}{GDP_2+b_2-qb_2'} + \frac{c_{11}}{GDP_1+b_1-qb_1'} > 1$. Therefore, if $\frac{c_{11}}{GDP_1+b_1-qb_1'} + \frac{c_{22}p_2}{GDP_2+b_2-qb_2'} > 1$, then $\frac{\partial RD}{\partial S_2} > 0$. □

Alternatively, we can rewrite the home bias condition as $\frac{c_{11}}{GDP_1+b_1-qb_1'} > \frac{c_{21}}{GDP_2+b_2-qb_2'}$, or $\frac{c_{22}p_2}{GDP_2+b_2-qb_2'} > \frac{c_{12}p_2}{GDP_1+b_1-qb_1'}$. That is, as long as for either final good, the expenditure share is higher in its home country than in the foreign country, then $\frac{\partial RD}{\partial S_2} > 0$ holds. It is clear that both countries being home biased in consumption is a sufficient though not necessary condition for $\frac{\partial RD}{\partial S_2} > 0$.

Proposition 2 *When $g_1 > g_2$, $\frac{\partial RD}{\partial S_2}$ increases with g_1 and decreases with g_2.*

Proof:

From Eq. 24 I calculate:

$$\partial \frac{\partial RD}{\partial S_2} / \partial g_1 = \frac{2 g_2^2 (1 - S_2) p_2 (g_1 - g_2)}{(g_1 g_2 - p_2 g_2 - S_2 p_2 g_1 + S_2 p_2 g_2)^3}. \tag{25}$$

When $g_1 > g_2$, Eq. 25's nominator is strictly positive, because $p_1 > 0$, $g_2 > 0$, and $0 < S_2 < 1$. For the denominator, I substitute $g_1 = (\frac{p_2\rho_1}{1-\rho_1})^{\frac{1}{1-\theta_1}} + p_2$ and $g_2 = [\frac{p_2(1-\rho_2)}{\rho_2}]^{\frac{1}{1-\theta_2}} + p_2$, and obtain

the following since $0 < \rho_1 < 1$ and $0 < \rho_2 < 1$:

$$\begin{aligned} & g_1 g_2 - p_2 g_2 - S_2 p_2 g_1 + S_2 p_2 g_2 \\ =&(1 - S_2) p_2 (\frac{p_2 \rho_1}{1 - \rho_1})^{\frac{1}{1-\theta_1}} + S_2 p_2 [\frac{p_2(1-\rho_2)}{\rho_2}]^{\frac{1}{1-\theta_2}} + (\frac{p_2 \rho_1}{1-\rho_1})^{\frac{1}{1-\theta_1}} [\frac{p_2(1-\rho_2)}{\rho_2}]^{\frac{1}{1-\theta_2}} \\ >&0 \end{aligned} \tag{26}$$

Therefore, I prove when $g_1 > g_2$, $\partial \frac{\partial RD}{\partial S_2} / \partial g_1 > 0$.
Again, from Eq. 24 I calculate:

$$\partial \frac{\partial RD}{\partial S_2} / \partial g_1 = \frac{g_1^2 [S_2 p_2 (g_2 - g_1) + g_2 (p_2 - g_1)]}{(g_1 g_2 - p_2 g_2 - S_2 p_2 g_1 + S_2 p_2 g_2)^3}. \tag{27}$$

As Eq. 26 suggests, Eq. A.1's denominator is strictly positive. Because $g_1 > g_2$ and $g_1 > p_2$, the nominator is strictly negative. Therefore, I prove when $g_1 > g_2$, $\partial \frac{\partial RD}{\partial S_2} / \partial g_2 < 0$. □

A.2 Data Sources

GDP value (in USD) and volume (in index), trade value (in USD) and volume (in index), trade as a share of GDP, net barter terms of trade, real exchange rate, and consumption are from the IMF and the World Bank. Latin American and U.S. data on labor force, domestic consumption share, capital stock, and PPP GDP (constant 2011 international dollar) come from the World Bank (WDI). The data on U.S. FDI to Latin America is from Bureau of Economic Analysis. The data for labor share in production is from the OECD and the ILO.

The frequency of defaults over the long term is calculated with information from Reinhart (2010). Sample default episodes are based on Laeven and Valencia (2018), Reinhart (2010), Mendoza and Yue (2012), and the treatment dates from the Paris Club. Slight date adjustments according to GDP fluctuations are made with regard to the Paris Club dates to reflect delayed treatments after defaults. The results are not sensitive to the default date adjustments.

The annual data for the intermediate goods exports of multiple countries (see Table A.1) come from the World Bank (WITS). The quarterly data for Mexico's intermediate goods exports are from Mexico's National Institute of Statistics and Geography (INEGI). They are also cross-checked with Mexico's annual intermediate goods exports data from the World Bank. Data for Latin American countries' intermediate good trade are from the World Integrated Trade Solution website. Real Effective Exchange Rates for Mexico come from FRED, maintained by the Federal Reverse Bank of St. Louis. Mexico's domestic capital stock is calculated by the author from combined data from FRED and the IMF. I use Mexico's

treasury bill rates from the IMF as its sovereign bond interest rates, and calculate the bond spreads with the U.S. government bond interest rates from FRED. Mexico's external public debt is from the combined sources of the IMF and Mexico's Secretary of Finance and Public Credit.

Table A.1: Default Events and Data Availability

Country	Event	Available Data
Argentina	1982	TOT, GDP val., GDP vol., Exp. val., Exp. vol., Exp/GDP, Imp. val., Imp. vol., Imp/GDP, Intm. imp. val.
	2002	TOT, GDP val., GDP vol., Exp. val., Exp. vol., Exp/GDP, Imp. val., Imp. vol., Imp/GDP, Intm. exp. & imp. val., Intm. exp. vol., Intm. exp./GDP
Brazil	1983	REXR, TOT, GDP val., GDP vol., Exp. val., Exp. vol., Exp/GDP, Imp. val., Imp. vol., Imp/GDP
Chile	1983	REXR, TOT, GDP val., GDP vol., Exp. val., Exp. vol., Exp/GDP, Imp. val., Imp. vol., Imp/GDP
Ecuador	1999	REXR, TOT, GDP val., GDP vol., Exp. val., Exp. vol., Exp/GDP, Imp. val., Imp. vol., Imp/GDP, Intm. exp. & imp. val., Intm. exp. vol., Intm. exp./GDP
Mexico	1982	REXR, TOT, GDP val., GDP vol., Exp. val., Exp. vol., Exp/GDP, Imp. val., Imp. vol., Imp/GDP, Intm. exp. val., Intm. exp. vol., Intm. exp./GDP
	1986	REXR, TOT, GDP val., GDP vol., Exp. val., Exp. vol., Exp/GDP, Imp. val., Imp. vol., Imp/GDP, Intm. exp. val., Intm. exp. vol., Intm. exp./GDP
	1989	REXR, TOT, GDP val., GDP vol., Exp. val., Exp. vol., Exp/GDP, Imp. val., Imp. vol., Imp/GDP, Intm. exp. val., Intm. exp. vol., Intm. exp./GDP
Paraguay	1986	REXR, TOT, GDP val., GDP vol., Exp. vol., Imp. vol.
	2003	REXR, TOT, GDP val., GDP vol., Exp. val., Exp. vol., Exp/GDP, Imp. val., Imp. vol., Imp/GDP
Peru	1983	TOT, GDP val., GDP vol., Exp. val., Exp. vol., Exp/GDP, Imp. val., Imp. vol., Imp/GDP
Uruguay	1990	REXR, TOT, GDP val., GDP vol., Exp. val., Exp. vol., Exp/GDP, Imp. val., Imp. vol., Imp/GDP
	2003	REXR, TOT, GDP val., GDP vol., Exp. val., Exp. vol., Exp/GDP, Imp. val., Imp. vol., Imp/GDP Intm. exp. & imp. val., Intm. exp. vol., Intm. exp./GDP
Venezuela	1995	REXR, TOT, GDP val., GDP vol., Exp. val., Exp. vol., Exp/GDP, Imp. val., Imp. vol., Imp/GDP, Intm. exp. & imp. val., Intm. exp. vol., Intm. exp./GDP
	1998	REXR, TOT, GDP val., GDP vol., Exp. val., Exp. vol., Exp/GDP, Imp. val., Imp. vol., Imp/GDP, Intm. exp. & imp. val., Intm. exp. vol., Intm. exp./GDP
	2004	REXR, TOT, GDP val., GDP vol., Exp. val., Exp. vol., Exp/GDP, Imp. val., Imp. vol., Imp/GDP, Intm. exp. & imp. val., Intm. exp. vol., Intm. exp./GDP

Note: Intermediate goods export value, volume, and share of GDP are also available for Brazil and Peru since 1988, after their sovereign defaults. The dating of external debt defaults comes from Mendoza and Yue (2012) and Reinhart (2010). Other dating sources include Laeven and Valencia (2018) and the Paris Club data.

Mexico's total hours worked comes from FRED, unemployment rates from the IMF, and total employment from the combined sources of the WDI, the IMF, and Mexico's INEGI. Total FDI stock in Mexico is calculated using annual data from the OECD, U.S. Bureau of Economic Analysis (BEA), and the IMF. Furthermore, according to the UN's 2013 report on Foreign Direct Investment in Latin America and Caribbean, about 4.4 jobs are created in Mexico for every 1 million USD invested from abroad during the period 2003-2013. Using this number, I impute Mexico's FDI related employment according to its FDI stock data. Hence, Mexico's domestic sector employment is its total employment minus its FDI employment.

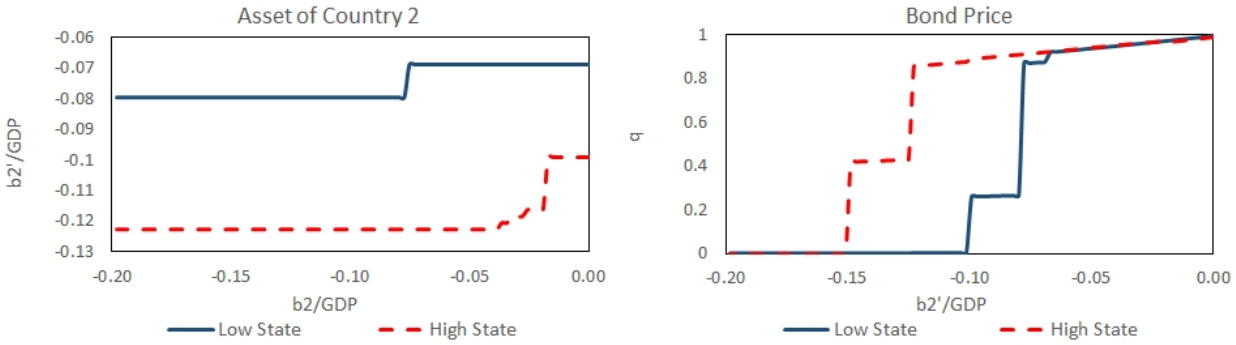
For the empirical regressions, the data for Latin American inputs to U.S. manufacturing

industries are obtained from World Input-Output Database. The data for U.S. manufacturing output by industry is the U.S. Industrial Production Index from Federal Reserve Board.

A.3 Policy Functions

The properties of bond quantity and its price in the baseline model are in line with other sovereign default papers. The left plot in Figure A.1 graphs the next-period assets for the borrower country against its current assets, in a high-productivity state and a low productivity state in the current period. As the borrower country accumulates debt (to the left of the bottom axis), its marginal borrowing capacity diminishes. Moreover, when the country is in a low-productivity state, its bond function starts to flatten out at a lower current debt amount than it would in a high-productivity state. That is to say, all else being equal, a higher productivity state supports a higher debt level.

Figure A.1: Policy Functions



The right plot in Figure A.1 graphs the bond price functions. It shows that the bond price decreases with the debt level (i.e., interest rate rises). Across productivity states, the bond price is significantly higher for a high-productivity state, which implies that interest rates are countercyclical.

A.4 Alternative Model with Intermediate Good Imports

This section presents an alternative model setup with imported intermediate goods to the borrower from the creditor. In order to make it easy to compare with the baseline model, the setup is kept as close as possible to the original model. There are two changes: (1) the creditor country now exports intermediate capital goods to the borrower country for its final good production, instead of the borrower exporting intermediate goods to the creditor; and

(2) the efficiency loss is now on the borrower's final good production. At the end of this section, I briefly highlight the key results that are different from those of the baseline.

A.4.1 Country 1: Creditor

Intermediate Good Firms: Intermediate good firms produce intermediate good inputs for borrower country 2's final good production. They decide how much capital to use, k_m, and capital is the only input needed for the intermediate good production. I assume the production to be linear in k_m and associated with the country's aggregate productivity $e_1 = 1$. The firms also pay capital rent r_m that is measured in final good 1. They maximize the following profit:

$$\max_{k_m}\{p_{km}e_1k_m - r_mk_m\} \tag{28}$$

Note that the supply of the intermediate good is no longer directly affected by the efficiency loss ε (which I introduce later), even though the equilibrium quantity is. From the first order condition, we have $p_{km} = r_m$.

Final Good Firms: Firms hire domestic workers n_1 and rent capital k_1 from households. Firms' goal is to maximize their profits, taking wage w_1 and capital rent r_1 as given:

$$\Pi_1 = \max_{n_1,k_1}\left\{e_1n_1^{\alpha_1}k_1^{1-\alpha_1} - w_1n_1 - r_1k_1\right\} \tag{29}$$

Households: Households in creditor country 1 are similar to the baseline model. Briefly, when the borrower country does not default in the current period, the creditor country households' optimization problem can be written recursively as:

$$\begin{aligned} V_{1c}(s,b_1) = \max_{b_1',c_{11},c_{12}} &\left\{U(c_{11},c_{12}) + \beta_1[\int_{s'\notin\mathcal{D}(b_2')} V_{1c}(s',b_1')dF(s'|s) + \int_{s'\in\mathcal{D}(b_2')} V_{1d}(s')dF(s'|s)]\right\} \\ s.t. \qquad & w_1\bar{n}_1 + r_1k_1 + r_mk_m + b_1 = c_{11} + p_2c_{12} + qb_1'. \end{aligned} \tag{30}$$

The creditor country's constrained maximization problem becomes when the borrower country defaults:

$$\begin{aligned} V_{1d}(s) = \max_{c_{11},c_{12}} &\{U(c_{11},c_{12}) + \beta_1E_1[\phi V_{1x}(s',0) + (1-\phi)V_{1d}(s')]\} \\ s.t. \qquad & w_1\bar{n}_1 + r_1k_1 + r_mk_m = c_{11} + p_2c_{12}. \end{aligned} \tag{31}$$

Given the above setup, I calculate creditor country 1's GDP as the gross production of final good 1 plus the sales of the imported intermediate good, i.e., $e_1n_1^{\alpha_1}k_1^{1-\alpha_1} + p_{km}e_1k_m$. Its

GDP volume is $e_1 n_1^{\alpha_1} k_1^{1-\alpha_1} + e_1 k_m$.

A.4.2 Country 2: Borrower/Defaulter

Intermediate Good Firms: Intermediate good firms produce intermediate good inputs for final good 2 production. They decide how many domestic workers to hire, n_m, and labor is the only input needed for the intermediate good production. I assume the production to be linear in n_m and associated with the country's aggregate productivity e_2. The firms also pay labor wage w_m that is measured in final good 2. They maximize the following profit:

$$\max_{n_m} \{p_{nm} e_2 n_m - p_2 w_m n_m\} \tag{32}$$

From the first order condition, we have $p_{nm} = \frac{p_2 w_m}{e_2}$.

Final Good Firms: Country 2's final good firms rent capital k_2, choose domestic worker allocation n_2, decide how many intermediate good inputs to import from the creditor country, q_{km}, and how many domestic intermediate good inputs to use, q_{nm}, to produce final good 2. They maximize the following profit:

$$\max_{n_2, k_2, q_{nm}, q_{km}} \{p_2 e_2 n_2^{\alpha_2} k_2^{1-\alpha_2} + p_2 (\varepsilon q_{nm})^{\alpha_3} (q_{km})^{1-\alpha_3} - p_2 w_2 n_2 - p_2 r_2 k_2 - p_{nm} q_{nm} - p_{km} q_{km}\} \tag{33}$$

To keep this alternative model as close as possible to the baseline model for comparison purpose, I keep the efficiency loss, ε, on the vertical production for final goods, and it takes the same value as in the baseline model. But notice that now the efficiency loss is directly on the borrower's side, instead of the creditor's side. It symbolizes extra output loss to the defaulter's final good production. During crises, defaulting country's workers switch from the intermediate good sector to the final good sector, which causes similar labor reallocation inefficiency and income reduction as in the baseline model.[29]

Households/Government: Country 2's households and sovereign government's problem is the same as before. Briefly:

$$V_{2x}(s, b_2) = \max \{V_{2c}(s, b_2), V_{2d}(s)\} \tag{34}$$

The nondefault value is given by the choice of (b_2', c_{21}, c_{22}) that maximizes the following

[29]The income reduction effect and subsequent result on terms of trade would be similar if the efficiency loss is imposed on the final good production that does not use foreign inputs, or on the intermediate good sector, or all sectors in the defaulting country.

problem, taking wages, capital rent, p_2, and bond price q as given:

$$V_{2c}(s,b_2) = \max_{b_2',c_{21},c_{22}} \left\{ U(c_{21},c_{22}) + \beta_2[\int_{s' \notin \mathcal{D}(b_2')} V_{2c}(s',b_2')dF(s'|s) + \int_{s' \in \mathcal{D}(b_2')} V_{2d}(s')dF(s'|s)] \right\}$$
$$s.t. \qquad p_2 w_2 n_2 + p_2 r_2 \bar{k}_2 + p_2 w_m n_m + b_2 = c_{21} + p_2 c_{22} + q b_2'. \tag{35}$$

where F and $\mathcal{D}$ are the sovereign's productivity process and default set, respectively. $q = \beta_1 \frac{\int_{s' \notin \mathcal{D}(b_2')} \partial V_{1c}'/\partial b_1' dF(s'|s)}{\lambda_1}$ is from creditor country 1's problem.

In the event of a default triggered by an adverse productivity shock to the borrower country, taking into account all the consequences of a sovereign default, the borrower country's default value is as follows:

$$V_{2d}(s) = \max_{c_{21},c_{22}} \{U(c_{21},c_{22}) + \beta_2 E_2[\phi V_{2x}(s',0) + (1-\phi)V_{2d}(s')]\}$$
$$s.t. \qquad p_2 w_2 n_2 + p_2 r_2 \bar{k}_2 + p_2 w_m n_m = c_{21} + p_2 c_{22} \tag{36}$$

The definitions of the actual default set $\mathcal{D}$ and the actual probability of default are the following:

$$\mathcal{D}(b_2) = \{s \in S : V_{2c}(s,b_2) < V_{2d}(s)\} \tag{37}$$
$$\pi(s,b_2') = \int_{s' \in \mathcal{D}(b_2')} f(s,s')ds' \tag{38}$$

Given the above setup, I calculate borrower country 2's GDP value as the gross production of final good 2 minus the intermediate good imports, $p_2 e_2 n_2^{\alpha_2} k_2^{1-\alpha_2} + p_2(\varepsilon q_{nm})^{\alpha_3}(q_{km})^{1-\alpha_3} - p_{km} q_{km}$.

A.4.3 Equilibrium

Finally, in equilibrium all goods, capital, labor, and bond markets clear for both countries in default and nondefault regimes. Also, in the creditor country, the intermediate good sector capital rent is equal to the rent paid in its domestic production sector, so that there is no capital flowing between the two sectors. Similarly for the wages in the borrower country.

The equilibrium conditions are formulated and defined as follows:

$$b_1'(s, b_1) + b_2'(s, b_2) = 0 \quad \text{in nondefault regime,} \tag{39}$$

$$\text{or} \quad b_1'(s, b_1 = 0) = 0 \quad \& \quad b_2'(s, b_2 = 0) = 0 \quad \text{in default regime,} \tag{40}$$

$$\text{and} \quad n_1 = \bar{n}_1, \quad k_1 + k_m = \bar{k}_1, \quad n_2 + n_m = \bar{n}_2, \quad k_2 = \bar{k}_2, \quad r_m = r_1, \quad w_m = w_2 \tag{41}$$

$$e_1 n_1^{\alpha_1} k_1^{1-\alpha_1} = c_{11} + c_{21},\ e_2 n_2^{\alpha_2} k_2^{1-\alpha_2} + (\varepsilon q_{nm})^{\alpha_3} q_{km}^{1-\alpha_3} = c_{12} + c_{22},\ e_1 k_m = q_{km},\ e_2 n_m = q_{nm}. \tag{42}$$

Definition 2 *A recursive equilibrium is defined as a set of functions for (a) Creditor country 1's capital allocation and borrower country 2's labor allocation; (b) Both countries' household consumption policy c and saving policy b′; (c) Price function for bonds $q(b_2, s)$; d) Welfare value V at default and nondefault regimes; and (e) The law of motion for the aggregate state s, such that: (i) Taking as given the borrower country's policies, firms' working capital and labor decisions, as well as households' consumption, satisfy both countries' optimization problems and the world resource constraint so that w_1, w_2, r_1, r_2, p_{km}, p_{nm}, and p_2 clear the labor and goods markets, r_m and r_1 stabilize capital flows between the two sectors in creditor country 1, and w_m and w_2 stabilize labor flows between the two sectors in borrower country 2; (ii) Taking as given the bond price function $q(b_2, s)$, the borrowing and lending policies and default sets satisfy both countries' optimization problems; (iii) Bonds prices $q(b_2, s)$ reflect the government's default probabilities and are consistent with the creditor country's optimization problem; (iv) the law of motion is consistent with the stochastic processes of e_2.*

Borrower country 2's terms of trade and real exchange rate are calculated using Laspeyres price index. More specifically, they are calculated as follows:

$$TOT_{2t} = \frac{(p_2^t c_{12}^0)/(c_{12}^0)}{(p_1^t c_{21}^0 + p_{km}^t q_{km}^0)/(c_{21}^0 + q_{km}^0)} \tag{43}$$

$$REXR_{2t} = NEXR \frac{(p_2^t c_{22}^0 + p_1^t c_{21}^0)/(p_2^0 c_{22}^0 + p_1^0 c_{21}^0)}{(p_2^t c_{12}^0 + p_1^t c_{11}^0)/(p_2^0 c_{12}^0 + p_1^0 c_{11}^0)} \tag{44}$$

A.4.4 Results

The results from the alternative model setup are similar to those of the baseline model. The key difference is that now it cannot generate terms of trade deterioration during sovereign default crises, as shown in Figure A.2. In fact, it produces better terms of trade. The reason is that, during crises, intermediate capital good import price p_m^t decreases due to the defaulter's falling demand, which makes the overall imports cheaper. In addition, the defaulter's final good 2's price increases due to even lower supply brought by the efficiency

loss that is now on the defaulter's final good production. Together, the increased export price and the decreased import price bring up the defaulting country's terms of trade during crises. The baseline model, however, generate terms of trade deterioration because there are intermediate good exports whose price declines during crises.

Figure A.2: Terms of Trade and Intermediate Goods Import

Notes: The intermediate capital good import value data come from the World Bank WITS.

Hence, model asymmetries with a focus on intermediate good exports from the borrower country and an efficiency loss placement on the creditor country's operations with those intermediate goods are needed in this paper to generate the correct direction of terms of trade changes. Symmetric intermediate good trade flows and efficiency losses in a model may cancel out terms of trade changes.

Also, notice that this alternative model can generate intermediate capital good import value declines during crises, which is consistent with the data.