The Great Trade Collapse: An Evaluation of Competing Stories*

Hakan Yilmazkuday†

July 27, 2019

Abstract

The reduction in international trade has been more than the reduction in economic activity during the 2008 financial crisis, against the one-to-one relationship between them implied by standard trade models. This so-called *the great trade collapse* (GTC) has been investigated extensively in the literature resulting in alternative competing stories as potential explanations. By introducing and estimating a dynamic stochastic general equilibrium model using eighteen quarterly series from the U.S., including those that represent the competing stories, this paper evaluates the contribution of each story to GTC. The results show that retail inventories have contributed the most to the collapse and the corresponding recovery, followed by protectionist policies, intermediate-input trade, and trade finance. Productivity and demand shocks have played negligible roles.

JEL Classification E32, F12, F41.

Key Words: Trade Collapse, Inventories, Intermediate Inputs, Trade Finance, Protectionist Policies

*The author would like thank the editor William A. Barnett, an associate editor, two anonymous referees, the participants of Midwest International Trade Meetings at Indiana University Bloomington, Society for Nonlinear Dynamics and Econometrics Meetings at Dallas Fed, Midwest Macroeconomics Meetings at University of Colorado-Boulder and at University of Illinois Urbana-Champaign for their helpful comments and suggestions. The usual disclaimer applies.

†Department of Economics, Florida International University, Miami, FL 33199, USA. Phone: 305-348-2316. Fax: 305-348-1524. E-mail: hyilmazk@fiu.edu

1 Introduction

The reduction in international trade has been more than the reduction in economic activity during the 2008 financial crisis. This observation has been accepted as extraordinary, because its magnitude has been far larger than in previous downturns (see Levchenko, Lewis, and Tesar (2010)); accordingly, it has been called as the Great Trade Collapse (GTC, henceforth).

Since the relation between trade and economic activity is one to one in standard trade models (mostly implied by constant elasticity of substitution preferences in gravity-type studies), this collapse in trade has attracted attention in the recent literature, and its causes have been investigated extensively not only because the decline in trade flows relative to overall economic activity is surprisingly high but also because it has important implications for optimal policy response.[1] Accordingly, among others, Alessandria, Kaboski, and Midrigan (2010a) and Alessandria, Kaboski, and Midrigan (2010b) have connected GTC to the dynamics of inventories and compositional differences between traded goods and GDP;[2] Bems, Johnson, and Yi (2010), Levchenko, Lewis, and Tesar (2010), Bussière, Callegari, Ghironi, Sestieri, and Yamano (2013), and Behrens, Corcos, and Mion (2013) to the composition of demand; Eaton, Kortum, Neiman, and Romalis (2016) to investment efficiency; Amiti and Weinstein (2011), Ahn, Amiti, and Weinstein (2011), Feenstra, Li, and Yu (2014), and Zymek (2012) to trade finance/credit, Crowley, Luo, et al. (2011) to declining aggregate demand, Baldwin and Evenett (2008), and Bown and Crowley (2013) to higher trade costs due to protectionist policies, and Chor and Manova (2012) and Paravisini, Rappoport, Schnabl, and Wolfenzon (2014) to overall (rather than trade) credit/finance market indicators in the source country.

Since most of these papers have competing stories, they have sometimes found conflicting results with each other; e.g., Levchenko, Lewis, and Tesar (2010) deny the contributions of inventories and trade finance, Crowley, Luo, et al. (2011) and Behrens, Corcos, and Mion (2013) deny the contribution of higher trade costs, Alessandria, Kaboski, and Midrigan (2010a) connect the results in Eaton, Kortum, Neiman, and Romalis (2016) to the lack of a dynamic inventory mechanism, etc. However, what if there were multiple stories contributing to GTC at the same time? If yes, what was the contribution of each story? In other words, are

[1] See Bems, Johnson, and Yi (2013) for an excellent survey.

[2] Also see Novy and Taylor (2014) who connects GTC to increased uncertainty, modeled as a second-moment shock to inventories.

these stories complements of or substitutes to each other? Based on the literature introduced so far, answering these questions requires a structural estimation of a dynamic trade model with ingredients such as intermediate-input trade, inventories, protectionist policies, trade finance, and financial interactions between countries.

Accordingly, we introduce a dynamic stochastic general equilibrium (DSGE) trade model to create a bridge between the literatures of international trade and macroeconomics through investigating trade patterns in a dynamic framework that borrows the stories explaining GTC from the literature introduced above. The most important advantage of this DSGE model is the ability to estimate its parameters using quarterly series, which is useful (and necessary) to identify the stories contributing to GTC. The model considers individuals, manufacturers and retailers, where the latter two hold inventories of finished goods. There is a monetary authority who decides for the policy rate, although the interest rate faced by individuals (due to intertemporal choices) and manufacturers/retailers (due to financial needs, including trade finance) is subject to a country-specific risk premium. To consider compositional effects, the model distinguishes between traded versus nontraded goods, home versus foreign goods, and durable versus nondurable goods.

The model is estimated by state-of-the-art Bayesian techniques using eighteen series of quarterly data from the U.S., including durable and nondurable imports, durable and nondurable production, services versus overall consumption, prices, inventories, duties, risk premium, and wages. The estimated model is further used to decompose durable and nondurable imports into their components, representing the competing stories of intermediate-input trade, retail inventories, protectionist policies, trade finance, retail productivity shocks, and consumer demand shocks. When overall U.S. imports are considered, the results show that retail inventories have contributed the most to GTC and the corresponding recovery, followed by protectionist policies, intermediate-input trade, and trade finance. The compositional effects within imports are significant: while retail inventories are mostly responsible for changes in durable imports, intermediate-input trade is responsible for changes in nondurable imports. In all cases, productivity and demand shocks have played negligible roles.

We proceed as follows. Section 2 introduces the economic environment. Section 3 estimates the model and depicts the results. Section 4 decomposes durable and nondurable imports into their components, where each component is connected to a competing story to explain GTC. Section 5 concludes. The log-linearized version of the model, the details of the data used, a descriptive analysis of GTC based on naive wedges, and certain derivations are given in the Appendix.

2 Economic Environment

The economic environment consists of two countries, each inhabited by a unique individual, manufacturers, retailers and a monetary authority. Individuals consume traded versus nontraded goods, home versus foreign goods, and durable versus nondurable goods. Continuum of retailers specializing in home versus foreign goods, and durable versus nondurable goods supply goods to individuals by using intermediate inputs purchased from manufacturers. Continuum of manufacturers specializing in durable versus nondurable goods supply intermediate inputs to both retailers and other manufacturers. The monetary authority decides on the policy rate, although the interest rate faced by individuals (due to intertemporal choices) and manufacturers/retailers (due to financial needs) is subject to a country-specific risk premium. Both manufacturers and retailers hold inventories of finished goods.

2.1 Individuals

The unique individual in the home country has the following standard intertemporal lifetime utility function:

$$E_t \left[\sum_{k=0}^{\infty} \beta^k \left\{ \frac{(C_{t+k})^{1-\upsilon}}{1-\upsilon} - \frac{(N_{t+k})^{1+\varrho}}{1+\varrho} \right\} \right] \tag{1}$$

where $\frac{(C_t)^{1-\upsilon}}{1-\upsilon}$ is utility out of consuming a composite index of C_t, $\frac{(N_t)^{1+\varrho}}{1+\varrho}$ is disutility out of supplying N_t hours of labor, and $0 < \beta < 1$ is a discount factor.

The composite index of C_t is further given by:

$$C_t = \left(\left(\gamma_t^H\right)^{\frac{1}{\theta}} \left(C_t^H\right)^{\frac{\theta-1}{\theta}} + \left(\gamma_t^F\right)^{\frac{1}{\theta}} \left(C_t^F\right)^{\frac{\theta-1}{\theta}} + \left(\gamma_t^N\right)^{\frac{1}{\theta}} \left(C_t^N\right)^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}} \tag{2}$$

where C_t^H, C_t^F and C_t^N represent consumption of home, foreign and nontraded goods, respectively, and taste parameters satisfy $\gamma_t^H + \gamma_t^F + \gamma_t^N = 1$.[3] Consumption of home goods is

[3] This strategy of aggregating home versus foreign products in the upper tier utility has been chosen to be consistent with the international trade literature.

further given by:

$$C_t^H = \left(\left(\gamma_{D,t}^H \right)^{\frac{1}{\theta^H}} \left(C_{D,t}^H \right)^{\frac{\theta^H - 1}{\theta^H}} + \left(\gamma_{ND,t}^H \right)^{\frac{1}{\theta^H}} \left(C_{ND,t}^H \right)^{\frac{\theta^H - 1}{\theta^H}} \right)^{\frac{\theta^H}{\theta^H - 1}} \tag{3}$$

where $C_{D,t}^H$ and $C_{ND,t}^H$ represent consumption of durable and nondurable goods that are produced in the home country, respectively, and taste parameters satisfy $\gamma_{D,t}^H + \gamma_{ND,t}^H = 1$.[4] Consumption of foreign goods is further given by:

$$C_t^F = \left(\left(\gamma_{D,t}^F \right)^{\frac{1}{\theta^F}} \left(C_{D,t}^F \right)^{\frac{\theta^F - 1}{\theta^F}} + \left(\gamma_{ND,t}^F \right)^{\frac{1}{\theta^F}} \left(C_{ND,t}^F \right)^{\frac{\theta^F - 1}{\theta^F}} \right)^{\frac{\theta^F}{\theta^F - 1}} \tag{4}$$

where $C_{D,t}^F$ and $C_{ND,t}^F$ represent consumption of durable and nondurable goods that are produced in the foreign country, respectively, and taste parameters satisfy $\gamma_{D,t}^F + \gamma_{ND,t}^F = 1$. Composite indices of C_t^N, $C_{D,t}^H$, $C_{ND,t}^H$, $C_{D,t}^F$ and $C_{ND,t}^F$ further consist of continuum of goods, each represented by g according to the following general formula for continuous CES aggregation in the home country:

$$\Psi_{j,t} = \left(\int_0^1 \left(\Psi_{j,t} \left(g \right) \right)^{\frac{\eta_j - 1}{\eta_j}} dg \right)^{\frac{\eta_j}{\eta_j - 1}} \tag{5}$$

where $\Psi_{j,t} \in \left\{ C_t^N, C_{D,t}^H, C_{ND,t}^H, C_{D,t}^F, C_{ND,t}^F \right\}$, $\Psi_{j,t}\left(g\right) \in \left\{ C_t^N\left(g\right), C_{D,t}^H\left(g\right), C_{ND,t}^H\left(g\right), C_{D,t}^F\left(g\right), C_{ND,t}^F\left(g\right) \right\}$, and $\eta_j \in \left\{ \eta^N, \eta_D^H, \eta_{ND}^H, \eta_D^F, \eta_{ND}^F \right\}$ is the elasticity of substitution across goods.

The optimization results in the following demand function for C_t^H:

$$C_t^H = \gamma_t^H \left(\frac{P_t^H}{P_t} \right)^{-\theta} C_t \tag{6}$$

where similar expressions are implied for other aggregated indices of C_t^F, C_t^N, $C_{D,t}^H$, $C_{ND,t}^H$, $C_{D,t}^F$ and $C_{ND,t}^F$, with P_t, P_t^H, P_t^F, P_t^N, $P_{D,t}^H$, $P_{ND,t}^H$, $P_{D,t}^F$ and $P_{ND,t}^F$ representing price indices per quantities of C_t, C_t^H, C_t^F, C_t^N, $C_{D,t}^H$, $C_{ND,t}^H$, $C_{D,t}^F$ and $C_{ND,t}^F$, respectively, that satisfy:

$$P_t = \left(\gamma_t^H \left(P_t^H \right)^{1-\theta} + \gamma_t^F \left(P_t^F \right)^{1-\theta} + \gamma_t^N \left(P_t^N \right)^{1-\theta} \right)^{\frac{1}{1-\theta}} \tag{7}$$

[4]It is implied that both durables and nondurable goods fully depreciate at the end of each period. Dynamics based on the alternative possibility of partial depreciation are potentially captured by the corresponding taste parameters.

and

$$P_t^H = \left(\gamma_{D,t}^H \left(P_{D,t}^H\right)^{1-\theta^H} + \left(\gamma_{ND,t}^H\right)\left(P_{ND,t}^H\right)^{1-\theta^H}\right)^{\frac{1}{1-\theta^H}} \tag{8}$$

and

$$P_t^F = \left(\gamma_{D,t}^F \left(P_{D,t}^F\right)^{1-\theta^F} + \left(\gamma_{ND,t}^F\right)\left(P_{ND,t}^F\right)^{1-\theta^F}\right)^{\frac{1}{1-\theta^F}} \tag{9}$$

For continuum of goods, the optimization results in the following general formula representing demand functions:

$$\Psi_{j,t}(g) = \left(\frac{\Pi_{j,t}(g)}{\Pi_{j,t}}\right)^{-\eta_j} \Psi_{j,t} \tag{10}$$

where $\Pi_{j,t}(g) \in \left\{P_t^N(g), P_{D,t}^H(g), P_{ND,t}^H(g), P_{D,t}^F(g), P_{ND,t}^F(g)\right\}$ is price per quantity of $\Psi_{j,t}(g) \in \left\{C_t^N(g), C_{D,t}^H(g), C_{ND,t}^H(g), C_{D,t}^F(g), C_{ND,t}^F(g)\right\}$ that satisfies:

$$\Pi_{j,t} = \left(\int_0^1 \left(\Pi_{j,t}(g)\right)^{1-\eta_j} dg\right)^{\frac{1}{1-\eta_j}} \tag{11}$$

where $\Pi_{j,t} \in \left\{P_t^N, P_{D,t}^H, P_{ND,t}^H, P_{D,t}^F, P_{ND,t}^F\right\}$ and $\eta_j \in \left\{\eta^N, \eta_D^H, \eta_{ND}^H, \eta_D^F, \eta_{ND}^F\right\}$.

The individual budget constraint in the home country is given by:

$$P_t C_t + E_t\left[F_{t,t+1} D_{t+1}\right] = W_t N_t + D_t + \pi_t \tag{12}$$

where D_{t+1} is the nominal pay-off in period $t+1$ of corporate bonds held at the end of period t, $F_{t,t+1}$ is the stochastic discount factor for one-period ahead nominal pay-offs, W_t is the wage rate, and π_t is the lump sum transfer of profits coming manufacturers and retailers. All values are represented in U.S. dollars. The individual maximizes her expected utility subject to her budget constraint (by choosing C_t, N_t, D_{t+1}, and F_{t+1} for all t), which results in the traditional intertemporal Euler equation for total real consumption:

$$\beta E_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\upsilon}\left(\frac{P_t}{P_{t+1}}\right)\right] = \frac{1}{I_t \mu_t} \tag{13}$$

where $I_t \mu_t = \frac{1}{E_t[F_{t,t+1}]}$ is the gross return on corporate bonds, with μ_t representing the risk premium due to holding corporate bonds (i.e., the difference between the return on corporate bonds and the policy rate controlled by the monetary authority).

The optimization also implies the following first order condition:

$$(C_t)^{\upsilon} (N_t)^{\varrho} = \frac{W_t}{P_t} \tag{14}$$

which corresponds to a positively sloped labor supply curve.

The same expressions hold for the foreign country with an asterisk superscript (*) for all variables and parameters, except for the discount factor β that is common across countries.

2.2 Manufacturing

Home durable goods are manufactured by a continuum of homogenous manufacturers, each producing a particular durable good m. Since the manufacturers are homogenous, for notational simplicity, we skip the indicators of manufacturers/goods (i.e., m) and present the equations for a representative manufacturer.

The representative manufacturer achieves production according to the following expression:

$$Y_{D,t} = Z_{D,t} (G_{D,t})^{\kappa_D} (N_{D,t})^{1-\kappa_D} \tag{15}$$

where $Z_{D,t}$ represents productivity that is common across home manufacturers of durable goods, $G_{D,t}$ represents intermediate inputs, and $N_{D,t}$ represents labor input.[5] Intermediate inputs are further given by:

$$G_{D,t} = \left(\left(\kappa_D^G\right)^{\frac{1}{\theta}} \left(G_{D,t}^H\right)^{\frac{\theta-1}{\theta}} + \left(1-\kappa_D^G\right)^{\frac{1}{\theta}} \left(G_{D,t}^F\right)^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}} \tag{16}$$

where $G_{D,t}^H$ represents an aggregate index of intermediate inputs of durable goods manufactured in the home country, $G_{D,t}^F$ represents an aggregate index of intermediate inputs of durable goods manufactured in the foreign country, and θ represents the elasticity between home and foreign inputs. The aggregate indices of $G_{D,t}^H$ and $G_{D,t}^F$ consist of continuum of individual manufacturing goods (each represented by k) that are further given by the general formula for continuous CES aggregation given in Equation 5, where $\Psi_{j,t} \in \left\{G_{D,t}^H, G_{D,t}^F\right\}$, $\Psi_{j,t}(k) \in \left\{G_{D,t}^H(k), G_{D,t}^F(k)\right\}$, and η_D^i is the elasticity of substitution across intermediate inputs of individual durable goods.

[5] Since the model lacks capital accumulation, the corresponding dynamics are potentially captured by the productivity measure of $Z_{D,t}$.

Cost minimization results in the following optimal intermediate input decision:

$$G_{D,t} = \frac{\kappa_D Y_{D,t} MC_{D,t}}{MC^G_{D,t}} \tag{17}$$

where $MC_{D,t}$ is the marginal cost of production given by:

$$MC_{D,t} = \frac{\left(MC^G_{D,t}\right)^{\kappa_D} (W_t)^{1-\kappa_D}}{Z_{D,t} (\kappa_D)^{\kappa_D} (1-\kappa_D)^{1-\kappa_D}} \tag{18}$$

where $MC^G_{D,t}$ is the marginal cost of intermediate inputs. The optimal labor input decision is given as follows:

$$N_{D,t} = \frac{(1-\kappa_D) Y_{D,t} MC_{D,t}}{W_t} \tag{19}$$

The demand for domestic and foreign intermediate inputs are given as follows:

$$G^H_{D,t} = \kappa^G_D \left(\frac{MC^{G,H}_{D,t}}{MC^G_{D,t}}\right)^{-\theta} G_{D,t} \tag{20}$$

and

$$G^F_{D,t} = \left(1-\kappa^G_D\right) \left(\frac{MC^{G,F}_{D,t}}{MC^G_{D,t}}\right)^{-\theta} G_{D,t} \tag{21}$$

where $MC^{G,H}_{D,t}$ and $MC^{G,F}_{D,t}$ are the costs per units of $G^H_{D,t}$ and $G^F_{D,t}$, respectively. Finally, demand for each intermediate input of good k within $G^H_{D,t}$ and $G^F_{D,t}$ are given by the functional form in Equation 10, which are:

$$G^H_{D,t}(k) = \left(\frac{P^Y_{D,t}(k)}{MC^{G,H}_{D,t}}\right)^{-\eta^i_D} G^H_{D,t} \tag{22}$$

and

$$G^F_{D,t}(k) = \left(\frac{P^{Y*}_{D,t}(k)\,\tau_t\,(I_t\mu_t)^{\delta_D}}{MC^{G,F}_{D,t}}\right)^{-\eta^i_D} G^F_{D,t} \tag{23}$$

where $P^Y_{D,t}(k)$ and $P^{Y*}_{D,t}(k)\,\tau_t\,(I_t\mu_t)^{\delta_D}$ are costs per units of $G^H_{D,t}(k)$ and $G^F_{D,t}(k)$, respectively. In particular, $P^Y_{D,t}(k)$ represents the cost of domestic intermediate input of good k paid to the domestic manufacturer, $P^{Y*}_{D,t}(k)$ represents the cost of foreign intermediate input good k paid to the foreign manufacturer, $\tau_t > 1$ represents iceberg trade costs from the foreign country to the home country, and $(I_t \mu_t)^{\delta_D}$ represents trade finance costs, with δ_D representing the elasticity of trade finance with respect to the gross return on corporate bonds. Trade finance costs are because of the payment (either complete or partial, depending on δ_D) for the foreign intermediate input that is achieved at the beginning of the period by borrowing from individuals, while the retail revenue is collected at the end of the period. It is implied that the the marginal cost of intermediate inputs $MC_{D,t}^{G}$ is given by:

$$MC_{D,t}^{G} = \left(\kappa_D^G \left(MC_{D,t}^{G,H} \right)^{1-\theta} + \left(1 - \kappa_D^G\right) \left(MC_{D,t}^{G,F} \right)^{1-\theta} \right)^{\frac{1}{1-\theta}} \tag{24}$$

where

$$MC_{D,t}^{G,H} = \left(\int_0^1 \left(P_{D,t}^{Y}(k) \right)^{1-\eta_D^i} dk \right)^{\frac{1}{1-\eta_D^i}} \tag{25}$$

and

$$MC_{D,t}^{G,F} = \left(\int_0^1 \left(P_{D,t}^{Y*}(k)\, \tau_t \left(I_t \mu_t\right)^{\delta_D} \right)^{1-\eta_D^i} dk \right)^{\frac{1}{1-\eta_D^i}} \tag{26}$$

The very same variables in the foreign country are represented by an asterisk superscript (*). The manufacturing of *nondurable* goods is achieved by exactly the same functional forms, where subscripts D's are replaced with ND's.

2.3 Retailing

Home and foreign durable goods are retailed in the home country by two separate continua of homogenous retailers. Since the retailers within each continuum are homogenous, for notational simplicity, we skip the indicators of retailers/goods and present the equations for a representative retailer.

The production function of the representative home retailer who supplies home durable good m is given by the following expression:

$$Y_{D,t}^{R,H} = Z_{D,t}^{R,H} \left(G_{D,t}^{R,H} \right)^{\kappa_D^{R,H}} \left(N_{D,t}^{R,H} \right)^{1-\kappa_D^{R,H}} \tag{27}$$

where $Z_{D,t}^{R,H}$ represents productivity that is common across home retailers supplying home durable goods, $G_{D,t}^{R,H}$ represents intermediate inputs, and $N_{D,t}^{R,H}$ represents labor input. Intermediate inputs $G_{D,t}^{R,H}$ consist of continuum of individual durable manufacturing goods (each represented by k) that are further given by the general formula for continuous CES aggregation given in Equation 5, where $\Psi_{j,t} = G_{D,t}^{R,H}$, $\Psi_{j,t}(k) = G_{D,t}^{R,H}(k)$, and η_D^i is the elasticity of substitution across intermediate inputs of individual durable goods.

Cost minimization results in the following optimal intermediate input decision:

$$G_{D,t}^{R,H} = \frac{\kappa_D^{R,H} Y_{D,t}^{R,H} MC_{D,t}^{R,H}}{MC_{D,t}^{R,H,G}} \tag{28}$$

where $MC_{D,t}^{R,H}$ is the marginal cost of production given by:

$$MC_{D,t}^{R,H} = \frac{\left(MC_{D,t}^{R,H,G}\right)^{\kappa_D^{R,H}} (W_t)^{1-\kappa_D^{R,H}}}{Z_{D,t}^{R,H}\left(\kappa_D^{R,H}\right)^{\kappa_D^{R,H}}\left(1-\kappa_D^{R,H}\right)^{1-\kappa_D^{R,H}}} \tag{29}$$

where $MC_{D,t}^{R,H,G}$ is the marginal cost of intermediate inputs. The optimal labor input decision is given as follows:

$$N_{D,t}^{R,H} = \frac{\left(1-\kappa_D^{R,H}\right) Y_{D,t}^{R,H} MC_{D,t}^{R,H}}{W_t} \tag{30}$$

Demand for each intermediate input of good k within $G_{D,t}^{R,H}$ is given by the same functional form as in Equation 10, which is:

$$G_{D,t}^{R,H}(k) = \left(\frac{P_{D,t}^{Y}(k)}{MC_{D,t}^{R,H,G}}\right)^{-\eta_D^i} G_{D,t}^{R,H} \tag{31}$$

where $P_{D,t}^{Y}(k)$ is the marginal cost of the home intermediate input of good k paid to the home manufacturer. The marginal cost of intermediate inputs is further given by:

$$MC_{D,t}^{R,H,G} = \left(\int_0^1 \left(P_{D,t}^{Y}(k)\right)^{1-\eta_D^i} dk\right)^{\frac{1}{1-\eta_D^i}} \tag{32}$$

The production by the representative home retailer who supplies foreign durable good m is achieved by exactly the same function forms, where superscripts H's are replaced with F's, and $P_{D,t}^{Y}(k)$ is replaced by $P_{D,t}^{Y*}(k)\,\tau_t\,(I_t\mu_t)^{\delta_D^R}$ for each k. The retailing of *nondurable* goods is achieved by exactly the same functional forms, where subscripts D's are replaced with ND's. The very same variables in the foreign country are represented by an additional asterisk superscript (*).

2.4 Market Clearing, Profit Maximization and Inventories

The representative manufacturer of durable goods in the home country supplies products to manufacturers and retailers of durable goods in both home and foreign countries by taking inventories into account. The corresponding profit maximization problem is as follows:

$$\max_{P^Y_{D,t}, L_t} E_t \left[\sum_{k=0}^{\infty} F_{t,t+k} \left(Q_{D,t+k} P^Y_{D,t+k} - Y_{D,t+k} MC_{D,t+k} \right) \right] \tag{33}$$

subject to available goods as in Bils and Kahn (2000):

$$L_{D,t} = S_{D,t-1} + Y_{D,t} = L_{D,t-1} - Q_{D,t-1} + Y_{D,t} \tag{34}$$

where $L_{D,t}$ represents available stock of goods to be sold at time t, $S_{D,t-1}$ represents inventories at the end of the previous period, and, finally, $Q_{D,t}$ represents the sales function. The latter is further given by:

$$Q_{D,t} = \left(L_{D,t}\right)^{\omega_D} C^Y_{D,t} \tag{35}$$

where $\omega_D \in (0,1)$ is the elasticity of sales with respect to available stock of goods, and $C^Y_{D,t}$ represents demand faced by the representative manufacturer:

$$C^Y_{D,t} = \underbrace{\int_0^1 G^H_{D,t}(m)\, dm + \int_0^1 G^{F*}_{D,t}(m)\, \tau_t dm}_{\text{Sold to manufacturers of durable goods}} + \underbrace{\int_0^1 G^{R,H}_{D,t}(r)\, dr + \int_0^1 G^{R,F*}_{D,t}(r)\, \tau_t dr}_{\text{Sold to retailers of durable goods}} \tag{36}$$

where trade costs represented by τ_t enter due to their "iceberg" nature. Using $E_t\left[F_{t,t+1}\right] = \left(I_t \mu_t\right)^{-1}$, the optimization results in the following pricing decision:

$$P^Y_{D,t} = \left(\frac{\eta^i_D}{\eta^i_D - 1}\right) \frac{E_t\left[MC_{D,t+1}\right]}{I_t \mu_t} \tag{37}$$

and the following optimal available stock of goods at time t:

$$L_{D,t} = \left(\frac{\omega_D P^Y_{D,t} C^Y_{D,t}}{\eta^i_D MC_{D,t} + \left(1 - \eta^i_D\right) P^Y_{D,t}} \right)^{\frac{1}{1-\omega_D}} \tag{38}$$

which increases when there is higher demand or an expected increase in marginal cost of production. Optimal level of inventories $S_{D,t}$ can be found by using Equations 34 and 35.

Similarly, the representative home retailer r of home durable goods supplies good r to the unique individual in the home country by taking inventories into account. The corresponding profit maximization problem is as follows:

$$\max_{P^H_{D,t}, L^{R,H}_t} E_t \left[\sum_{k=0}^{\infty} F_{t,t+k} \left(Q^{R,H}_{D,t+k} P^H_{D,t+k} - Y^{R,H}_{D,t+k} MC^{R,H}_{D,t+k} \right) \right] \tag{39}$$

subject to available goods:

$$L^{R,H}_{D,t} = S^{R,H}_{D,t-1} + Y^{R,H}_{D,t} = L^{R,H}_{D,t-1} - Q^{R,H}_{D,t-1} + Y^{R,H}_{D,t} \tag{40}$$

where $P^H_{D,t}$ is the price of the retail good, $L^{R,H}_{D,t}$ represents available stock of goods to be sold at time t, $S^{R,H}_{D,t-1}$ represents inventories at the end of the previous period, and, finally, $Q^{R,H}_{D,t}$ represents a sales function. The latter is further given by:

$$Q^{R,H}_{D,t} = \left(L^{R,H}_{D,t} \right)^{\omega^{R,H}_D} C^H_{D,t} \tag{41}$$

where $\omega^{R,H}_D \in (0,1)$ is the elasticity of sales with respect to available stock of goods, and $C^H_{D,t}$ represents demand coming from the unique individual. The optimization results in the following pricing decision:

$$P^H_{D,t} = \left(\frac{\eta^H_D}{\eta^H_D - 1} \right) \frac{E_t \left[MC^{R,H}_{D,t+1} \right]}{I_t \mu_t} \tag{42}$$

and the following optimal available stock of goods at time t:

$$L^{R,H}_{D,t} = \left(\frac{\omega^{R,H}_D P^H_{D,t} C^H_{D,t}}{\eta^H_D MC^{R,H}_{D,t} + \left(1 - \eta^H_D\right) P^H_{D,t}} \right)^{\frac{1}{1-\omega^{R,H}_D}} \tag{43}$$

The very same functional forms hold for the representative home retailer of foreign durable goods, where the superscript H is replaced with F.

The manufacturing and retailing of *nondurable* traded goods are achieved by exactly the same functional forms, where subscripts D's are replaced with ND's. The very same variables and the corresponding parameters in the foreign country are represented by an asterisk superscript $(^*)$.

2.5 Retailing of Nontraded Goods

Nontraded goods are supplied by a continuum of homogenous retailers, each producing and retailing a particular nontraded good g. The corresponding production is achieved according to the following expression:

$$Y_t^N(g) = Z_t^N N_t^N(g) \tag{44}$$

where Z_t^N represents productivity that is common across retailers of nontraded goods, and $N_t^N(g)$ represents labor input. Considering the corresponding market clearing condition of $Y_t^N(g) = C_t^N(g)$, profit maximization problem results in the following expression for any nontraded good g:

$$P_t^N(g) = \left(\frac{\eta^N}{\eta^N - 1}\right)\frac{W_t}{Z_t^N} \tag{45}$$

where $\frac{W_t}{Z_t^N}$ represents the marginal cost of production. The very same variables in the foreign country are represented by an asterisk superscript $(^*)$.

2.6 Labor Market

Total labor demand in the home country is given by the sum of labor demand coming from all manufacturers and retailers in the economy:

$$N_t = N_t^N + N_{D,t} + N_{ND,t} + N_{D,t}^{R,H} + N_{D,t}^{R,F} + N_{ND,t}^{R,H} + N_{ND,t}^{R,F} \tag{46}$$

where $N_t^N = \int_0^1 \left(\frac{Y_t^N(g)}{Z_t^N}\right) dg$, $N_{D,t} = \int_0^1 \left(\frac{(1-\kappa_D)Y_{D,t}(m)MC_{D,t}(m)}{W_t}\right) dm$, and similar expressions hold for $N_{ND,t}$, $N_{D,t}^{R,H}$, $N_{D,t}^{R,F}$, $N_{ND,t}^{R,H}$ and $N_{ND,t}^{R,F}$. The very same variables in the foreign country are represented by an asterisk superscript $(^*)$.

2.7 Monetary Policy

Regarding the monetary policy rule, Rudebusch et al. (2009) and Carlstrom, Zaman, et al. (2014) have shown that a measure of employment (rather than output) in the monetary policy fits the data better regarding the U.S. monetary policy. Accordingly, we consider the following standard expression:

$$\underbrace{I_t}_{\text{Policy Rate}} = \underbrace{\left(E_t \left[\frac{P_{t+1}}{P_t} \right]^{\chi_p} (N_t)^{\chi_n} \right)}_{\text{Policy Rule}} \times \underbrace{\left(\exp v_t^i \right)}_{\text{Policy Shock}} \tag{47}$$

where the monetary authority increases the policy rate when expected inflation (measured by $E_t \left[P_{t+1} / P_t \right]$) or employment gets higher; $(\exp v_t^i)$ represents the monetary policy shock. The very same variables in the foreign country are represented by an asterisk superscript (*).

2.8 Implications for International Trade

Introducing back the notation based on individual manufacturers (each represented by m) and individual retailers (each represented by r), the *real* durable imports $IM_{D,t}$ and the *real* nondurable imports $IM_{ND.t}$ are given by the following expressions:

$$IM_{D,t} = \underbrace{\int_0^1 G_{D,t}^F (m)\, dm}_{\text{Durable Imports for Further Production}} + \underbrace{\int_0^1 G_{D,t}^{R,F} (r)\, dr}_{\text{Durable Imports for Final Consumption}} \tag{48}$$

and

$$IM_{ND,t} = \underbrace{\int_0^1 G_{ND,t}^F (m)\, dm}_{\text{Nondurable Imports for Further Production}} + \underbrace{\int_0^1 G_{ND,t}^{R,F} (r)\, dr}_{\text{Nondurable Imports for Final Consumption}} \tag{49}$$

which consist of imports by manufacturers (as intermediate inputs for further production) and imports by retailers (to be sold to the individual for final consumption). The total *real* imports IM_t of the home country are defined as the sum of $IM_{D.t}$ and $IM_{ND.t}$:

$$IM_t = IM_{D,t} + IM_{ND.t} \tag{50}$$

Total *nominal* durable imports $IM_{D.t}^{N}$ and total *nominal* nondurable imports $IM_{ND.t}^{N}$ are given by:

$$IM_{D.t}^{N} = \left(\int_0^1 P_{D,t}^{Y*}(m)\, \tau_t \left(I_t \mu_t\right)^{\delta_D} G_{D,t}^{F}(m)\, dm + \int_0^1 P_{D,t}^{Y*}(r)\, \tau_t \left(I_t \mu_t\right)^{\delta_D^R} G_{D,t}^{R,F}(r)\, dr \right) \tag{51}$$

and

$$IM_{ND.t}^{N} = \left(\int_0^1 P_{ND,t}^{Y*}(m)\, \tau_t \left(I_t \mu_t\right)^{\delta_{ND}} G_{ND,t}^{F}(m)\, dm + \int_0^1 P_{ND,t}^{Y*}(r) \left(I_t \mu_t\right)^{\delta_{ND}^R} G_{ND,t}^{R,F}(r)\, dr \right) \tag{52}$$

Accordingly, the import price index for durable goods $P_{D,t}^{IM}$ is implied as:

$$P_{D,t}^{IM} = \frac{IM_{D,t}^{N}}{IM_{D,t}} \tag{53}$$

and the import price index for nondurable goods $P_{ND,t}^{IM}$ is implied as:

$$P_{ND,t}^{IM} = \frac{IM_{ND,t}^{N}}{IM_{ND,t}} \tag{54}$$

which will be used in the estimation of the model that we detail next.

3 Estimation of the Model

The loglinearized version of the model, as depicted in the Appendix, is estimated by a Bayesian approach which is achieved in two steps: (1) The mode of the posterior distribution is estimated by maximizing the log posterior function, which combines the prior information on the parameters with the likelihood of the data. (2) The Metropolis-Hastings algorithm is used to get a complete picture of the posterior distribution. Regarding the choice of priors, for parameters assumed to be between zero and one, we use the beta distribution; for parameters representing the standard errors of shocks, we use the inverse gamma distribution; and for remaining parameters assumed to be positive, we use the gamma distribution.[6] Eighteen

[6] Appendix Table A.1 provides information on prior distributions for all parameters. We have selected symmetrical priors for both the home (i.e., the U.S.) and the foreign country following studies such as by Smets and Wouters (2003).

series of quarterly data from the U.S. are used, including durable and nondurable imports, durable and nondurable production, prices, inventories, duties, risk premium, and wages. In particular, using the notation of the loglinearized model, the eighteen series that are described in the Appendix are matched with the variables of $\widehat{c}_t$, $\widehat{c}_t^N$, $\widehat{y}_{D,t}$, $\widehat{y}_{ND,t}$, $\widehat{im}_{D,t}$, $\widehat{im}_{ND,t}$, $\widehat{s}_{D,t}$, $\widehat{s}_{ND,t}$, $\widehat{s}_{D,t}^{R,H}$, $\widehat{s}_{ND,t}^{R,H}$, $\widehat{s}_{D,t}^{R,F}$, $\widehat{s}_{ND,t}^{R,F}$, $\widehat{\tau}_t$, $\widehat{\mu}_t$, $\widehat{i}_t$, $\widehat{w}_t$, $\widehat{p}_{D,t}^Y$, $\widehat{p}_{ND,t}^Y$, $\widehat{p}_t^N$, $\widehat{p}_{D,t}^{IM}$ and $\widehat{p}_{ND,t}^{IM}$. It is important to emphasize that these variables include those that can be connected to the competing stories introduced above, namely inventories represented by $\widehat{s}_{D,t}$, $\widehat{s}_{ND,t}$, $\widehat{s}_{D,t}^{R,H}$, $\widehat{s}_{ND,t}^{R,H}$, $\widehat{s}_{D,t}^{R,F}$, $\widehat{s}_{ND,t}^{R,F}$, protectionist policies represented by $\widehat{\tau}_t$, trade finance represented by $\widehat{\mu}_t$, and intermediate-input trade implied by $\widehat{y}_{D,t}$, $\widehat{y}_{ND,t}$, $\widehat{im}_{D,t}$, $\widehat{im}_{ND,t}$.

The Bayesian estimates of structural parameters can be found in Appendix Table A.1, where posterior means are reported as point estimates together with the corresponding 90% posterior probability intervals. Although it is not possible to go over all estimated structural parameters (165 of them) and standard errors of shocks (26 of them), we can talk about the estimates of key parameters and their consistency with the literature (when applicable). We start with the estimates of key elasticity measures. The elasticity of substitution between home and foreign goods θ is estimated as around 1.047, highly consistent with international macroeconomics studies that employ quarterly series (as in this paper) such as by Bergin (2006), Corsetti and Pesenti (2001), Corsetti, Dedola, and Leduc (2008), or Heathcote and Perri (2002). The estimates of δ's measuring the effects of trade finance costs range between 0.087 and 0.879, suggesting that trade finance has contributed positively to the overall trade costs. The estimates of the elasticity of sales with respect to available stock of goods (ω's) range between 0.092 and 0.713, supporting the existence of inventories in the model.

4 Decomposition of Wedges

Using the estimated model, the next step is to evaluate the contribution of each competing story to GTC and the corresponding recovery. This is achieved by introducing and decomposing trade, durable and nondurable wedges that are consistent with the complete general equilibrium model.[7] Since the main objective is to understand the contribution of each competing story to GTC, we define wedges as parts of imports data that cannot be explained by

[7] Wedges introduced in this section are based on the DSGE model and are different from the naive wedges discussed in the Appendix that are based on a simple demand-side approach for motivation purposes.

the implications of the general equilibrium model (e.g., by price effects) plus the competing stories so that we can evaluate their contribution. The derivation of wedges and their decomposition are achieved in the Appendix. In terms of notation, lower case variables with a time subscript and a cap (e.g., $\widehat{h}_t$) represent percentage deviations from the steady state, and upper case variables without a time subscript (e.g., H) represent their steady-state values.

We start with the decomposition of the durable wedge given by the following expression:

$$\underbrace{\widehat{tw}_{D,t}}_{\text{Durable Wedge}} = \underbrace{\frac{G_D^F}{IM_D}\widehat{g}_{D,t}^F}_{\text{Intermediate Inputs}} + \underbrace{\left(1-\frac{G_D^F}{IM_D}\right)\left(s_1\widehat{s}_{D,t}^{R,F}-s_2\widehat{s}_{D,t-1}^{R,F}\right)}_{\text{Retail Inventories}} \tag{55}$$

$$+\underbrace{\left(1-\frac{G_D^F}{IM_D}\right)\left(\kappa_D^{R,F}-1\right)\widehat{\tau}_t}_{\text{Protectionist Policies}}+\underbrace{\left(1-\frac{G_D^F}{IM_D}\right)\left(\kappa_D^{R,F}-1\right)\delta_D^R\left(\widehat{i}_t+\widehat{\mu}_t\right)}_{\text{Trade Finance}}$$

$$-\underbrace{\left(1-\frac{G_D^F}{IM_D}\right)\widehat{z}_{D,t}^{R,F}}_{\text{Productivity Shocks}}+\underbrace{\left(1-\frac{G_D^F}{IM_D}\right)\frac{s_1}{s_2}\left(\widehat{\gamma}_t^F+\widehat{\gamma}_{D,t}^F\right)}_{\text{Demand Shocks}}$$

where $s_1 = \left(\left(1-\left(1-\frac{S_D^{R,F}}{L_D^{R,F}}\right)\omega_D^{R,F}\right)\left(\frac{L_D^{R,F}}{S_D^{R,F}}-1\right)\right)^{-1}$ and $s_2 = \frac{S_D^{R,F}}{L_D^{R,F}-S_D^{R,F}}$. All parameters (including those representing the steady-state values) are identified during the estimation. As is evident, the right hand side of this expression clearly shows the contribution of each story to GTC.[8]

The corresponding results are given in Figure 1 over the sample period for the durable wedge. To quantify the contribution of each story, as implied by the U.S. imports data and is consistent with Eaton, Kortum, Neiman, and Romalis (2016), GTC is connected to the period between 2008Q3-2009Q2. Table 1 represents the change in wedges and the contribution of each competing story during this period, where retail inventories contribute the most to the collapse in durable imports.[9] The contribution of retail inventories is followed by protectionist

[8] The only common right hand side variables between this equation and the naive durable wedge given in the Appendix are those representing demand shocks, $\widehat{\gamma}_t^F+\widehat{\gamma}_{D,t}^F$. Therefore, moving from a demand-side model to a general-equilibrium one has resulted in many competing stories showing up as additional explanatory variables.

[9] A further variance decomposition analysis suggests that the volatility of these retail inventories is 67.3% due to demand shocks, 30.5% due to productivity shocks, and 2.2% due to policy shocks according to the categorizationof shocks given in the Appendix.

policies, while the contribution of other stories has been minor. Similarly, the recovery is connected to the period between 2009Q2-2011Q1 (again consistent with the U.S. imports data and Eaton, Kortum, Neiman, and Romalis (2016)). The corresponding decomposition is given in Table 2, where retail inventories contribute the most to the recovery in durable imports, followed protectionist policies and trade finance.

The decomposition of the nondurable wedge $\widehat{tw}_{ND,t}$ is achieved by using the same functional form as in Equation 55, where subscripts D's are replaced with ND's. The corresponding results are given in Figure 2 together with Tables 1 and 2. Different from durable imports, the decomposition of the nondurable wedge suggests that intermediate-input trade has contributed the most to GTC, followed by protectionist policies. The contribution of retail inventories is much smaller compared to the case of durable imports. Regarding the recovery, intermediate-input trade has again contributed the most, followed by protectionist policies and retail inventories.

Since total imports is given as the sum of durable and nondurable imports according to Equation 50, as shown in the Appendix, the trade wedge $\widehat{tw}_t$ is implied as the weighted average of the durable and nondurable wedges, where weights are determined by long-run share of durable and nondurable imports within the overall imports. The corresponding trade wedge is given in Figure 3, and the corresponding quantification is achieved in Tables 1 and 2. As is evident, retail inventories (with a contribution of about 47%) have contributed the most to GTC when total U.S. imports are considered.[10] The contribution of retail inventories is followed by that of protectionist policies (with a contribution of about 28%) and intermediate-input trade (with a contribution of about 21%), while the contribution of trade finance is only about 5%.

When the recovery is investigated using total U.S. imports, the results in Table 2 suggest that retail inventories have again contributed the most (with a contribution of about 57%), followed by intermediate-input trade (with a contribution of about 21%), protectionist policies (with a contribution of about 18%) and trade finance (with a contribution of about 10%). The contribution of productivity and demand shocks has been minor.

[10] It is important to emphasize one more time that the wedges introduced in this section are based on the DSGE model and thus they are different from the naive wedges discussed in the Appendix that are based on a simple demand-side approach. Accordingly, consistent with studies such as by Alessandria, Kaboski, and Midrigan (2011) or Alessandria, Kaboski, and Midrigan (2013), naive wedges in simple demand-side approaches are mostly accounted for by changes in inventories.

Overall, retail inventories have contributed the most to GTC and the corresponding recovery (as in Alessandria, Kaboski, and Midrigan (2010a) and Alessandria, Kaboski, and Midrigan (2010b)), followed by protectionist policies (as in Baldwin and Evenett (2008) and Bown and Crowley (2013)), intermediate-input trade (as in Bems, Johnson, and Yi (2013)), and trade finance (as in Amiti and Weinstein (2011), Ahn, Amiti, and Weinstein (2011), Feenstra, Li, and Yu (2014), and Zymek (2012)). Compositional effects within imports have been significant; i.e., while retail inventories have been the main driver of durable imports, intermediate-input trade has been the main driver of nondurable imports. Although the results in this paper are also consistent with those in Eaton, Kortum, Neiman, and Romalis (2016) in the sense that the composition of demand (rather than productivity shocks) is important in explaining GTC, this paper deviates from theirs by showing higher contributions of retail inventories and protectionist policies to GTC. Potential reasons behind this deviation may include alternative model ingredients; e.g., Eaton, Kortum, Neiman, and Romalis (2016) do not consider any retail sector or inventories, while this paper does not consider any capital accumulation of which effects are reflected as productivity shocks with minor contributions to GTC as discussed above. Another potential reason may be estimating all parameters entering the evaluation of GTC by using eighteen series of quarterly data in this paper, which is essential for the identification of alternative stories contributing to GTC.

5 Conclusion

This paper has investigated the factors leading to the decline in U.S. imports during the 2008 financial crisis. Since there are competing (and sometimes conflicting) stories with each other in the related literature, our analysis has focused on evaluating the contribution of each story by introducing a dynamic trade model that considers intermediate-input trade, inventories, protectionist policies, and trade finance. The model is also rich enough to consider compositional effects by distinguishing between home versus foreign goods, traded versus nontraded goods, and durable versus nondurable goods. The model has been estimated by using eighteen quarterly series from the U.S., some of which represent the actual competing stories (e.g., inventories, imports versus production of durable and nondurable goods, duties, risk premium, services versus overall consumption, etc.).

Using the implications of the estimated model, a decomposition has been achieved to evaluate the contribution of each competing story to GTC. When total U.S. imports are considered, retail inventories have contributed the most to GTC and the corresponding recovery, followed by protectionist policies, intermediate-input trade and trade finance. Productivity and demand shocks have played negligible roles. To address concerns regarding compositional effects, the same decomposition has been achieved for durable and nondurable imports individually. It has been shown that while retail inventories have been mostly responsible for the collapse and recovery of durable imports, it has been intermediate-input trade that has contributed the most to the collapse and recovery of nondurable imports. Both durable and nondurable imports have been significantly affected by protectionist policies, while the contribution of trade finance has been more for durable imports.

References

Ahn, J., M. Amiti, and D. E. Weinstein (2011): "Trade finance and the great trade collapse," *American Economic Review*, 101(3), 298–302.

Alessandria, G., J. Kaboski, and V. Midrigan (2013): "Trade wedges, inventories, and international business cycles," *Journal of Monetary Economics*, 60(1), 1–20.

Alessandria, G., J. P. Kaboski, and V. Midrigan (2010a): "The great trade collapse of 2008–09: An inventory adjustment?," *IMF Economic Review*, 58(2), 254–294.

——— (2010b): "Inventories, lumpy trade, and large devaluations," *American Economic Review*, 100(5), 2304–39.

——— (2011): "US trade and inventory dynamics," *American Economic Review*, 101(3), 303–07.

Amiti, M., and D. E. Weinstein (2011): "Exports and financial shocks," *The Quarterly Journal of Economics*, 126(4), 1841–1877.

Baldwin, R., and S. J. Evenett (2008): "The crisis and protectionism: Steps world leaders should takeâĂİ," *VOXeu. org*.

Behrens, K., G. Corcos, and G. Mion (2013): “Trade crisis? What trade crisis?,” *Review of economics and statistics*, 95(2), 702–709.

Bems, R., R. C. Johnson, and K.-M. Yi (2010): “Demand spillovers and the collapse of trade in the global recession,” *IMF Economic review*, 58(2), 295–326.

——— (2013): “The great trade collapse,” *Annu. Rev. Econ.*, 5(1), 375–400.

Bergin, P. R. (2006): “How well can the New Open Economy Macroeconomics explain the exchange rate and current account?,” *Journal of International Money and Finance*, 25, 675–701.

Bils, M., and J. A. Kahn (2000): “What inventory behavior tells us about business cycles,” *American Economic Review*, 90(3), 458–481.

Bown, C. P., and M. A. Crowley (2013): “Import protection, business cycles, and exchange rates: Evidence from the Great Recession,” *Journal of International Economics*, 1(90), 50–64.

Bussière, M., G. Callegari, F. Ghironi, G. Sestieri, and N. Yamano (2013): “Estimating trade elasticities: Demand composition and the trade collapse of 2008-2009,” *American economic Journal: macroeconomics*, 5(3), 118–51.

Carlstrom, C. T., S. Zaman, et al. (2014): “Using an improved Taylor rule to predict when policy changes will occur,” *Economic Commentary, Federal Reserve Bank of Cleveland, March*.

Chor, D., and K. Manova (2012): “Off the cliff and back? Credit conditions and international trade during the global financial crisis,” *Journal of international economics*, 87(1), 117–133.

Corsetti, G., L. Dedola, and S. Leduc (2008): “High exchange-rate volatility and low pass-through,” *Journal of Monetary Economics*, 55(6), 1113–1128.

Corsetti, G., and P. Pesenti (2001): “Welfare and Macroeconomic Interdependence,” *The Quarterly Journal of Economics*, 116(2), 421–445.

Crowley, M. A., X. Luo, et al. (2011): "Understanding the great trade collapse of 2008–09 and the subsequent trade recovery," *Economic Perspectives*, (Q II), 44–68.

Eaton, J., S. Kortum, B. Neiman, and J. Romalis (2016): "Trade and the global recession," *American Economic Review*, 106(11), 3401–38.

Feenstra, R. C., Z. Li, and M. Yu (2014): "Exports and credit constraints under incomplete information: Theory and evidence from China," *Review of Economics and Statistics*, 96(4), 729–744.

Heathcote, J., and F. Perri (2002): "Financial autarky and international business cycles," *Journal of Monetary Economics*, 49(3), 601–627.

Levchenko, A. A., L. T. Lewis, and L. L. Tesar (2010): "The collapse of international trade during the 2008–09 crisis: in search of the smoking gun," *IMF Economic review*, 58(2), 214–253.

Novy, D., and A. M. Taylor (2014): "Trade and Uncertainty," Working Paper 19941, National Bureau of Economic Research.

Paravisini, D., V. Rappoport, P. Schnabl, and D. Wolfenzon (2014): "Dissecting the effect of credit supply on trade: Evidence from matched credit-export data," *The Review of Economic Studies*, 82(1), 333–359.

Rudebusch, G. D., et al. (2009): "The Fed's monetary policy response to the current crisis," *FRBSF economic Letter*.

Smets, F., and R. Wouters (2003): "An estimated dynamic stochastic general equilibrium model of the euro area," *Journal of the European economic association*, 1(5), 1123–1175.

Stockman, A. C., and L. L. Tesar (1995): "Tastes and Technology in a Two-Country Model of the Business Cycle: Explaining International Comovements," *The American Economic Review*, pp. 168–185.

Zymek, R. (2012): "Sovereign default, international lending, and trade," *IMF Economic Review*, 60(3), 365–394.

6 Appendix

6.1 Loglinearized Model

Loglinearization is achieved around the steady state. In terms of the notation, lower case variables with a time subscript and a cap (e.g., $\widehat{h}_t$) represent percentage deviations from the steady state, and upper case variables without a time subscript (e.g., H) represent their steady-state values.

6.1.1 Individuals

The loglinearized equations regarding the individual optimization are as follows.

$$\begin{aligned}\widehat{c}_t = & \left(\gamma^H\right)^{\frac{1}{\theta}} \left(\frac{C^H}{C}\right)^{\frac{\theta-1}{\theta}} \left(\frac{\widehat{\gamma}_t^H}{\theta-1} + \widehat{c}_t^H\right) + \left(\gamma^F\right)^{\frac{1}{\theta}} \left(\frac{C^F}{C}\right)^{\frac{\theta-1}{\theta}} \left(\frac{\widehat{\gamma}_t^F}{\theta-1} + \widehat{c}_t^F\right) \\ & + \left(\gamma^N\right)^{\frac{1}{\theta}} \left(\frac{C^N}{C}\right)^{\frac{\theta-1}{\theta}} \left(\frac{\widehat{\gamma}_t^N}{\theta-1} + \widehat{c}_t^N\right)\end{aligned} \tag{56}$$

$$\begin{aligned}\widehat{p}_t = & \gamma^H \left(\frac{P^H}{P}\right)^{1-\theta} \left(\frac{\widehat{\gamma}_t^H}{1-\theta} + \widehat{p}_t^H\right) + \gamma^F \left(\frac{P^F}{P}\right)^{1-\theta} \left(\frac{\widehat{\gamma}_t^F}{1-\theta} + \widehat{p}_t^F\right) \\ & + \gamma^N \left(\frac{P^N}{P}\right)^{1-\theta} \left(\frac{\widehat{\gamma}_t^N}{1-\theta} + \widehat{p}_t^N\right)\end{aligned} \tag{57}$$

$$\widehat{p}_t^H = \gamma_D^H \left(\frac{P_D^H}{P^H}\right)^{1-\theta^H} \left(\frac{\widehat{\gamma}_{D,t}^H}{1-\theta^H} + \widehat{p}_{D,t}^H\right) + \gamma_{ND}^H \left(\frac{P_{ND}^H}{P^H}\right)^{1-\theta^H} \left(\frac{\widehat{\gamma}_{ND,t}^H}{1-\theta^H} + \widehat{p}_{ND,t}^H\right) \tag{58}$$

$$\widehat{p}_t^F = \gamma_D^F \left(\frac{P_D^F}{P^F}\right)^{1-\theta^F} \left(\frac{\widehat{\gamma}_{D,t}^F}{1-\theta^F} + \widehat{p}_{D,t}^F\right) + \gamma_{ND}^F \left(\frac{P_{ND}^F}{P^F}\right)^{1-\theta^F} \left(\frac{\widehat{\gamma}_{ND,t}^F}{1-\theta^F} + \widehat{p}_{ND,t}^F\right) \tag{59}$$

$$\gamma^H \widehat{\gamma}_t^H + \gamma^F \widehat{\gamma}_t^F + \gamma^N \widehat{\gamma}_t^N = 0 \tag{60}$$

$$\gamma_D^H \widehat{\gamma}_{D,t}^H + \gamma_{ND}^H \widehat{\gamma}_{ND,t}^H = 0 \tag{61}$$

$$\gamma_D^F \widehat{\gamma}_{D,t}^F + \gamma_{ND}^F \widehat{\gamma}_{ND,t}^F = 0 \tag{62}$$

$$\widehat{c}_t^H = \widehat{\gamma}_t^H - \theta \widehat{p}_t^H + \theta \widehat{p}_t + \widehat{c}_t \tag{63}$$

$$\widehat{c}_t^F = \widehat{\gamma}_t^F - \theta \widehat{p}_t^F + \theta \widehat{p}_t + \widehat{c}_t \tag{64}$$

$$\widehat{c}_t^N = \widehat{\gamma}_t^N - \theta \widehat{p}_t^N + \theta \widehat{p}_t + \widehat{c}_t \tag{65}$$

$$\widehat{c}_{D,t}^H = \widehat{\gamma}_{D,t}^H - \theta^H \widehat{p}_{D,t}^H + \theta^H \widehat{p}_t^H + \widehat{c}_t^H \tag{66}$$

$$\widehat{c}_{ND,t}^H = \widehat{\gamma}_{ND,t}^H - \theta^H \widehat{p}_{ND,t}^H + \theta^H \widehat{p}_t^H + \widehat{c}_t^H \tag{67}$$

$$\widehat{c}_{D,t}^F = \widehat{\gamma}_{D,t}^F - \theta^F \widehat{p}_{D,t}^F + \theta^F \widehat{p}_t^F + \widehat{c}_t^F \tag{68}$$

$$\widehat{c}_{ND,t}^F = \widehat{\gamma}_{ND,t}^F - \theta^F \widehat{p}_{ND,t}^F + \theta^F \widehat{p}_t^F + \widehat{c}_t^F \tag{69}$$

$$\upsilon \widehat{c}_t + \widehat{p}_t = E_t \left[\upsilon \widehat{c}_{t+1} + \widehat{p}_{t+1} \right] - \widehat{i}_t - \widehat{\mu}_t \tag{70}$$

$$\upsilon \widehat{c}_t + \varrho \widehat{n}_t = \widehat{w}_t - \widehat{p}_t \tag{71}$$

The very same variables in the foreign country are represented by an asterisk superscript (*).

6.1.2 Manufacturing

The loglinearized equations regarding the cost minimization of the home manufacturers producing durable goods are as follows, where the variables with an asterisk superscript (*) represent the foreign country.

$$\widehat{g}_{D,t} = \widehat{y}_{D,t} + \widehat{mc}_{D,t} - \widehat{mc}_{D,t}^G \tag{72}$$

$$\widehat{mc}_{D,t} = \kappa_D \widehat{mc}^G_{D,t} + (1-\kappa_D)\,\widehat{w}_t - \widehat{z}_{D,t} \tag{73}$$

$$\widehat{n}_{D,t} = \widehat{y}_{D,t} + \widehat{mc}_{D,t} - \widehat{w}_t \tag{74}$$

$$\widehat{g}^H_{D,t} = -\theta \widehat{mc}^{G,H}_{D,t} + \theta \widehat{mc}^G_{D,t} + \widehat{g}_{D,t} \tag{75}$$

$$\widehat{g}^F_{D,t} = -\theta \widehat{mc}^{G,F}_{D,t} + \theta \widehat{mc}^G_{D,t} + \widehat{g}_{D,t} \tag{76}$$

$$\widehat{mc}^{G,H}_{D,t} = \widehat{p}^Y_{D,t} \tag{77}$$

$$\widehat{mc}^{G,F}_{D,t} = \widehat{p}^{Y*}_{D,t} + \widehat{\tau}_t + \delta_D\left(\widehat{i}_t + \widehat{\mu}_t\right) \tag{78}$$

$$\widehat{mc}^G_{D,t} = \kappa^G_D \widehat{p}^Y_{D,t} + \left(1-\kappa^G_D\right)\widehat{p}^{Y*}_{D,t} + \left(1-\kappa^G_D\right)\widehat{\tau}_t + \left(1-\kappa^G_D\right)\delta_D\left(\widehat{i}_t + \widehat{\mu}_t\right) \tag{79}$$

The manufacturing of *nondurable* goods is achieved by exactly the same functional forms, where subscripts D's are replaced with ND's. The very same variables in the foreign country are represented by an asterisk superscript (*).

6.1.3 Retailing

The loglinearized equations regarding the cost minimization of the representative home retailer selling home durable goods are as follows.

$$\widehat{g}^{R,H}_{D,t} = \widehat{y}^{R,H}_{D,t} + \widehat{mc}^{R,H}_{D,t} - \widehat{mc}^{R,H,G}_{D,t} \tag{80}$$

$$\widehat{mc}^{R,H}_{D,t} = \kappa^{R,H}_D \widehat{mc}^{R,H,G}_{D,t} + \left(1-\kappa^{R,H}_D\right)\widehat{w}_t - \widehat{z}^{R,H}_{D,t} \tag{81}$$

$$\widehat{n}^{R,H}_{D,t} = \widehat{y}^{R,H}_{D,t} + \widehat{mc}^{R,H}_{D,t} - \widehat{w}_t \tag{82}$$

$$\widehat{mc}_{D,t}^{R,H,G} = \widehat{p}_{D,t}^{Y} \tag{83}$$

Similarly, the loglinearized equations regarding the cost minimization of the home retailers selling foreign durable goods are as follows.

$$\widehat{g}_{D,t}^{R,F} = \widehat{y}_{D,t}^{R,F} + \widehat{mc}_{D,t}^{R,F} - \widehat{mc}_{D,t}^{R,F,G} \tag{84}$$

$$\widehat{mc}_{D,t}^{R,F} = \kappa_D^{R,F}\widehat{mc}_{D,t}^{R,F,G} + \left(1 - \kappa_D^{R,F}\right)\widehat{w}_t - \widehat{z}_{D,t}^{R,F} \tag{85}$$

$$\widehat{n}_{D,t}^{R,F} = \widehat{y}_{D,t}^{R,F} + \widehat{mc}_{D,t}^{R,F} - \widehat{w}_t \tag{86}$$

$$\widehat{mc}_{D,t}^{R,F,G} = \widehat{p}_{D,t}^{Y*} + \widehat{\tau}_t + \delta_D^R\left(\widehat{i}_t + \widehat{\mu}_t\right) \tag{87}$$

The retailing of *nondurable* goods is achieved by exactly the same functional forms, where subscripts D's are replaced with ND's. The very same variables in the foreign country are represented by an asterisk superscript (*).

6.1.4 Market Clearing, Profit Maximization and Inventories

The loglinearized equations regarding the profit maximization of the representative home manufacturer producing durable goods are as follows, where the variables with an asterisk superscript (*) represent the foreign country.

$$\widehat{l}_{D,t} = \frac{S_D}{L_D}\widehat{s}_{D,t-1} + \frac{Y_D}{L_D}\widehat{y}_{D,t} \tag{88}$$

$$\widehat{l}_{D,t} = \frac{S_D}{L_D}\widehat{s}_{D,t} + \frac{Q_D}{L_D}\widehat{q}_{D,t} \tag{89}$$

$$\widehat{q}_{D,t} = \widehat{c}_{D,t}^{Y} + \omega_D\widehat{l}_{D,t} \tag{90}$$

$$C_D^Y \widehat{c}_{D,t}^Y = G_D^H \widehat{g}_{D,t}^H + G_D^{F*}\left(\widehat{g}_{D,t}^{F*} + \widehat{\tau}_t\right) + G_D^{R,H} \widehat{g}_{D,t}^{R,H} + G_D^{R,F*}\left(\widehat{g}_{D,t}^{R,F*} + \widehat{\tau}_t\right) \tag{91}$$

$$\widehat{p}_{D,t}^Y = E_t\left[\widehat{mc}_{D,t+1}\right] - \widehat{\mu}_t - \widehat{i}_t \tag{92}$$

$$\widehat{l}_{D,t}\beta\left(1-\omega_D\right)\omega_D = \left(\widehat{p}_{D,t}^Y - \widehat{mc}_{D,t}\right)\left(\eta_D^i - 1\right)\left(\frac{L_D}{Q_D}\right) + \beta\omega_D \widehat{c}_{D,t}^Y \tag{93}$$

The manufacturing of *nondurable* goods are achieved by exactly the same functional forms, where subscripts D's are replaced with ND's. The very same variables and the corresponding parameters in the foreign country are represented by an asterisk superscript (*).

The loglinearized equations regarding the profit maximization of the representative home retailer selling home durable goods are as follows.

$$\widehat{l}_{D,t}^{R,H} = \left(\frac{S_D^{R,H}}{L_D^{R,H}}\right)\widehat{s}_{D,t-1}^{R,H} + \left(\frac{Y_D^{R,H}}{L_D^{R,H}}\right)\widehat{y}_{D,t}^{R,H} \tag{94}$$

$$\widehat{l}_{D,t}^{R,H} = \left(\frac{S_D^{R,H}}{L_D^{R,H}}\right)\widehat{s}_{D,t}^{R,H} + \left(\frac{Q_D^{R,H}}{L_D^{R,H}}\right)\widehat{q}_{D,t}^{R,H} \tag{95}$$

$$\widehat{q}_{D,t}^{R,H} = \widehat{c}_{D,t}^H + \omega_D^{R,H}\widehat{l}_{D,t}^{R,H} \tag{96}$$

$$\widehat{p}_{D,t}^H = E_t\left[\widehat{mc}_{D,t+1}^{R,H}\right] - \widehat{\mu}_t - \widehat{i}_t \tag{97}$$

$$\widehat{l}_{D,t}^{R,H}\beta\left(1-\omega_D^{R,H}\right)\omega_D^{R,H} = \left(\widehat{p}_{D,t}^H - \widehat{mc}_{D,t}^{R,H}\right)\left(\eta_D^H - 1\right)\left(\frac{L_D^{R,H}}{Q_D^{R,H}}\right) + \beta\omega_D^{R,H}\widehat{c}_{D,t}^H \tag{98}$$

The very same functional forms hold for the representative home retailer of foreign durable goods, where the superscript H is replaced with F. The retailing of *nondurable* goods are achieved by exactly the same functional forms, where subscripts D's are replaced with ND's. The very same variables and the corresponding parameters in the foreign country are represented by an asterisk superscript (*).

6.1.5 Retailing of Nontraded Goods

The loglinearized equations regarding the home retailing of nontraded goods are as follows.

$$\widehat{y}_t^N = \widehat{z}_t^N + \widehat{n}_t^N \tag{99}$$

$$\widehat{y}_t^N = \widehat{c}_t^N \tag{100}$$

$$\widehat{p}_t^N = \widehat{w}_t - \widehat{z}_t^N \tag{101}$$

The very same variables in the foreign country are represented by an asterisk superscript (*).

6.1.6 Labor Market

The loglinearized equation regarding the total labor demand is as follows.

$$N\widehat{n}_t = N_D\widehat{n}_{D,t} + N_{ND}\widehat{n}_{ND,t} + N_D^{R,H}\widehat{n}_{D,t}^{R,H} + N_D^{R,F}\widehat{n}_{D,t}^{R,F} + N_{ND}^{R,H}\widehat{n}_{ND,t}^{R,H} + N_{ND}^{R,F}\widehat{n}_{ND,t}^{R,F} + N^N\widehat{n}_t^N \tag{102}$$

The very same variables in the foreign country are represented by an asterisk superscript (*).

6.1.7 Monetary Policy

The loglinearized equation regarding the home monetary policy are as follows.

$$\widehat{i}_t = \chi_p E_t \pi_{t+1} + \chi_n \widehat{n}_t + v_t^i \tag{103}$$

The very same variables in the foreign country are represented by an asterisk superscript (*).

6.1.8 Implications for International Trade

The loglinearized equations representing the imports of the home country are given by the following expressions.

$$\widehat{im}_{D,t} = \frac{G_D^F}{IM_D}\widehat{g}_{D,t}^F + \frac{G_D^{R,F}}{IM_D}\widehat{g}_D^{R,F} \tag{104}$$

$$\widehat{im}_{ND,t} = \frac{G^F_{ND}}{IM_{ND}}\widehat{g}^F_{ND,t} + \frac{G^{R,F}_{ND}}{IM_{ND}}\widehat{g}^{R,F}_{ND} \tag{105}$$

$$\widehat{im}_t = \frac{IM_D}{IM}\widehat{im}_{D,t} + \frac{IM_{ND}}{IM}\widehat{im}_{ND,t} \tag{106}$$

$$\begin{aligned}\widehat{im}^N_{D,t} = & \frac{P^{Y*}_D \tau I^{\delta_D} G^F_D}{IM^N_D}\left(\widehat{p}^{Y*}_{D,t} + \widehat{\tau}_t + \delta_D\left(\widehat{i}_t + \widehat{\mu}_t\right) + \widehat{g}^F_{D,t}\right) \\ & + \frac{P^{Y*}_D \tau I^{\delta^R_D} G^{R,F}_D}{IM^N_D}\left(\widehat{p}^{Y*}_{D,t} + \widehat{\tau}_t + \delta^R_D\left(\widehat{i}_t + \widehat{\mu}_t\right) + \widehat{g}^{R,F}_D\right)\end{aligned} \tag{107}$$

$$\begin{aligned}\widehat{im}^N_{ND,t} = & \frac{P^{Y*}_{ND} \tau I^{\delta_{ND}} G^F_{ND}}{IM^N_{ND}}\left(\widehat{p}^{Y*}_{ND,t} + \widehat{\tau}_t + \delta_{ND}\left(\widehat{i}_t + \widehat{\mu}_t\right) + \widehat{g}^F_{ND,t}\right) \\ & + \frac{P^{Y*}_{ND} \tau I^{\delta^R_{ND}} G^{R,F}_{ND}}{IM^N_{ND}}\left(\widehat{p}^{Y*}_{ND,t} + \widehat{\tau}_t + \delta^R_{ND}\left(\widehat{i}_t + \widehat{\mu}_t\right) + \widehat{g}^{R,F}_{ND}\right)\end{aligned} \tag{108}$$

$$\widehat{p}^{IM}_{D,t} = \widehat{im}^N_{D,t} - \widehat{im}_{D,t} \tag{109}$$

$$\widehat{p}^{IM}_{ND,t} = \widehat{im}^N_{ND,t} - \widehat{im}_{ND,t} \tag{110}$$

6.1.9 Shocks

The following variables in the home country are subject to AR(1) processes in the form of $h_t = \rho_h h_{t-1} + \varepsilon^h_t$, where h represents the variable, $\rho_h \in [0, 1)$, and ε^h_t is an i.i.d. shock with zero mean and variance of σ^2_h.

1. Preferences (compositional effects)
   $\widehat{\gamma}^H_t, \widehat{\gamma}^F_t, \widehat{\gamma}^H_{D,t}, \widehat{\gamma}^F_{D,t}$

2. Productivities
   $\widehat{z}_{D,t}, \widehat{z}_{ND,t}, \widehat{z}^{R,H}_{D,t}, \widehat{z}^{R,H}_{ND,t}, \widehat{z}^{R,F}_{D,t}, \widehat{z}^{R,F}_{ND,t}, \widehat{z}^N_t$

3. Policy Variables
   $\widehat{\tau}_t, v^i_t$

The very same variables in the foreign country (represented by an asterisk superscript $(^*)$) are also subject to AR(1) processes. Therefore, there are 26 shocks in total.

6.2 Data Appendix

The U.S. data cover the quarterly period between 2002:Q1-2018:Q2.[11] All data have been obtained from FRED Economic Data web page, except for duties (τ_t) that have been obtained from the USITC DataWeb. The introduction of a large number of shocks in the model allows us to estimate the full model using a large data set (with eighteen series). Using the notation of the loglinearized model, the model is estimated by using the following series that are converted into logs, seasonally adjusted (when applicable), and detrended by using the Hodrick-Prescott (HP) filter:

- "Real Personal Consumption Expenditures, Billions of Chained 2012 Dollars, Quarterly, Seasonally Adjusted Annual Rate" has been used for $\widehat{c}_t$.
- "Real Personal Consumption Expenditures: Services, Billions of Chained 2012 Dollars, Quarterly, Seasonally Adjusted Annual Rate" has been used for $\widehat{c}_t^N$.
- "Consumer Price Index for All Urban Consumers: Services, Index 1982-1984=100, Quarterly, Seasonally Adjusted" has been used for $\widehat{p}_t^N$.
- "Real private inventories: Manufacturing: Durable goods industries, Billions of Chained 2012 Dollars, Quarterly, Seasonally Adjusted" has been used for $\widehat{s}_{D,t}$.
- "Real private inventories: Manufacturing: Nondurable goods industries, Billions of Chained 2012 Dollars, Quarterly, Seasonally Adjusted" has been used for $\widehat{s}_{ND,t}$.
- "Real private inventories: Retail trade, Billions of Chained 2012 Dollars, Quarterly, Seasonally Adjusted" has been used for the weighted average of $\widehat{s}_{D,t}^{R,H}$, $\widehat{s}_{ND,t}^{R,H}$, $\widehat{s}_{D,t}^{R,F}$, $\widehat{s}_{ND,t}^{R,F}$ represented by $\widehat{s}_t^R$, where weights (arising due to the loglinearization of total retail inventories) are estimated during the estimation of the model according to the loglinearized equation:

$$S^R\widehat{s}_t^R = S_D^{R,H}\widehat{s}_{D,t}^{R,H} + S_{ND}^{R,H}\widehat{s}_{ND,t}^{R,H} + S_D^{R,F}\widehat{s}_{D,t}^{R,F} + S_{ND}^{R,F}\widehat{s}_{ND,t}^{R,F} \tag{111}$$

[11] The start and the end of the sample period have been determined by the data availability.

- "Producer Prices Index: Total Durable Consumer Goods for the United States, Index 2010=100, Quarterly, Not Seasonally Adjusted" has been used for $\widehat{p}_{D,t}^{Y}$.

- "Producer Prices Index: Total Nondurable Consumer Goods for the United States, Index 2010=100, Quarterly, Not Seasonally Adjusted" has been used for $\widehat{p}_{ND,t}^{Y}$.

- "Industrial Production: Durable Manufacturing (NAICS), Index 2012=100, Quarterly, Seasonally Adjusted" has been used for $\widehat{y}_{D,t}$.

- "Industrial Production: Nondurable Manufacturing (NAICS), Index 2012=100, Quarterly, Seasonally Adjusted" has been used for $\widehat{y}_{ND,t}$.

- "Real imports of durable goods, Billions of Chained 2012 Dollars, Quarterly, Seasonally Adjusted Annual Rate" has been used for $\widehat{im}_{D,t}$.

- "Real imports of nondurable goods, Billions of Chained 2012 Dollars, Quarterly, Seasonally Adjusted Annual Rate" has been used for $\widehat{im}_{ND,t}$.

- "Average Hourly Earnings of Production and Nonsupervisory Employees: Total Private, Dollars per Hour, Quarterly, Seasonally Adjusted" has been used for $\widehat{w}_t$.

- "All Import Commodities: Calculated Duties by Customs Value for ALL Countries" divided by "All Import Commodities: Customs Value by Customs Value for ALL Countries" has been used for $\widehat{\tau}_t$.

- "Moody's Seasoned Baa Corporate Bond Minus Federal Funds Rate, Percent, Quarterly, Not Seasonally Adjusted" has been used for $\widehat{\mu}_t$.

- "Effective Federal Funds Rate, Percent, Quarterly, Not Seasonally Adjusted" has been used for $\widehat{i}_t$.

- "Import Price Index (End Use): Durables, manufactured, Index 2000=100, Quarterly, Not Seasonally Adjusted" has been used for $\widehat{p}_{D,t}^{IM}$.

- "Import Price Index (End Use): Nondurables, manufactured, Index 2000=100, Quarterly, Not Seasonally Adjusted" has been used for $\widehat{p}_{ND,t}^{IM}$.

Using the notation of the loglinearized model when applicable, Appendix Figures A.1-A.4 (as detailed in the next subsection) employ the following series that are converted into logs, seasonally adjusted (when applicable), and detrended by using the Hodrick-Prescott (HP) filter:

- "Real Personal Consumption Expenditures, Billions of Chained 2012 Dollars, Quarterly, Seasonally Adjusted Annual Rate" has been used for $\widehat{c}_t$.
- "Consumer Price Index for All Urban Consumers: All Items, Index 1982-1984=100, Quarterly, Seasonally Adjusted" has been used for $\widehat{p}_t$.
- "Real imports of goods, Billions of Chained 2012 Dollars, Quarterly, Seasonally Adjusted Annual Rate" has been used for $\widehat{c}_t^F$.
- "Import Price Index (End Use): All commodities, Index 2000=100, Quarterly, Not Seasonally Adjusted" has been used for $\widehat{p}_t^F$.
- "Real Personal Consumption Expenditures: Services, Billions of Chained 2012 Dollars, Quarterly, Seasonally Adjusted Annual Rate" has been used for $\widehat{c}_t^N$.
- "Consumer Price Index for All Urban Consumers: Services, Index 1982-1984=100, Quarterly, Seasonally Adjusted" has been used for $\widehat{p}_t^N$.
- "Real imports of durable goods, Billions of Chained 2012 Dollars, Quarterly, Seasonally Adjusted Annual Rate" has been used for $\widehat{c}_{D,t}^F$.
- "Import Price Index (End Use): Durables, manufactured, Index 2000=100, Quarterly, Not Seasonally Adjusted" has been used for $\widehat{p}_{D,t}^F$.
- "Real imports of nondurable goods, Billions of Chained 2012 Dollars, Quarterly, Seasonally Adjusted Annual Rate" has been used for $\widehat{c}_{ND,t}^F$.
- "Import Price Index (End Use): Nondurables, manufactured, Index 2000=100, Quarterly, Not Seasonally Adjusted" has been used for $\widehat{p}_{ND,t}^F$.
- "Moody's Seasoned Baa Corporate Bond Minus Federal Funds Rate, Percent, Quarterly, Not Seasonally Adjusted" has been used for "Risk Premium."

- "Industrial Production: Manufacturing (NAICS), Index 2012=100, Quarterly, Seasonally Adjusted" has been used for "Domestic Production of Goods."
- "Total Business: Inventories to Sales Ratio, Ratio, Quarterly, Seasonally Adjusted" has been used for "Sales to Inventories Ratio."
- "All Import Commodities: Calculated Duties by Customs Value for ALL Countries" divided by "All Import Commodities: Customs Value by Customs Value for ALL Countries" has been used for "Duties."

6.3 Naive Trade Wedge and the Competing Stories

This subsection has two objectives. The first objective is to show that GTC has been an extraordinary event using the concept of *naive trade wedge* when all imports are consumed by individuals; in such a case, a demand-side approach is enough to have an expression for the naive trade wedge. The second one is to show that the naive trade wedge based on the demand-side approach is highly correlated with the variables representing the competing stories explaining GTC as introduced in the main text, suggesting that a more advanced (general-equilibrium) model including these competing stories is necessary to understand GTC.

Following studies such as by Levchenko, Lewis, and Tesar (2010), naive trade wedge is defined as the part of the trade data that cannot be explained by the implications of a standard trade model. All variables are represented as percentage deviations from their steady state. Considering only the demand side of the model introduced in this paper (obtained from the optimization of individuals), the naive trade wedge $\widetilde{tw}_t$ is given by the following expression:

$$\widetilde{tw}_t = \left(\widehat{c}_t^F - \widehat{c}_t\right) - \theta\left(\widehat{p}_t - \widehat{p}_t^F\right) = \widehat{\gamma}_t^F \tag{112}$$

where $\widehat{c}_t^F - \widehat{c}_t$ represents the relative consumption of imported goods (with respect to overall consumption), $\widehat{p}_t - \widehat{p}_t^F$ represents the relative price of imports (with respect to overall prices), θ is the elasticity of substitution between home and foreign goods, and γ_t^F represents time-varying preferences (determined by demand shocks) toward imported goods. The reason for calling this the *naive* trade wedge is that it only considers the implications of a demand-side model, while wedges considered in the main text are based on the implications of the complete DSGE model.

When all imports are consumed by individuals, trade and consumption data (together with the corresponding prices) are enough to calculate the naive trade wedge $\widetilde{tw}_t$, subject to the knowledge of θ. In such a case, the naive trade wedge is nothing more than a preference shock as in Stockman and Tesar (1995). The corresponding naive trade wedge is given in Appendix Figure A.1 for two alternative elasticity θ measures. The first one follows the international macro literature by having $\theta = 1$, while the second one follows the international trade literature by having $\theta = 5$. As is evident, independent of the elasticity used, GTC and the corresponding recovery based on the naive trade wedge are extraordinary in the sense that their scale is not observed in any other part of the sample period.

Several studies introduced above have suggested that a shift in final spending away from tradable sectors accounts for most of the GTC. This compositional-effect story can be captured by the naive service wedge $\widetilde{tw}_t^N$ given by the following expression, consistent with the model introduced below:

$$\widetilde{tw}_t^N = \left(\widehat{c}_t^N - \widehat{c}_t\right) - \theta\left(\widehat{p}_t - \widehat{p}_t^N\right) = \widehat{\gamma}_t^N \tag{113}$$

where $\widehat{c}_t^N - \widehat{c}_t$ represents the relative consumption of services (with respect to overall consumption), $\widehat{p}_t - \widehat{p}_t^N$ represents the relative price of services (with respect to overall prices), and $\widehat{\gamma}_t^N$ represents time-varying preferences (determined by demand shocks) toward services. The corresponding service wedge is given in Appendix Figure A.1 for two alternative θ measures. The results confirm the compositional-effect story in the literature, since, independent of the value of θ, GTC and the corresponding recovery based on the naive trade wedge coincide with the opposite changes in the naive service wedge. Therefore, it is essential to consider compositional effects while investigating GTC, as we achieve in this paper.

To investigate the compositional effects within imports, again based on only the demand side of the model introduced in this paper, the naive durable wedge $\widetilde{tw}_{D,t}$ is given by the following expression:

$$\widetilde{tw}_{D,t} = \left(\widehat{c}_{D,t}^F - \widehat{c}_t\right) - \theta^F\left(\widehat{p}_t^F - \widehat{p}_{D,t}^F\right) - \theta\left(\widehat{p}_t - \widehat{p}_t^F\right) = \widehat{\gamma}_t^F + \widehat{\gamma}_{D,t}^F \tag{114}$$

where $\widehat{c}_{D,t}^F - \widehat{c}_t$ represents the relative consumption of durable imports (with respect to overall consumption), $\widehat{p}_t^F - \widehat{p}_{D,t}^F$ represents the relative price of durable imports (with respect to overall imports), $\widehat{p}_t - \widehat{p}_t^F$ represents the relative price of imports (with respect to overall consumption), θ^F is the elasticity of substitution between durable and nondurable foreign goods, and $\widehat{\gamma}_{D,t}^F$ represents time-varying preferences toward imported durable goods. Similarly, the nondurable wedge $\widetilde{tw}_{ND,t}$ is given by the following expression:

$$\widetilde{tw}_{ND,t} = \left(\widehat{c}_{ND,t}^F - \widehat{c}_t\right) - \theta^F\left(\widehat{p}_t^F - \widehat{p}_{ND,t}^F\right) - \theta\left(\widehat{p}_t - \widehat{p}_t^F\right) = \widehat{\gamma}_t^F + \widehat{\gamma}_{ND,t}^F \tag{115}$$

where $\widehat{c}_{ND,t}^F - \widehat{c}_t$ represents the relative consumption of nondurable imports (with respect to overall consumption), and $\widehat{p}_t^F - \widehat{p}_{ND,t}^F$ represents the relative price of nondurable imports (with respect to overall imports). For alternative elasticity measures, the durable and nondurable wedges in Appendix Figure A.2 are obtained when all (durable and nondurable) imports are consumed by individuals. As is evident, both wedges highly mimic the naive trade wedge, suggesting that both types of imports have been subject to GTC. Accordingly, we will consider both types of imports in our formal investigation, below.

Although Appendix Figures A.1-A.2 provide useful information on the compositional effects based on the assumption that all imports are consumed by individuals, it is well known that imports are not only consumed by individuals but also used as intermediate inputs for further production and kept as inventories (as in the competing stories discussed above). In other words, the calculation of the naive trade wedge by assuming that all imports are consumed by individuals may be biased, since these additional determinants of trade may simply show up as changes in preferences in this naive calculation due to the mismeasurement of $\widehat{c}_t^F$ and $\widehat{p}_t^F$ (or $\widehat{c}_t^N, \widehat{p}_t^N, \widehat{c}_{D,t}^F, \widehat{p}_{D,t}^F, \widehat{c}_{ND,t}^F, \widehat{p}_{ND,t}^F$) representing the consumption of individuals. To support this claim, we plot the naive trade wedge $\widetilde{tw}_t$ against selected variables, each representing a competing story to explain GTC, in Appendix Figures A.3 and A.4 for alternative elasticity measures. In particular, to observe the visual correlation between GTC and the competing stories, the *negative* value of risk premium faced by corporate bonds is used as a measure of trade finance, domestic production of goods is used as a measure of intermediate input usage, the *negative* value of effective tariffs/duties in ad-valorem term is used to measure protectionist policies, and sales to inventories ratio is used as a measure of inventories. As is evident in Appendix Figures A.3 and A.4, independent of θ, all variables (each representing a competing story) have correlations with the naive trade wedge $\widetilde{tw}_t$.

It is implied that the naive wedges based on a simple demand-side model may be capturing the potential effects of competing stories based on a general-equilibrium framework. Accordingly, it is essential to consider all potential model ingredients, each representing a competing story to explain GTC in the literature, in a single general equilibrium framework as we have achieved in the main text of this paper.

6.4 Decomposition of Wedges

The decomposition of wedges (which are different from naive wedges due to considering the implications of the DSGE model) is achieved by using the loglinearized version of the DSGE model.

6.4.1 Decomposition of the Durable Wedge

We start with finding an expression for durable imports using the loglinearized model. According to the equations used to depict the implications for international trade above, we have:

$$\widehat{im}_{D,t} = \frac{G_D^F}{IM_D}\widehat{g}_{D,t}^F + \frac{G_D^{R,F}}{IM_D}\widehat{g}_D^{R,F} \tag{116}$$

where

$$\widehat{g}_{D,t}^{R,F} = \widehat{y}_{D,t}^{R,F} + \widehat{mc}_{D,t}^{R,F} - \widehat{mc}_{D,t}^{R,F,G} \tag{117}$$

and

$$\widehat{mc}_{D,t}^{R,F} = \kappa_D^{R,F}\widehat{mc}_{D,t}^{R,F,G} + \left(1 - \kappa_D^{R,F}\right)\widehat{w}_t - \widehat{z}_{D,t}^{R,F} \tag{118}$$

and

$$\widehat{mc}_{D,t}^{R,F,G} = \widehat{p}_{D,t}^{Y*} + \widehat{\tau}_t + \delta_D^R\left(\widehat{i}_t + \widehat{\mu}_t\right) \tag{119}$$

Using to the equations used to depict the market clearing, profit maximization and inventories, we have:

$$\widehat{l}_{D,t}^{R,F} = \left(\frac{S_D^{R,F}}{L_D^{R,F}}\right)\widehat{s}_{D,t-1}^{R,F} + \left(\frac{Y_D^{R,F}}{L_D^{R,F}}\right)\widehat{y}_{D,t}^{R,F} \tag{120}$$

and

$$\widehat{l}^{R,F}_{D,t} = \left(\frac{S^{R,F}_D}{L^{R,F}_D}\right)\widehat{s}^{R,F}_{D,t} + \left(\frac{Q^{R,F}_D}{L^{R,F}_D}\right)\widehat{q}^{R,F}_{D,t} \tag{121}$$

and

$$\widehat{q}^{R,F}_{D,t} = \widehat{c}^{F}_{D,t} + \omega^{R,F}_D \widehat{l}^{R,F}_{D,t} \tag{122}$$

which can be combined to have:

$$\widehat{y}^{R,F}_{D,t} = s_1 \widehat{s}^{R,F}_{D,t} - s_2 \widehat{s}^{R,F}_{D,t-1} + \frac{s_1}{s_2}\widehat{c}^{F}_{D,t} \tag{123}$$

where $s_1 = \left(\left(1 - \left(1 - \frac{S^{R,F}_D}{L^{R,F}_D}\right)\omega^{R,F}_D\right)\left(\frac{L^{R,F}_D}{S^{R,F}_D} - 1\right)\right)^{-1}$ and $s_2 = \frac{S^{R,F}_D}{L^{R,F}_D - S^{R,F}_D}$. Also using the demand-side expressions for $\widehat{c}^{F}_{D,t}$ and $\widehat{c}^{F}_{t}$ given by Equations 64 and 68, a final expression for $\widehat{im}_{D,t}$ can be found as follows:

$$\begin{aligned}
\underbrace{\widehat{im}_{D,t}}_{\text{Durable Imports Data}} &= \underbrace{\frac{G^F_D}{IM_D}\widehat{g}^{F}_{D,t}}_{\text{Intermediate Inputs}} + \underbrace{\left(1 - \frac{G^F_D}{IM_D}\right)\left(s_1 \widehat{s}^{R,F}_{D,t} - s_2 \widehat{s}^{R,F}_{D,t-1}\right)}_{\text{Retail Inventories}} \qquad (124) \\
&+ \underbrace{\left(1 - \frac{G^F_D}{IM_D}\right)\left(\kappa^{R,F}_D - 1\right)\widehat{\tau}_t}_{\text{Protectionist Policies}} + \underbrace{\left(1 - \frac{G^F_D}{IM_D}\right)\left(\kappa^{R,F}_D - 1\right)\delta^R_D\left(\widehat{i}_t + \widehat{\mu}_t\right)}_{\text{Trade Finance}} \\
&- \underbrace{\left(1 - \frac{G^F_D}{IM_D}\right)\widehat{z}^{R,F}_{D,t}}_{\text{Productivity Shocks}} + \underbrace{\left(1 - \frac{G^F_D}{IM_D}\right)\frac{s_1}{s_2}\left(\widehat{\gamma}^F_t + \widehat{\gamma}^F_{D,t}\right)}_{\text{Demand Shocks}} \\
&+ \underbrace{\left(1 - \frac{G^F_D}{IM_D}\right)\left(\begin{array}{c} \frac{s_1}{s_2}\left(-\theta^F \widehat{p}^F_{D,t} + \theta^F \widehat{p}^F_t - \theta \widehat{p}^F_t + \theta \widehat{p}_t + \widehat{c}_t\right) \\ + \left(\kappa^{R,F}_D - 1\right)\left(\widehat{p}^{Y*}_{D,t} - \widehat{w}_t\right) \end{array}\right)}_{\text{Implications of the Model excluding GTC Stories and Shocks}}
\end{aligned}$$

Using this expression, the durable wedge is defined as the difference between "Durable Imports Data" and "Implications of the Model excluding GTC Stories:"

$$\underbrace{\widehat{tw}_{D,t}}_{\text{Durable Imports Data}} = \underbrace{\widehat{im}_{D,t}}_{\text{Durable Imports Data}} \underbrace{-\left(1-\frac{G_D^F}{IM_D}\right)\left(\begin{array}{c} \frac{s_1}{s_2}\left(-\theta^F\widehat{p}_{D,t}^F+\theta^F\widehat{p}_t^F-\theta\widehat{p}_t^F+\theta\widehat{p}_t+\widehat{c}_t\right) \\ +\left(\kappa_D^{R,F}-1\right)\left(\widehat{p}_{D,t}^{Y*}-\widehat{w}_t\right) \end{array}\right)}_{\text{Implications of the Model excluding GTC Stories}} \tag{125}$$

The combination of the last two expressions imply Equation 55 in the main text.

6.4.2 Decomposition of the Nondurable Wedge

The decomposition of the nondurable wedge is achieved by exactly the same functional form as in the durable wedge, where subscripts D's are replaced with ND's

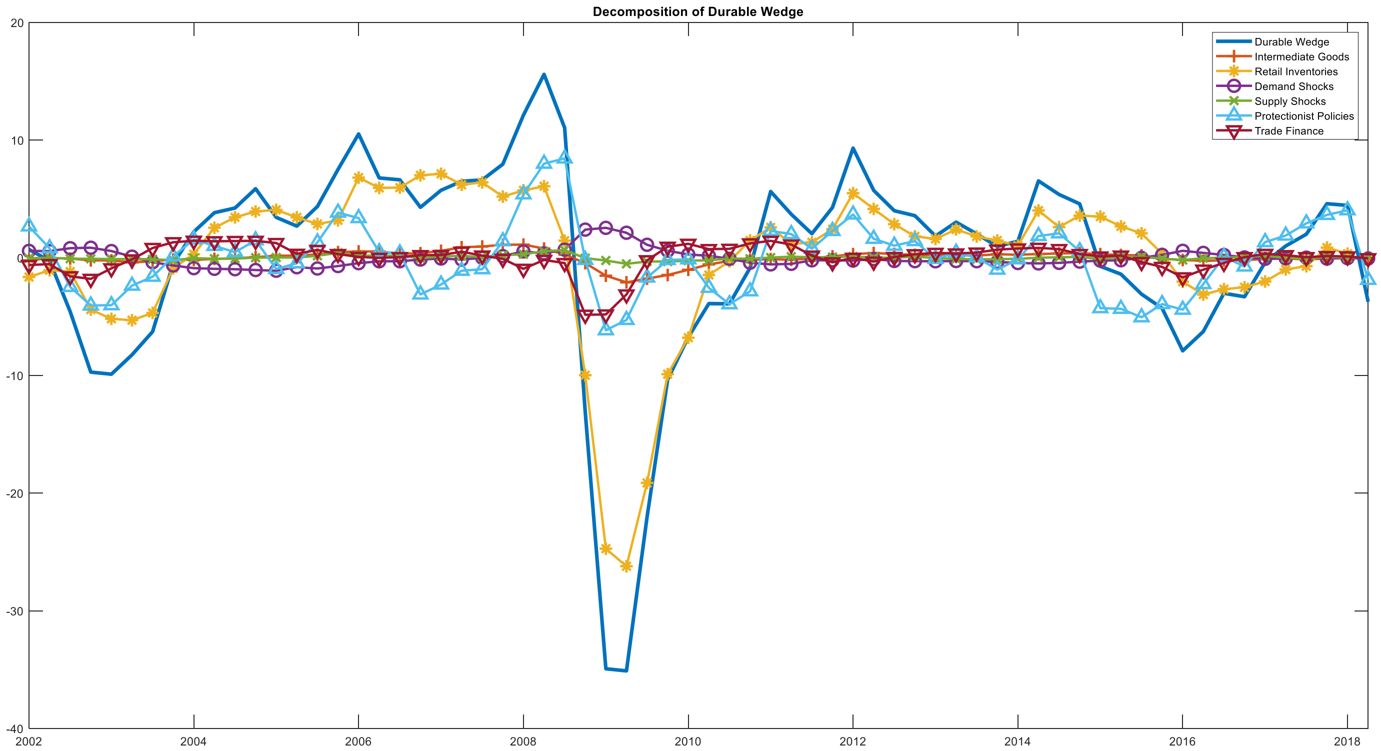
6.4.3 Decomposition of the Trade Wedge

In order to calculate the trade wedge, log linearized total *real* imports given by the following expression is used:

$$\widehat{im}_t = \frac{IM_D}{IM}\widehat{im}_{D,t} + \frac{IM_{ND}}{IM}\widehat{im}_{ND,t} \tag{126}$$

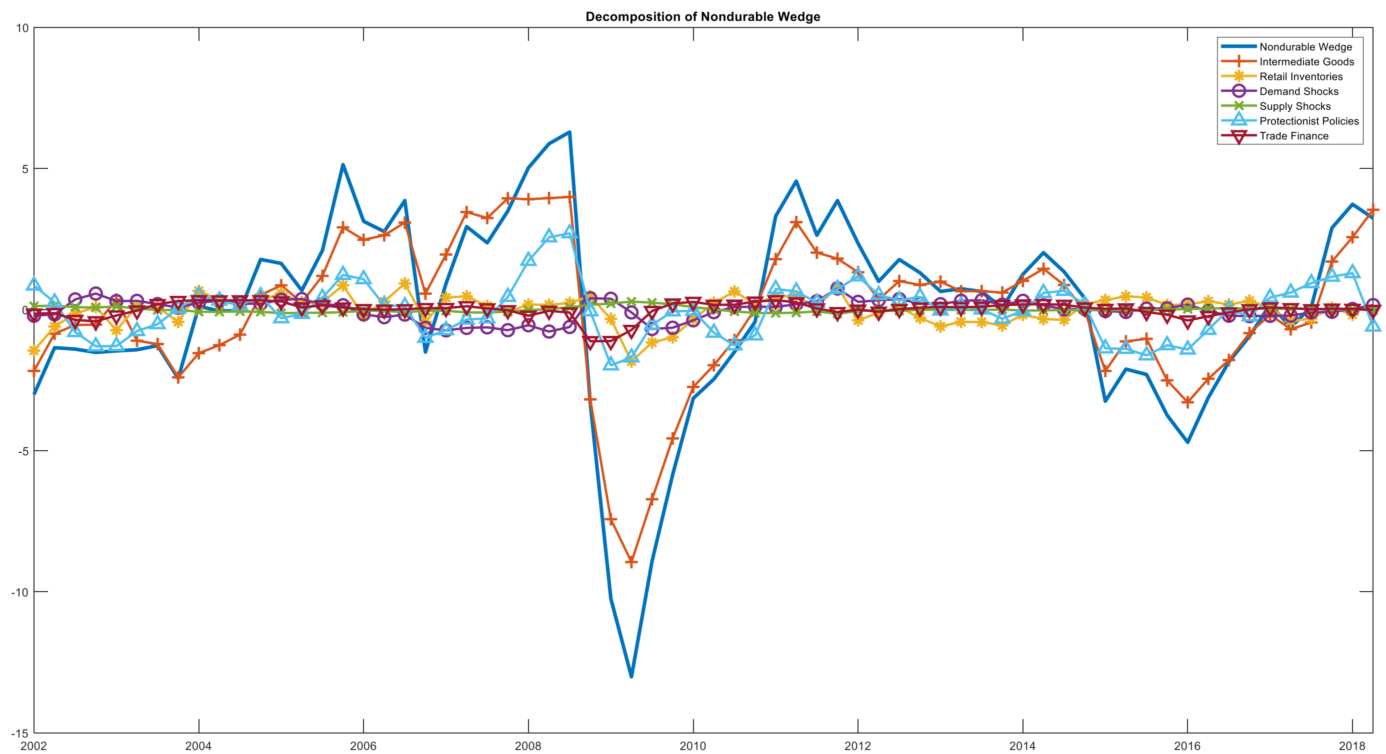
where $\frac{IM_D}{IM} = 0.552$ according to the long-run average of $\frac{IM_{D,t}}{IM_t}$ implied by the data introduced above. Using the decomposition of the durable and nondurable wedges given by the functional form in Equation 55, the trade wedge is decomposed as the weighted average of the stories contributing to the durable and nondurable wedges (with $\frac{IM_D}{IM}$ and $\frac{IM_{ND}}{IM} = 1 - \frac{IM_D}{IM}$ acting as weights).

Figure 1 – Decomposition of the Durable Wedge



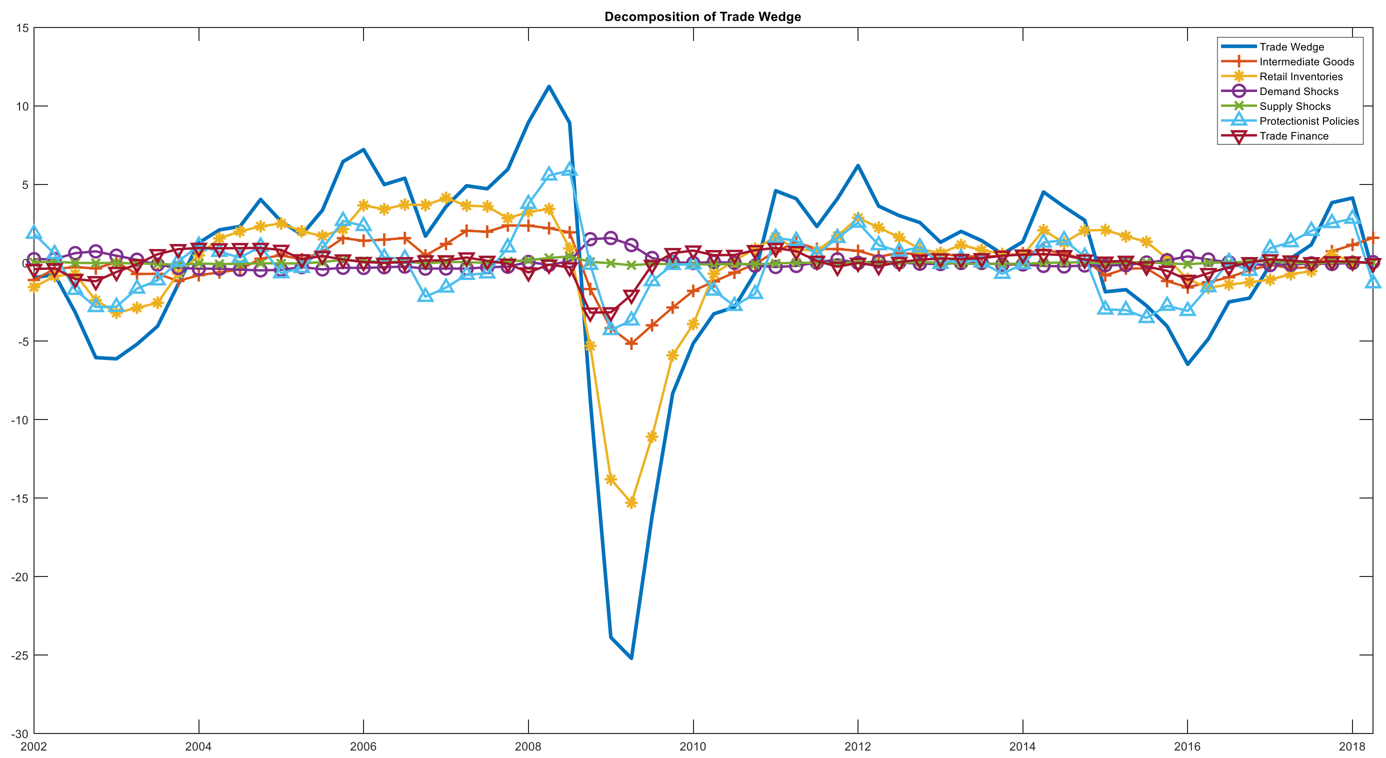
Notes: The durable wedge is calculated as the percentage difference between data on durable imports and their fitted value calculated by the complete DSGE model, excluding the stories explaining the Great Trade Collapse. All other variables are implications of the estimated model.

Figure 2 – Decomposition of the Nondurable Wedge



Notes: The nondurable wedge is calculated as the percentage difference between data on nondurable imports and their fitted value calculated by the complete DSGE model, excluding the stories explaining the Great Trade Collapse. All other variables are implications of the estimated model.

Figure 3 – Decomposition of the Trade Wedge



Notes: The trade wedge is calculated as the percentage difference between data on imports (the weighted average of durable and nondurable imports) and their fitted value calculated by the complete DSGE model, excluding the stories explaining the Great Trade Collapse. All other variables are implications of the estimated model.

Table 1 – Contribution of Competing Stories to the Collapse

	Durable Wedge	Nondurable Wedge	Trade Wedge
	-0.461	-0.193	-0.341
Contribution of			
Intermediate Inputs	-0.024	-0.129	-0.071
Retail Inventories	-0.277	-0.021	-0.162
Protectionist Policies	-0.137	-0.044	-0.095
Trade Finance	-0.027	-0.006	-0.017
Productivity Shocks	-0.012	0.002	-0.006
Demand Shocks	0.014	0.005	0.010
% Contribution of			
Intermediate Inputs	5	67	21
Retail Inventories	60	11	47
Protectionist Policies	30	23	28
Trade Finance	6	3	5
Productivity Shocks	3	-1	2
Demand Shocks	-3	-3	-3

Notes: The trade wedge, durable wedge and nondurable wedge are calculated as the percentage difference between the corresponding data and their fitted values calculated by the complete model, excluding the stories explaining the Great Trade Collapse. All other variables are implications of the estimated model. The % contribution of each story has been calculated by using the percentage change of the variable representing the story divided by the percentage of the corresponding import measure during the collapse between 2008Q3-2009Q2.

Table 2 – Contribution of Competing Stories to the Recovery

	Durable Wedge	Nondurable Wedge	Trade Wedge
	0.407	0.163	0.298
Contribution of			
Intermediate Inputs	0.020	0.107	0.059
Retail Inventories	0.288	0.023	0.169
Protectionist Policies	0.076	0.024	0.053
Trade Finance	0.046	0.011	0.030
Productivity Shocks	0.005	-0.004	0.001
Demand Shocks	-0.027	0.002	-0.014
% Contribution of			
Intermediate Inputs	5	66	20
Retail Inventories	71	14	57
Protectionist Policies	19	15	18
Trade Finance	11	6	10
Productivity Shocks	1	-2	0
Demand Shocks	-7	1	-5

Notes: The trade wedge, durable wedge and nondurable wedge are calculated as the percentage difference between the corresponding data and their fitted values calculated by the complete model, excluding the stories explaining the Great Trade Collapse. All other variables are implications of the estimated model. The % contribution of each story has been calculated by using the percentage change of the variable representing the story divided by the percentage of the corresponding import measure during the recovery between 2009Q2-20011Q1.

Appendix Table A.1 – Prior and Posterior Distributions in the Estimation

			Prior		Posterior		
Parameter	Density	Domain	Mean	Std	Mean	Lower	Upper
P^H/P	Gamma	$\Re^+$	1	0.2	0.947	0.938	0.954
P^F/P	Gamma	$\Re^+$	1	0.2	2.006	1.991	2.025
P^N/P	Gamma	$\Re^+$	1	0.2	1.345	1.339	1.353
P^{H*}/P^*	Gamma	$\Re^+$	1	0.2	1.132	1.123	1.140
P^{F*}/P^*	Gamma	$\Re^+$	1	0.2	1.292	1.287	1.297
P^{N*}/P^*	Gamma	$\Re^+$	1	0.2	2.400	2.391	2.411
P_D^H/P^H	Gamma	$\Re^+$	1	0.2	1.067	1.060	1.074
P_{ND}^H/P^H	Gamma	$\Re^+$	1	0.2	2.729	2.720	2.738
P_D^F/P^F	Gamma	$\Re^+$	1	0.2	0.794	0.784	0.803
P_{ND}^F/P^F	Gamma	$\Re^+$	1	0.2	2.313	2.299	2.331
P_D^{H*}/P^{H*}	Gamma	$\Re^+$	1	0.2	1.805	1.799	1.810
P_{ND}^{H*}/P^{H*}	Gamma	$\Re^+$	1	0.2	2.301	2.292	2.310
P_D^{F*}/P^{F*}	Gamma	$\Re^+$	1	0.2	1.227	1.218	1.236
P_{ND}^{F*}/P^{F*}	Gamma	$\Re^+$	1	0.2	2.361	2.356	2.368
C^H/C	Gamma	$\Re^+$	1	0.2	1.452	1.437	1.468
C^F/C	Gamma	$\Re^+$	1	0.2	1.104	1.089	1.115
C^N/C	Gamma	$\Re^+$	1	0.2	0.706	0.697	0.717
C^{H*}/C^*	Gamma	$\Re^+$	1	0.2	0.905	0.884	0.924
C^{F*}/C^*	Gamma	$\Re^+$	1	0.2	1.205	1.196	1.221
C^{N*}/C^*	Gamma	$\Re^+$	1	0.2	1.950	1.945	1.953
χ_p	Gamma	$\Re^+$	1	0.2	2.153	2.150	2.156
χ_n	Gamma	$\Re^+$	1	0.2	0.652	0.646	0.660
χ_p^*	Gamma	$\Re^+$	1	0.2	2.516	2.509	2.524
χ_n^*	Gamma	$\Re^+$	1	0.2	1.035	1.029	1.040
δ_D	Beta	[0,1)	0.5	0.1	0.848	0.842	0.854
δ_D^*	Beta	[0,1)	0.5	0.1	0.537	0.532	0.541
δ_{ND}	Beta	[0,1)	0.5	0.1	0.474	0.467	0.482
δ_{ND}^*	Beta	[0,1)	0.5	0.1	0.576	0.573	0.580
δ_D^R	Beta	[0,1)	0.5	0.1	0.722	0.718	0.728
δ_D^{R*}	Beta	[0,1)	0.5	0.1	0.879	0.875	0.883
δ_{ND}^R	Beta	[0,1)	0.5	0.1	0.521	0.514	0.528
δ_{ND}^{R*}	Beta	[0,1)	0.5	0.1	0.087	0.084	0.090
η_D^F	Gamma	$\Re^+$	5	1	9.976	9.905	10.048
η_D^{F*}	Gamma	$\Re^+$	5	1	13.182	13.130	13.219
η_{ND}^F	Gamma	$\Re^+$	5	1	1.788	1.745	1.841
η_{ND}^{F*}	Gamma	$\Re^+$	5	1	13.181	13.132	13.235
η_D^H	Gamma	$\Re^+$	5	1	6.959	6.904	7.010
η_D^{H*}	Gamma	$\Re^+$	5	1	13.833	13.785	13.901
η_{ND}^H	Gamma	$\Re^+$	5	1	6.277	6.165	6.388
η_{ND}^{H*}	Gamma	$\Re^+$	5	1	13.471	13.406	13.532

Appendix Table A.1 (cont'd.) – Prior and Posterior Distributions in the Estimation

			Prior		Posterior		
Parameter	Density	Domain	Mean	Std	Mean	Lower	Upper
η_D^i	Gamma	$\Re^+$	5	1	7.110	7.054	7.167
η_{ND}^i	Gamma	$\Re^+$	5	1	2.277	2.121	2.398
γ^H	Beta	[0,1)	0.25	0.05	0.221	0.217	0.225
γ^{H*}	Beta	[0,1)	0.25	0.05	0.560	0.556	0.563
γ^F	Beta	[0,1)	0.25	0.05	0.444	0.442	0.447
γ^{F*}	Beta	[0,1)	0.25	0.05	0.290	0.288	0.292
γ_D^F	Beta	[0,1)	0.5	0.1	0.581	0.574	0.590
γ_D^{F*}	Beta	[0,1)	0.5	0.1	0.737	0.735	0.738
γ_D^H	Beta	[0,1)	0.5	0.1	0.344	0.341	0.347
γ_D^{H*}	Beta	[0,1)	0.5	0.1	0.123	0.118	0.126
G_D^F/IM_D	Beta	[0,1)	0.5	0.1	0.119	0.114	0.125
$P_D^{Y*}\tau I^{\delta_D} G_D^F/IM_D^N$	Beta	[0,1)	0.5	0.1	0.117	0.111	0.122
G_{ND}^F/IM_{ND}	Beta	[0,1)	0.5	0.1	0.687	0.681	0.694
$P_{ND}^{Y*}\tau I^{\delta_{ND}} G_{ND}^F/IM_{ND}^N$	Beta	[0,1)	0.5	0.1	0.506	0.500	0.510
κ_D	Beta	[0,1)	0.5	0.1	0.498	0.493	0.503
κ_D^*	Beta	[0,1)	0.5	0.1	0.161	0.150	0.170
κ_D^G	Beta	[0,1)	0.5	0.1	0.652	0.647	0.658
κ_D^{G*}	Beta	[0,1)	0.5	0.1	0.447	0.445	0.450
κ_{ND}^G	Beta	[0,1)	0.5	0.1	0.183	0.175	0.194
κ_{ND}^{G*}	Beta	[0,1)	0.5	0.1	0.525	0.522	0.526
κ_{ND}	Beta	[0,1)	0.5	0.1	0.459	0.456	0.463
κ_{ND}^*	Beta	[0,1)	0.5	0.1	0.810	0.802	0.820
$\kappa_D^{R,F}$	Beta	[0,1)	0.5	0.1	0.048	0.047	0.048
$\kappa_D^{R,F*}$	Beta	[0,1)	0.5	0.1	0.526	0.523	0.531
$\kappa_{ND}^{R,F}$	Beta	[0,1)	0.5	0.1	0.142	0.139	0.145
$\kappa_{ND}^{R,F*}$	Beta	[0,1)	0.5	0.1	0.370	0.367	0.373
$\kappa_D^{R,H}$	Beta	[0,1)	0.5	0.1	0.653	0.645	0.662
$\kappa_D^{R,H*}$	Beta	[0,1)	0.5	0.1	0.858	0.855	0.861
$\kappa_{ND}^{R,H}$	Beta	[0,1)	0.5	0.1	0.246	0.240	0.250
$\kappa_{ND}^{R,H*}$	Beta	[0,1)	0.5	0.1	0.235	0.232	0.238
G_D^H	Gamma	$\Re^+$	1	0.2	0.318	0.306	0.331
G_D^{H*}	Gamma	$\Re^+$	1	0.2	0.227	0.215	0.239
G_{ND}^H	Gamma	$\Re^+$	1	0.2	0.384	0.377	0.393
GN_D^{H*}	Gamma	$\Re^+$	1	0.2	0.460	0.450	0.473
G_D^{F*}	Gamma	$\Re^+$	1	0.2	2.016	2.007	2.026
G_D^F	Gamma	$\Re^+$	1	0.2	1.072	1.062	1.083
G_{ND}^{F*}	Gamma	$\Re^+$	1	0.2	2.827	2.818	2.837
G_{ND}^F	Gamma	$\Re^+$	1	0.2	2.346	2.331	2.361
$G_D^{R,H}$	Gamma	$\Re^+$	1	0.2	1.643	1.628	1.662
$G_D^{R,H*}$	Gamma	$\Re^+$	1	0.2	2.556	2.552	2.562

Appendix Table A.1 (cont'd.) – Prior and Posterior Distributions in the Estimation

			Prior		Posterior		
Parameter	Density	Domain	Mean	Std	Mean	Lower	Upper
$G_{ND}^{R,H}$	Gamma	$\Re^{+}$	1	0.2	0.734	0.723	0.744
$G_{ND}^{R,H*}$	Gamma	$\Re^{+}$	1	0.2	0.453	0.444	0.462
$G_{D}^{R,F*}$	Gamma	$\Re^{+}$	1	0.2	1.071	1.062	1.082
$G_{D}^{R,F}$	Gamma	$\Re^{+}$	1	0.2	0.725	0.716	0.734
$G_{ND}^{R,F*}$	Gamma	$\Re^{+}$	1	0.2	1.905	1.892	1.917
$G_{ND}^{R,F}$	Gamma	$\Re^{+}$	1	0.2	1.765	1.756	1.774
ϱ	Gamma	$\Re^{+}$	1	0.2	0.939	0.932	0.946
ϱ^{*}	Gamma	$\Re^{+}$	1	0.2	2.555	2.540	2.571
N_{D}	Gamma	$\Re^{+}$	1	0.2	1.645	1.635	1.657
N_{D}^{*}	Gamma	$\Re^{+}$	1	0.2	2.729	2.720	2.737
N_{ND}	Gamma	$\Re^{+}$	1	0.2	1.611	1.598	1.626
N_{ND}^{*}	Gamma	$\Re^{+}$	1	0.2	1.897	1.884	1.910
$N_{D}^{R,H}$	Gamma	$\Re^{+}$	1	0.2	1.668	1.662	1.675
$N_{D}^{R,H*}$	Gamma	$\Re^{+}$	1	0.2	1.455	1.445	1.466
$N_{D}^{R,F}$	Gamma	$\Re^{+}$	1	0.2	1.914	1.908	1.920
$N_{D}^{R,F*}$	Gamma	$\Re^{+}$	1	0.2	0.568	0.557	0.576
$N_{ND}^{R,H}$	Gamma	$\Re^{+}$	1	0.2	1.734	1.724	1.745
$N_{ND}^{R,H*}$	Gamma	$\Re^{+}$	1	0.2	1.346	1.334	1.355
$N_{ND}^{R,F}$	Gamma	$\Re^{+}$	1	0.2	2.123	2.117	2.129
$N_{ND}^{R,F*}$	Gamma	$\Re^{+}$	1	0.2	0.394	0.385	0.404
N^{N}	Gamma	$\Re^{+}$	1	0.2	2.660	2.646	2.674
N^{N*}	Gamma	$\Re^{+}$	1	0.2	2.399	2.392	2.408
ω_{D}	Beta	[0,1)	0.5	0.1	0.433	0.430	0.437
ω_{D}^{*}	Beta	[0,1)	0.5	0.1	0.469	0.466	0.471
ω_{ND}	Beta	[0,1)	0.5	0.1	0.174	0.167	0.180
ω_{ND}^{*}	Beta	[0,1)	0.5	0.1	0.594	0.587	0.601
$\omega_{D}^{R,F}$	Beta	[0,1)	0.5	0.1	0.112	0.108	0.117
$\omega_{D}^{R,F*}$	Beta	[0,1)	0.5	0.1	0.380	0.372	0.388
$\omega_{ND}^{R,F}$	Beta	[0,1)	0.5	0.1	0.688	0.685	0.692
$\omega_{ND}^{R,F*}$	Beta	[0,1)	0.5	0.1	0.266	0.260	0.272
$\omega_{D}^{R,H}$	Beta	[0,1)	0.5	0.1	0.092	0.091	0.095
$\omega_{D}^{R,H*}$	Beta	[0,1)	0.5	0.1	0.713	0.707	0.718
$\omega_{ND}^{R,H}$	Beta	[0,1)	0.5	0.1	0.436	0.434	0.438
$\omega_{ND}^{R,H*}$	Beta	[0,1)	0.5	0.1	0.415	0.412	0.419
$\rho(\gamma^{F})$	Beta	[0,1)	0.8	0.1	0.805	0.797	0.815
$\rho(\gamma_{D}^{F})$	Beta	[0,1)	0.8	0.1	0.863	0.858	0.866
$\rho(\gamma_{D}^{F*})$	Beta	[0,1)	0.8	0.1	0.590	0.586	0.595
$\rho(\gamma^{F*})$	Beta	[0,1)	0.8	0.1	0.773	0.769	0.778
$\rho(\gamma^{H})$	Beta	[0,1)	0.8	0.1	0.477	0.471	0.483
$\rho(\gamma_{D}^{H})$	Beta	[0,1)	0.8	0.1	0.504	0.498	0.509

Appendix Table A.1 (cont'd.) – Prior and Posterior Distributions in the Estimation

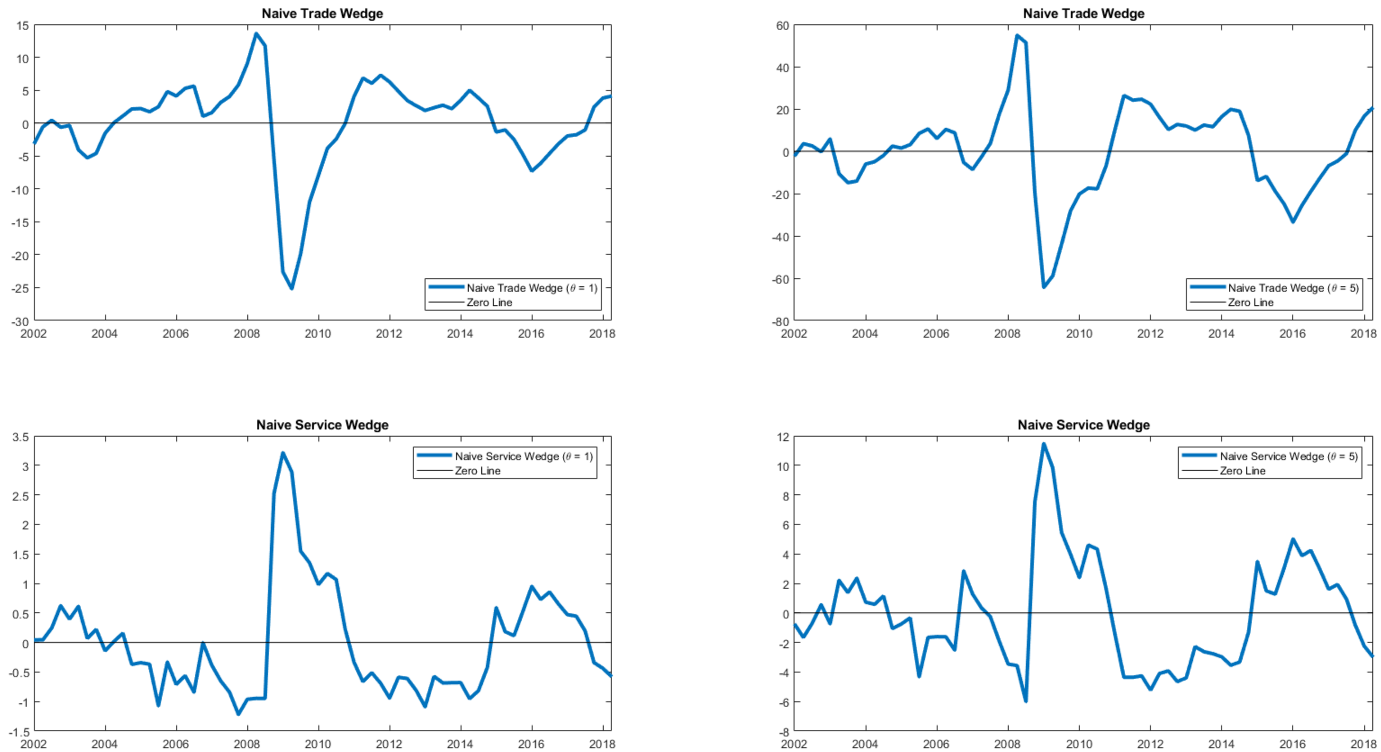
			Prior		Posterior		
Parameter	Density	Domain	Mean	Std	Mean	Lower	Upper
$\rho(\gamma_D^{H*})$	Beta	[0,1)	0.8	0.1	0.291	0.286	0.297
$\rho(\gamma^{H*})$	Beta	[0,1)	0.8	0.1	0.334	0.327	0.342
$\rho(\tau)$	Beta	[0,1)	0.8	0.1	0.753	0.749	0.756
$\rho(\tau^*)$	Beta	[0,1)	0.8	0.1	0.962	0.954	0.973
$\rho(v^i)$	Beta	[0,1)	0.8	0.1	0.748	0.741	0.755
$\rho(v^{i*})$	Beta	[0,1)	0.8	0.1	0.441	0.437	0.448
$\rho(z_D)$	Beta	[0,1)	0.8	0.1	0.515	0.511	0.519
$\rho(z_D^*)$	Beta	[0,1)	0.8	0.1	0.764	0.759	0.769
$\rho(z^N)$	Beta	[0,1)	0.8	0.1	0.229	0.221	0.237
$\rho(z_{ND})$	Beta	[0,1)	0.8	0.1	0.757	0.752	0.761
$\rho(z_{ND}^*)$	Beta	[0,1)	0.8	0.1	0.469	0.466	0.471
$\rho(z^{N*})$	Beta	[0,1)	0.8	0.1	0.420	0.417	0.424
$\rho(z_D^{R,F})$	Beta	[0,1)	0.8	0.1	0.221	0.215	0.228
$\rho(z_D^{R,F*})$	Beta	[0,1)	0.8	0.1	0.186	0.182	0.189
$\rho(z_{ND}^{R,F})$	Beta	[0,1)	0.8	0.1	0.730	0.726	0.733
$\rho(z_{ND}^{R,F*})$	Beta	[0,1)	0.8	0.1	0.501	0.493	0.507
$\rho(z_D^{R,H})$	Beta	[0,1)	0.8	0.1	0.852	0.850	0.855
$\rho(z_D^{R,H*})$	Beta	[0,1)	0.8	0.1	0.950	0.942	0.959
$\rho(z_{ND}^{R,H})$	Beta	[0,1)	0.8	0.1	0.314	0.309	0.317
$\rho(z_{ND}^{R,H*})$	Beta	[0,1)	0.8	0.1	0.383	0.380	0.385
$-400 \times log(\beta)$	Gamma	$\mathfrak{R}^+$	2.5	0.5	1.575	1.542	1.610
S_D^*/L_D^*	Beta	[0,1)	0.5	0.1	0.629	0.623	0.637
S_{ND}^*/L_{ND}^*	Beta	[0,1)	0.5	0.1	0.377	0.372	0.381
S_D/L_D	Beta	[0,1)	0.5	0.1	0.475	0.467	0.483
S_{ND}/L_{ND}	Beta	[0,1)	0.5	0.1	0.097	0.094	0.100
$S_D^{R,H}/L_D^{R,H}$	Beta	[0,1)	0.5	0.1	0.862	0.857	0.869
$S_D^{R,F}/L_D^{R,F}$	Beta	[0,1)	0.5	0.1	0.773	0.770	0.775
$S_{ND}^{R,H}/L_{ND}^{R,H}$	Beta	[0,1)	0.5	0.1	0.235	0.225	0.243
$S_{ND}^{R,F}/L_{ND}^{R,F}$	Beta	[0,1)	0.5	0.1	0.122	0.118	0.126
$S_D^{R,H*}/L_D^{R,H*}$	Beta	[0,1)	0.5	0.1	0.926	0.920	0.932
$S_D^{R,F*}/L_D^{R,F*}$	Beta	[0,1)	0.5	0.1	0.121	0.114	0.127
$S_{ND}^{R,H}/L_{ND}^{R,H}$	Beta	[0,1)	0.5	0.1	0.086	0.084	0.089
$S_{ND}^{R,F}/L_{ND}^{R,F}$	Beta	[0,1)	0.5	0.1	0.772	0.769	0.774
θ	Gamma	$\mathfrak{R}^+$	2.5	0.5	1.047	1.043	1.052
θ^F	Gamma	$\mathfrak{R}^+$	2.5	0.5	4.405	4.394	4.416
θ^{F*}	Gamma	$\mathfrak{R}^+$	2.5	0.5	2.912	2.902	2.920
θ^H	Gamma	$\mathfrak{R}^+$	2.5	0.5	2.621	2.590	2.649
θ^{H*}	Gamma	$\mathfrak{R}^+$	2.5	0.5	6.533	6.526	6.540
θ^*	Gamma	$\mathfrak{R}^+$	2.5	0.5	3.672	3.645	3.716
υ	Gamma	$\mathfrak{R}^+$	1	0.2	1.998	1.991	2.005

Appendix Table A.1 (cont'd.) – Prior and Posterior Distributions in the Estimation

Parameter	Density	Domain	Prior		Posterior		
			Mean	Std	Mean	Lower	Upper
υ^*	Gamma	$\Re^+$	1	0.2	0.357	0.353	0.360
$S_D^{R,H}$	Gamma	$\Re^+$	1	0.2	1.636	1.617	1.654
$S_{ND}^{R,H}$	Gamma	$\Re^+$	1	0.2	1.265	1.250	1.279
$S_D^{R,F}$	Gamma	$\Re^+$	1	0.2	1.579	1.571	1.586
$S_{ND}^{R,F}$	Gamma	$\Re^+$	1	0.2	0.886	0.871	0.902
$\sigma(\gamma^H)$	InvGamma	$\Re^+$	0.01	2	0.004	0.003	0.004
$\sigma(\gamma^F)$	InvGamma	$\Re^+$	0.01	2	0.003	0.003	0.003
$\sigma(z_D)$	InvGamma	$\Re^+$	0.01	2	0.003	0.003	0.004
$\sigma(z_{ND})$	InvGamma	$\Re^+$	0.01	2	0.019	0.017	0.021
$\sigma(z_D^{R,H})$	InvGamma	$\Re^+$	0.01	2	0.020	0.018	0.023
$\sigma(z_{ND}^{R,H})$	InvGamma	$\Re^+$	0.01	2	0.005	0.004	0.005
$\sigma(z_D^{R,F})$	InvGamma	$\Re^+$	0.01	2	0.003	0.002	0.003
$\sigma(z_{ND}^{R,F})$	InvGamma	$\Re^+$	0.01	2	0.002	0.002	0.003
$\sigma(z^N)$	InvGamma	$\Re^+$	0.01	2	0.004	0.003	0.004
$\sigma(\tau)$	InvGamma	$\Re^+$	0.01	2	0.026	0.022	0.029
$\sigma(\upsilon^i)$	InvGamma	$\Re^+$	0.01	2	0.027	0.023	0.030
$\sigma(\gamma^{H*})$	InvGamma	$\Re^+$	0.01	2	0.019	0.016	0.022
$\sigma(\gamma^{F*})$	InvGamma	$\Re^+$	0.01	2	0.044	0.035	0.054
$\sigma(z_D^*)$	InvGamma	$\Re^+$	0.01	2	0.005	0.003	0.006
$\sigma(z_{ND}^*)$	InvGamma	$\Re^+$	0.01	2	0.029	0.024	0.034
$\sigma(z_D^{R,H*})$	InvGamma	$\Re^+$	0.01	2	0.006	0.004	0.008
$\sigma(z_{ND}^{R,H*})$	InvGamma	$\Re^+$	0.01	2	0.005	0.003	0.007
$\sigma(z_D^{R,F*})$	InvGamma	$\Re^+$	0.01	2	0.042	0.033	0.049
$(z_{ND}^{R,F*})$	InvGamma	$\Re^+$	0.01	2	0.013	0.011	0.015
$\sigma(z^{N*})$	InvGamma	$\Re^+$	0.01	2	0.006	0.003	0.008
$\sigma(\tau^*)$	InvGamma	$\Re^+$	0.01	2	0.012	0.008	0.016
$\sigma(\upsilon^{i*})$	InvGamma	$\Re^+$	0.01	2	0.007	0.002	0.014
$\sigma(\gamma_D^H)$	InvGamma	$\Re^+$	0.01	2	0.134	0.117	0.150
$\sigma(\gamma_D^F)$	InvGamma	$\Re^+$	0.01	2	0.003	0.002	0.003
$\sigma(\gamma_D^{H*})$	InvGamma	$\Re^+$	0.01	2	0.018	0.003	0.037
$\sigma(\gamma_D^{F*})$	InvGamma	$\Re^+$	0.01	2	0.009	0.002	0.015

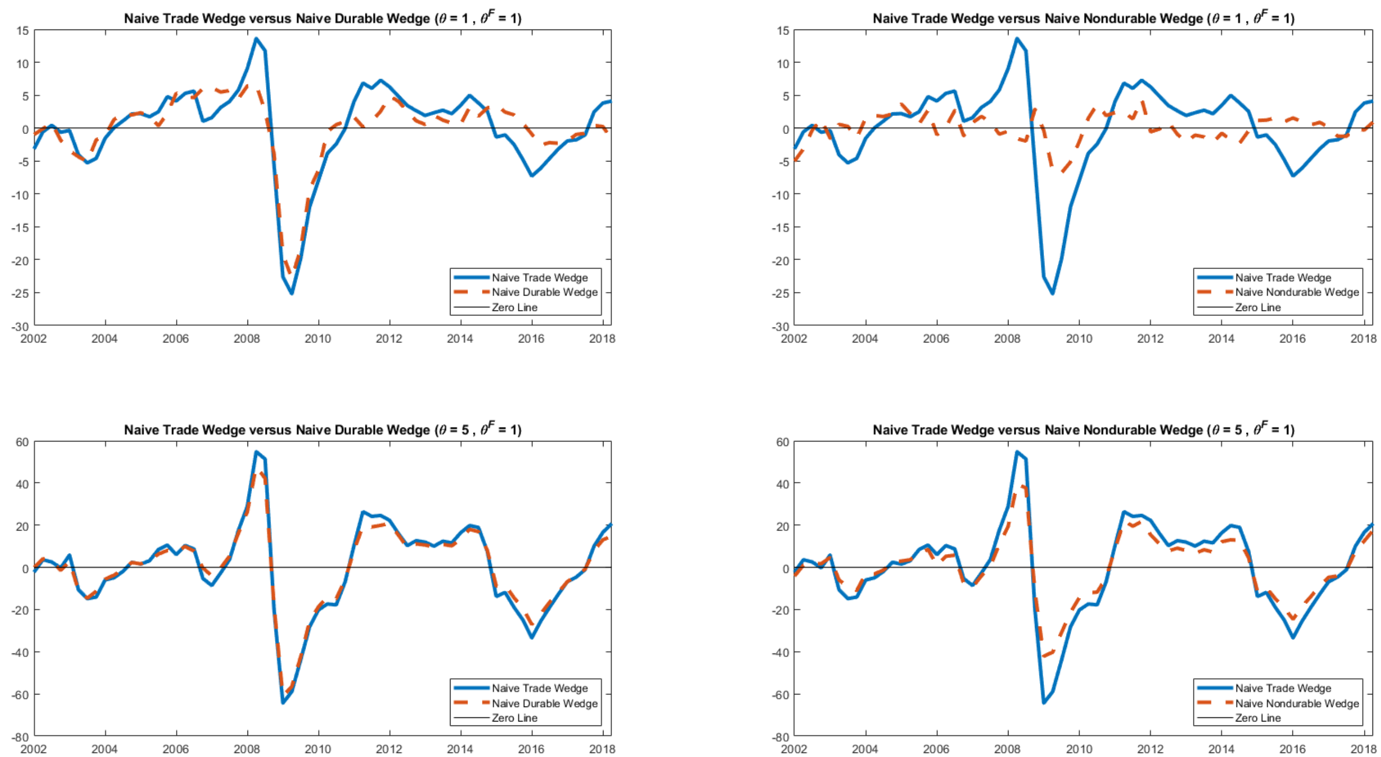
Notes: Std represents the standard deviation, while lower and upper represent the bounds of the 90% highest probability density interval.

Appendix Figure A.1 – Naïve Trade Wedge



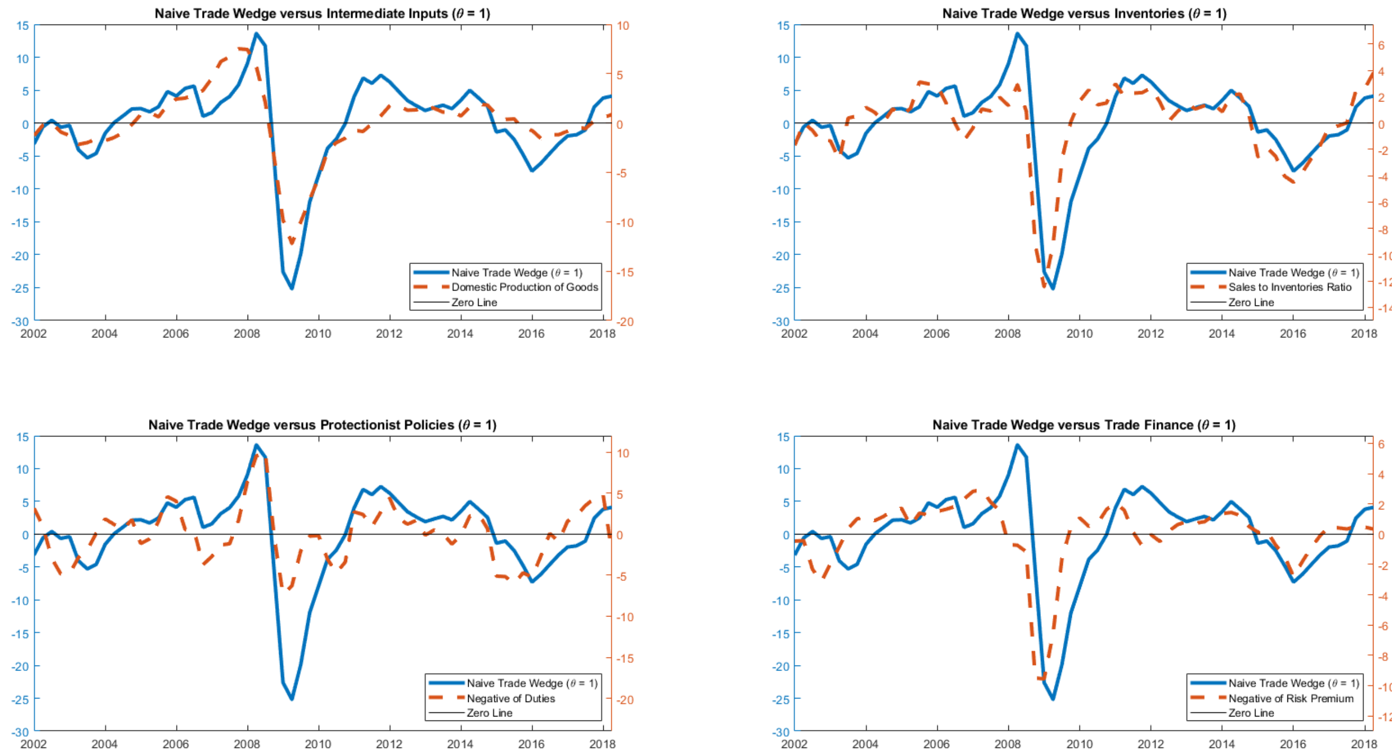
Notes: The naïve trade wedge is calculated as the percentage difference between data on imports (the weighted average of durable and nondurable imports) and their fitted value calculated by using only the demand side of the model. The naïve service wedge is calculated as the percentage difference between data on consumption of services and their fitted value calculated by using only the demand side of the model. Data are described in the Data Appendix.

Appendix Figure A.2 – Naïve Durable versus Naïve Nondurable Wedges



Notes: The naïve durable wedge is calculated as the percentage difference between data on imported durables and their fitted value calculated by using only the demand side of the model. The naïve nondurable wedge is calculated as the percentage difference between data on imported nondurables and their fitted value calculated by using only the demand side of the model. Data are described in the Data Appendix.

Appendix Figure A.3 – Naïve Trade Wedge and Competing Stories ($\theta = 1$)



Notes: The naïve trade wedge is the same as in Appendix Figure A.1. The naïve trade wedge is represented by the left vertical axes, while other variables are represented by the right vertical axes. Data are described in the Data Appendix.

Appendix Figure A.4 – Naïve Trade Wedge and Competing Stories ($\theta = 5$)

Notes: The naïve trade wedge is the same as in Appendix Figure A.1. The naïve trade wedge is represented by the left vertical axes, while other variables are represented by the right vertical axes. Data are described in the Data Appendix.