Technical Appendix to “Protectionism and the Business Cycle”

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Abstract
This Appendix gathers supplementary material to Barattieri, Cacciatore, and Ghironi (2019).

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A Data Description

Here we describe in detail the variables used in Section 2 of the main paper as well as in Appendix B below.

**Antidumping Initiatives.** Our baseline measure of antidumping initiatives is the number of HS-6 products affected by new antidumping investigations in a given quarter or month. The data come from the Global Antidumping Database (Bown, 2016). We match the date of each anti-dumping investigation recorded in the GAD to the number of HS-6 products covered by each investigation.

**Tariffs.** In the panel VAR, we use data from the UN-WITS Database. We aggregate HS-2 product-level applied tariff rates using an import-weighted average of tariffs for each country and year. In our baseline specification, we use constant weights (using imports data for the year 1999). We linearly detrend the tariff measure for each country.

**Real GDP.** In the quarterly VAR, we use data from the OECD quarterly national account database. We use the measure VPVOBARSA (U.S. dollars, volume estimates, fixed PPPs, OECD reference year 2010, annual levels, seasonally adjusted). In the panel VAR, we use data from the World Bank World Developing Indicators. Annual GDP is measured in 2010 USD.

**Inflation.** For the quarterly and monthly VARs, we use the Core CPI Inflation series (“All Items, Less Food and Energy”) provided by the OECD prices database for Turkey and Canada. For India, only CPI Inflation (“All Items”) is available. Since these series are not seasonally adjusted, we deseasonalize each series by regressing the inflation rate on quarterly (monthly) dummies. Moreover, in Turkey, there is a clear regime shift before and after 2004 (Turkey announced the adoption of inflation targeting in 2002). We therefore use a regime-specific demeaned series for Turkey. In the panel VAR, we use annual CPI inflation data coming from the World Bank World Development Indicators.

**Real Net Exports.** In the quarterly VAR, exports and imports of good and services are from the OECD quarterly national account database. We use the measure VPVOBARSA (U.S. dollars, volume estimates, fixed PPPs, OECD reference year 2010, annual levels, seasonally adjusted). In the monthly VAR, we use data on exports and imports of goods from the OECD main indicator database. The data are reported in USD Billions. Thus, we deflate each series using country-specific CPI indexes. Since Indian net exports dynamics feature clear time trends, we linearly detrend the series. In the panel VAR, we construct net exports over GDP using data on exports and imports.
from the World Bank Development Indicators.

**Industrial Production.** In the monthly VAR, we use data for from the OECD main economic indicators. In the baseline VAR, we linearly detrend the series.

**Nominal Exchange Rates.** The Nominal Effective Exchange Rates is from the Bank of International Settlement. We use the growth rate of the nominal effective exchange rate, where due to the BIS convention, an increase in the rate denotes an appreciation.

**Interest Rates.** In the quarterly VAR, we use the interbank overnight interest rate provided by the OECD main economic indicators. In the monthly VAR, we use the overnight interest rate provided by the OECD main economic indicators for India and Canada. For Turkey, we use the average daily interest rate on the interbank REPO rate provided by the Bolsa Istanbul. We linearly detrend the Turkish series, since it features a clear downward trend during the sample period we consider.

**Oil Price.** The Oil price series is the Global Price of WTI Crude provided by the Federal Reserve Bank of St. Louis. The real price of oil is obtained by deflating the nominal price of oil using the U.S. CPI.

**Real GDP and Imports Forecast.** The quarterly forecast for real GDP and imports of goods and services come from the Bank of Canada’s Staff Economic Projections available at https://www.bankofcanada.ca/rates/staff-economic-projections/.

**Stock prices.** In the Granger causality test presented in Appendix B, we use the year-to-year growth of overall stock prices for Canada provided at quarterly frequency by the OECD Main Economic Indicators.

**Investment.** In the panel VAR presented in Appendix H, we use the real Annual Gross Fixed Capital Formation series (measured in 2010 USD) from the World Bank World Developing Indicators.

**Labor Productivity.** In the panel VAR presented in Appendix H, we use the Labor Productivity series from the World Bank World Developing Indicators. The series is measured as GDP per person employed (in 2011 USD PPP).

### B VAR Additional Robustness

As discussed in the main text, we conduct several robustness checks. We report the results for all the scenarios that we consider for the quarterly VAR. The results for the monthly VAR are similar and are available upon request.
Alternative Measures of Protectionism

*Antidumping Initiatives*

As explained in the main text, we consider alternative measures of antidumping initiatives. Our baseline measure does not include the products recorded at 4-digits level of disaggregation. A possible alternative approach could be imputing investigations recorded at 4-digits to all 6-digit sub-products contained in a given 4-digits sector. However, this would imply overstating the importance of such investigations—not all 6-digit products that are part of the 4-digit aggregate are necessarily subject to the investigation. As a reasonable alternative, we compute a measure where each time a product is recorded as being subject to an antidumping investigation, we count it as one, regardless of the level of disaggregation provided by the GAD database. This allows us to account for the fact that our baseline measure could miss some products effectively subject to an antidumping investigation. At the same time, this alternative measure avoids the risk of overstating the number of products subject to a new investigation.

In addition, for both the baseline measure and the alternative measure described above, we considered a version that only includes the subset of initiatives that effectively ended with the imposition of an antidumping tariff.

The results obtained using these four different measures are reported by Figures A.1. The first panel reproduces the result obtained with our baseline measure. The second panel reports the results obtained with the measure counting as one each product subject to an investigation. The third panel reports the results when the baseline measure only includes antidumping initiatives that resulted in an antidumping tariff. Finally, the fourth panel reports the results when the alternative measure only includes antidumping initiatives that resulted in an antidumping tariff. The recessionary and inflationary effects of protectionism are very robust to the alternative measures used.

*Total Temporary Trade Barriers*

As discussed in the main text, antidumping investigations account for between 80 and 90 percent of total temporary trade barriers. Here we consider a broader trade policy measure that includes all temporary trade barriers (antidumping duties, global safeguards, and countervailing duties). Figures A.2 shows that the results are very similar to those reported in the main text.
Detrended GDP

In the main text, we use the growth rate of real GDP in the quarterly VAR. Figure A.3 shows that the results are very similar when using linearly detrended GDP. An increase in the number of antidumping initiatives increases inflation and reduces output, with a modest positive effect on the trade balance over GDP.

Granger Causality Test

Table A.1 shows that the identified structural trade-policy shocks in the baseline VARs are not Granger-caused by time series that contain information about future economic conditions: the forecast of real GDP growth, the forecast of real imports growth, the oil price, and the growth rate of Canadian stock-market prices. We report the F-statistic of joint significance of the coefficients of the first two lags of each control variable.

Additional Countries: Turkey and India

We corroborate the evidence provided in the main text for Canada by using Turkish and Indian data. These two countries are the main user of antidumping initiatives among emerging countries. Institutional details about the opening of new investigations are very similar to those in Canada.\(^1\)

**Turkey**

Figure A.4 shows the evolution of AD initiatives in Turkey for the period 1994:Q1 until 2015Q:4. Overall, the picture is similar to Canada. However, there is a more pronounced increase in 2000:Q4, which predates by a year the trough of GDP following the Turkish financial crisis of 2001. As discussed below, our results are qualitatively unaffected when we restrict the Turkish sample to the period after 2002.

Figure A.5 presents the impulse responses for the quarterly VAR. The results are qualitatively identical to the estimates for Canada, although the response of macroeconomic variables is stronger. Annualized inflation rises by approximately 1.5 percent at the peak, while GDP growth declines by 0.4 percent at the trough. These heightened effects are explained by three factors. First, the size of the shock is larger, since now a one-standard deviation shock doubles the number of antidumping

\(^1\)For instance, in Turkey the industry application must represent at least 25 percent of the product’s total production. Once producers have gathered evidence about the margins of dumping, they bring the petition before the board. The preliminary assessment of compliance takes up to 60 days (see the Turkish Official Gazette, article 20295 on September 27, 1989).
initiatives. Second, the imposed tariffs remain in place longer (at least six and a half years). Third, in our sample, the cycle of the Turkish economy is five times more volatile than Canada, implying larger responses to macroeconomic shocks—the standard deviation of GDP growth is about 2.7 percent in Turkey and 0.6 percent in Canada. Moreover, in Turkey, the annualized average inflation rate between 1994 and 2002 was approximately 75 percent.\footnote{This suggests that real frictions imply a stronger propagation of aggregate shocks in Turkey. When we restrict the Turkish sample to the period after 2002:Q1, the magnitude of the responses becomes similar to those for Canada. This finding reflects the substantial decline in aggregate volatility in the Turkish economy brought about by the adoption of inflation targeting and far-reaching reforms in the financial sector following the financial crisis of 2001.} This suggests that real frictions imply a stronger propagation of aggregate shocks in Turkey. When we restrict the Turkish sample to the period after 2002:Q1, the magnitude of the responses becomes similar to those for Canada. This finding reflects the substantial decline in aggregate volatility in the Turkish economy brought about by the adoption of inflation targeting and far-reaching reforms in the financial sector following the financial crisis of 2001.\footnote{In May 2001, the Banking Regulation and Supervision Agency initiated a comprehensive restructuring program for the banking system. In January 2002, Turkey adopted inflation targeting.}

Figure A.6 presents the estimates for the monthly VAR. The increased number of observations also allows us to control for the role of macroeconomic developments that characterize the Turkish economy in the early 2000s. In particular, we restrict the sample to the post-2004 period. The period of analysis is hence 2004:M1-2015M:12. Similarly to the quarterly VAR, an increase in antidumping initiations results in higher inflation, and the response remains positive for the first four months. A second positive and significant peak occurs at the seventh month. Industrial production declines for seven months with a decline of about 0.5 percent at the trough. Real net exports display a modest increase. The nominal exchange rate, after an initial depreciation, displays a persistent appreciation, with a significant peak at the seventh month. By contrast, the response of the interest rate is not significant.

India

Figure A.7 shows the evolution of AD initiatives in India from 1996:Q2 to 2015:Q4, while Figure A.8 reports the VAR results using quarterly data.\footnote{The choice of the sample period is due to data availability.} Following the trade policy shock, there is a statistically significant decline in real GDP. Net exports over GDP increase, while we do not find a significant inflationary effect. It is important to stress, however, that data limitations imply that only a series for headline inflation (as opposed to core inflation) is available. In Figure A.9 we...
report the results obtained using monthly data. Also in this case, the results are similar to those obtained for Canada and Turkey: protectionism triggers a fall in industrial production, increasing net exports over GDP. Inflation, as in the VAR with quarterly data, at first decreases (though the fall is not significant) and then slowly rises to a positive and significant peak that is reached after 6 months.

C Panel VAR: Imports and Exports Dynamics

Figure A.10 reports impulse responses from the panel-VAR including (linearly detrended) real imports and exports. The figure shows that following a tariff increase, both imports and exports decrease. However, the decline in imports is stronger than the decline in exports.

D Model Equilibrium Conditions

Demand Schedules

The demand for tradables is $C^T_t = (1 - \alpha_N) \left( \frac{P^T_t}{P_t} \right)^{-\phi_N} C_t$; the demand for non-tradables is $C^N_t = \alpha_N \left( \frac{P^N_t}{P_t} \right)^{-\phi_N} C_t$. Home demand for domestic tradable consumption is $C^*_{DT,t} = (1 - \alpha_X) \left( \frac{P^*_{DT,t}}{P^T_t} \right)^{-\phi_T} C^T_t$, while the demand for the imported bundle is $C^*_{DX,t} = \alpha_X \left( \frac{P^*_{DX,t}}{P^T_t} \right)^{-\phi_T} C^T_t$. Finally, Home demand for a domestic tradable variety is $C^*_{DX,t} = \frac{1 + \tau^{IM}_t}{1 + \tau^{IM*}_t} \left( \frac{P^*_{X,t}}{P^T_t} \right)^{-\phi_T} C^T_t$, while the demand for a Foreign tradable product is $C^*_{DX,t} = \frac{1 + \tau^{IM*}_t}{1 + \tau^{IM}_t} \left( \frac{P^*_{X,t}}{P^T_t} \right)^{-\phi_T} C^T_t$.

Model Aggregation

Home domestic demand is $Y^T_{DT,t} (z) = \left( \frac{P^T_{DT,t} (z)}{P^T_{DT,t}} \right)^{-\theta_T} Y^T_{DT,t}$, while export demand is

$$Y^T_{DX,t} (z) = \left[ \left( \frac{1 + \tau^{IM*}_t}{1 + \tau^{IM}_t} \right) \frac{P^T_{X,t} (z)}{P^T_{X,t}} \right]^{-\theta_T} Y^T_{DX,t},$$

where $\tau^{IM*}_t \geq 0$ is an ad-valorem import tariff imposed by Foreign. The terms $Y^T_{DT,t}$ and $Y^T_{DX,t}$ denote, respectively, Home and Foreign aggregate demand of the basket of Home tradable goods.

Due to the fixed export cost, firms with low productivity levels $z$ may decide not to export in any given period. When making this decision, a firm decomposes its total real profit $d^T_t (z)$ into portions earned from domestic sales, $d^T_{DT,t} (z)$, and from potential export sales, $d^T_{DX,t} (z)$. These profit levels,

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5The period covered is 1995:Q5 to 2015:Q2, due to the limited availability of the industrial production series from the OECD.
expressed in units of Home consumption, are given by the following expressions:

\[
d_T^D(z) \equiv \left( \rho_T^D(z) - \frac{\varphi_t}{z} \right) Y_T^D(z),
\]

and

\[
d_T^X(z) \equiv \left[ Q_t \rho_T^X(z) - (1 + \tau_t) \frac{\varphi_t}{z} \right] Y_T^X(z) - \varphi_t f_X t.
\]

A firm will export if and only if the expected profit from exporting is non-negative. This will be the case as long as productivity \(z\) is above a cutoff level \(z_{X,t}\) such that: \(z_{X,t} = \inf \{ z : d_T^X(z) > 0 \}\). We assume that the lower-bound productivity \(z_{\text{min}}\) is low enough relative to the export costs that \(z_{X,t}\) is above \(z_{\text{min}}\). Firms with productivity levels between \(z_{\text{min}}\) and the export cutoff level \(z_{X,t}\) produce only for their domestic market in period \(t\). The set of exporting firms fluctuates over time with changes in the profitability of export.

In every period, a mass \(N_{D,t}\) of tradable-sector firms produces in the Home country. Among these firms, there are \(N_{X,t} = [1 - G(z_{X,t})] N_{D,t}\) exporters. As in Melitz (2003) and Ghironi and Melitz (2005), all the information on the distribution of productivity levels \(G(z)\) that is relevant for aggregate outcomes can be summarized by appropriately defined average productivity levels. Define an average productivity level \(\bar{z}_D\) for all producing firms that serve the domestic market and an average \(\bar{z}_{X,t}\) for all Home exporters:

\[
\bar{z}_D \equiv \left[ \int_{z_{\text{min}}}^{\infty} z \theta_T^{-1} dG(z) \right]^{1/(\theta_T - 1)}, \quad \bar{z}_{X,t} \equiv \left[ \frac{1}{1 - G(z_{X,t})} \int_{z_{X,t}}^{\infty} z \theta_T^{-1} dG(z) \right]^{1/(\theta_T - 1)},
\]

where \(\bar{z}_D\) and \(\bar{z}_{X,t}\) are based on weights proportional to relative firm output shares. The model can be restated in terms of average (representative) firms. The average price of Home firms in their domestic market is \(\bar{\rho}_{D,t} \equiv \rho_T^D(\bar{z}_D)\), while the average price of Home exports is \(\bar{\rho}_{X,t} \equiv \rho_T^X(\bar{z}_{X,t})\). Average domestic tradable output is \(\bar{Y}_{D,t} = \left( \bar{\rho}_{D,t} / \rho_T^T \right) Y_{D,t}\), while average export is \(\bar{Y}_{X,t} = \left( \bar{\rho}_X \rho_T^X \right) Y_{X,t}^T\). The average profit from domestic sales is \(\bar{d}_{D,t}^D \equiv d_T^D(\bar{z}_D)\), while the average export profit is \(\bar{d}_{X,t}^X \equiv d_T^X(\bar{z}_{X,t})\). Thus, the average total profit of Home firms is given by \(\bar{d}_t^T = \bar{d}_{D,t}^D + (N_{X,t} / N_{D,t}) \bar{d}_{X,t}^X\).

Following Melitz (2003) and Ghironi and Melitz (2005), we assume that \(z\) is drawn from a Pareto distribution with lower bound \(z_{\text{min}}\) and shape parameter \(\kappa > \theta_T - 1\). The share of exporting firms is then given by \(N_{X,t} / N_{D,t} = (z_{\text{min}} / \bar{z}_{X,t})^\kappa \left[ (\kappa / (\kappa - \theta_T + 1)) \right]^{1/(\theta_T - 1)},\) while the zero-profit condition that determines the productivity cutoff \(z_{X,t}\) is such that \(\bar{d}_{X,t} = (\theta_T - 1) / \left[ \kappa / (\kappa - \theta_T + 1) \right] \varphi_t f_X t.\)
Equilibrium Conditions

In equilibrium, households and non-tradable firms are symmetric. Labor market clearing requires:

\[ Z_t K_t L_t^{1-\alpha} = Y_t^N + N_{DT,t} \tilde{Y}^{\tilde{T}_t} / \tilde{z}_D + (1 + \tau_t) N_{X,t} \tilde{Y}^{T_{X,t}} / \tilde{z}_{X,t} + N_{E,t} f_{E,t} + N_{X,t} f_{X,t}. \]

The lump-sum transfer is:

\[ T_t = \left( \frac{\psi}{2} \right) \varepsilon_t P^* \left( \frac{A_{t+1}^*}{P^*_t} \right)^2 + d_t^N + \tau_t^M \rho_{X,t}^* \tilde{Y}^{T_{X,t}}. \]

Aggregate demand of the final consumption basket must be equal to the sum of market consumption, investment in physical capital, and the cost of adjusting nominal wages:

\[ Y_t = C_t + I_{K,t} + \left[ 1 - \frac{\nu_w}{2} (\pi_{w,t})^2 \right] w_t L_t. \]

Table A.2 summarizes the equilibrium conditions of the model. Eight Foreign variables directly affect macroeconomic dynamics in the small open economy: \( Y_{t}^*, i_{t+1}^*, \pi_t^C, \rho_{t}^{T_{X}}, \rho_{X,t}^{T_{X}}, \tilde{Y}_{X,t}^T, \) and \( N_{X,t}^* \). Aggregate demand, \( Y_t^* \), the nominal interest rate, \( i_{t+1}^* \), and inflation, \( \pi_t^C \), are determined by treating the rest of the world (Foreign) as a closed economy that features the same production structure, technology and frictions that characterize the small open economy. Here we focus on the determination of the real price of the basket of tradable goods, \( \rho_{t}^{T_{X}} \), the real price of the exported consumption bundle, \( \tilde{Y}_{X,t}^T \), the real average price of an exported variety, \( \tilde{\rho}_{X,t}^{T_{X}} \), the average export demand, \( \tilde{Y}_{X,t}^{T_{X}} \), and the number of Foreign exporters, \( N_{X,t}^* \). Since the small open economy is infinitesimally small relative to the rest of the world, these variables affect macroeconomic dynamics in the small open economy without having any effect on the rest of the world.

To determine price and quantities related to exports and imports, we assume that Foreign producers solve a profit maximization problem that is equivalent to that faced by Home producers. Therefore:

\[ \tilde{Y}_{X,t}^{T_{X}} = \alpha_X (1 - \alpha_N) \left[ (1 + \tau_t^*) \tilde{\rho}_{X,t}^{T_{X}} \right]^{-\phi_T} (N_{X,t}^*)^{\theta_T-\phi_T} (\rho_{t}^{T_{X}})^{\phi_T-\phi_N} Y_t, \]

where \( \tilde{\rho}_{X,t}^{T_{X}} = Q_t (1 + \tau_t^*) \rho_{DT,t}^{T_{X}} \) and \( N_{X,t}^* = \left( \tilde{z}_{X,t}^* / \bar{z}_{X,t}^* \right)^{-k} k_{r_{T,t}}^{-1} N_{D,t}^*. \) In turn, the Foreign average export productivity, \( \tilde{z}_{X,t}^* \), is determined by the zero-profit condition:

\[ \frac{k - (\theta_T - 1) \varphi_t^* Y_{X,t}^*}{(\theta_T - 1)k} \tilde{z}_{X,t}^* N_{X,t}^* (1 + \tau_t^*) = f_{X,t}^* \varphi_t^*, \]
where \( \tau_t^* \geq 0 \) denotes iceberg trade costs faced by Foreign exporters. Finally, \( \rho_t^{T*} = \rho_{D,t}^{T*} \) and \( \varphi_t^* = \tilde{z}_D \) and \( \rho_X^{T*} = N_{X,t}^{1/(1-\phi_T)} \tilde{p}_{X,t}^{T*} \). The variables \( \rho_{D,t}^{T*}, N_{D,t}^*, \) and \( \varphi_t^* \) that appear above are determined also by treating the rest of the world (Foreign) as a closed economy.

E Data-Consistent Variables

**Definition**

First, decompose the price of domestic and imported tradable goods as \( P_{D,t}^T = \Delta_{D,t}^T \tilde{p}_{D,t}^T \) and \( P_{X,t}^{T*} = \Delta_{X,t}^{T*} \tilde{p}_{X,t}^{T*} \), where

\[
\Delta_{D,t}^T \equiv N_{D,t}^{1/\phi_T} \quad \text{and} \quad \Delta_{X,t}^{T*} \equiv N_{D,t}^{1/\phi_T}.
\]

As in Ghironi and Melitz (2005), \( \tilde{p}_{D,t}^T \) and \( \tilde{p}_{X,t}^{T*} \) represents average prices that are not affected by changes in the number of goods available to consumers. Now recall that

\[
P_t^T = \left[ (1-\alpha_X) \left( P_{D,t}^T \right)^{1-\phi_T} + \alpha_X \left( P_{X,t}^{T*} \right)^{1-\phi_T} \right]^{\frac{1}{1-\phi_T}},
\]

and consider the decomposition: \( P_t^T = \Delta_t^T \tilde{p}_t^T \), where

\[
\Delta_t^T \equiv \left[ (1-\alpha_X) \left( \Delta_{D,t}^T \tilde{p}_{D,t}^T \right)^{1-\phi_T} + \alpha_X \left( \Delta_{X,t}^{T*} \tilde{p}_{X,t}^{T*} \right)^{1-\phi_T} \right]^{\frac{1}{1-\phi_T}}
\]

captures fluctuations in \( P_t^T \) due to variety effects, i.e., fluctuations that would occur even in the absence of changes in the average prices \( \tilde{p}_{D,t}^T \) and \( \tilde{p}_{X,t}^{T*} \). As a result:

\[
P_t^T = \Delta_t^T \tilde{p}_t^T = \left[ (1-\alpha_X) \left( \Delta_{D,t}^T \tilde{p}_{D,t}^T \right)^{1-\phi_T} + \alpha_X \left( \Delta_{X,t}^{T*} \tilde{p}_{X,t}^{T*} \right)^{1-\phi_T} \right]^{\frac{1}{1-\phi_T}}.
\]

By combining the above results, we can decompose the CPI index \( P_t \) as follows:

\[
P_t \equiv \Delta_t \tilde{P}_t = \left[ (1-\alpha_N) \left( \Delta_t^T \tilde{p}_t^T \right)^{1-\phi_N} + \alpha_N \left( P_t^N \right)^{1-\phi_N} \right]^{\frac{1}{1-\phi_N}},
\]

where the overall CPI deflator \( \Delta_t \) is defined by:

\[
\Delta_t \equiv \left[ (1-\alpha_N) \left( \Delta_t^T \right)^{1-\phi_N} + \alpha_N \right]^{\frac{1}{1-\phi_N}}.
\]
In turn, given any variable $X_t$ in units of consumption, its data-consistent counterpart is:

$$X_{R,t} = \frac{P_t X_t}{\bar{P}_t} = X_t \Delta_t.$$

**Model Fit**

In the main paper, we present impulse responses for welfare-consistent variables, i.e., variables deflated by the CPI index $P_t$. Here we show that our results are not affected by deflating nominal variables using the data-consistent price index $\bar{P}_t$. For instance, Figure A.11 reproduces Panel B in Figure 9 using the data-consistent price index $\bar{P}_t$ to construct inflation and real GDP. In each subplot, dashed lines plot confidence bands from the panel-VAR estimates.

**F Sensitivity Analysis: Size and Persistence of Tariff Shocks**

Figure A.12 assesses the sensitivity of the results to tariff shocks of different size (we consider positive tariff shocks of size equal to 5, 10, and 15 percent). The top row assumes that the tariff increase occurs in normal times, while the bottom row refers to a recession. The third row plots the difference between the first and the second row. The negative short-run response of output is essentially monotonic in the size of the shock, implying that the contractionary effects are the higher the tariff increase.

Figure A.13 plots the impulse responses following a 5 percent increase in the Home tariff for three different levels of persistence ($\rho_{\tau_{it}}$). We consider $\rho_{\tau_{it}} = 0.75$, $\rho_{\tau_{it}} = 0.8$, and $\rho_{\tau_{it}} = 0.85$. As for Figure A.12, the top row assumes that the tariff increase occurs in normal times, while the second row refers to a recession. The figure shows that protectionism remains recessionary, regardless of the persistence of the tariff shock. However, there is a difference between normal times and ZLB. In normal times, the recession is stronger when the tariff shock is more persistent. At the ZLB, the opposite is true—a more persistent shock induces a milder contraction. The reason for these different results is that the ZLB the higher persistence induces a longer lasting increase in inflation, which other things reduces the real interest rate by more. Notice however, that the same argument does not hold true when considering shocks of larger size (see Figure A.12). The reason is twofold. First, the short-run income loss is significantly larger when the size the tariff shock increases. Second, larger shocks can trigger a contractionary monetary policy response if their impact on inflation is sufficiently big.
G The Role of Macro and Micro Dynamics

Figure A.17 assesses the empirical support for the two key transmission channels highlighted by the model (endogenous physical capital accumulation and endogenous producers dynamics). Toward this end, we estimate an additional version of the panel VAR that also includes measures of investment in physical capital and labor productivity. The panel-VAR impulse responses (continuous lines) show that both investment and productivity display a statistically-significant decline over time following the tariff increase, consistent with the predictions of the baseline model (dashed lines).

In addition, Figure A.17 assesses the relative importance of macro and micro forces for the model’s ability to match the panel-VAR evidence. We plot model-based impulse responses for two simplified versions of the model. One abstracts from firm-level dynamics (by assuming a constant number of symmetric producers in the tradable sector, dashed-dotted lines); the other abstracts from both firm dynamics and physical capital (long-dashed lines). The figure shows that physical capital accumulation and producer-level dynamics are central features of the model to reproduce the panel-VAR evidence. The intuition mirrors the discussion in the main text.

H The Role of Price Stickiness

Non- Tradable Sector

We introduce price stickiness by following Rotemberg (1982) and assuming that final producers must pay a quadratic price adjustment cost:

$$\frac{\nu_N}{2} \left( \frac{P_t^N(i)}{P_{t-1}^N(i)} - 1 \right)^2 P_t^N(i) Y_t^N(i),$$

where $\nu_N \geq 0$ determines the size of the adjustment cost. Per-period (real) profits are given by

$$d_t^N(i) = \left\{ \left[ 1 - \frac{\nu_N}{2} \left( \frac{P_t^N(i)}{P_{t-1}^N(i)} \right)^2 \right] \frac{P_t^N(i)}{P_t} - \varphi_t \right\} Y_t^{CN}(i).$$

Firms maximize the expected present discounted value of the stream of current and future real profits: $E_t \left[ \sum_{s=t}^{\infty} \beta_{t,t+s} d_s^N(i) \right]$, where, as in the main text, $\beta_{t,t+s} \equiv \beta^s u_{C,t+s}/u_{C,t}$. Optimal price

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6The total real adjustment cost implies a loss of revenue when implementing a price change. The size of this loss is assumed to be larger when revenue increases.
setting implies that the real output price is equal to a markup, \( \mu_t^N (i) \), over marginal cost, \( \varphi_t \):

\[
\rho_t^N (i) \equiv \frac{P_t^N (i)}{P_t} = \mu_t^N (i) \varphi_t,
\]

where the endogenous, time-varying markup \( \mu_t^N (i) \) is given by

\[
\mu_t^N (i) \equiv \frac{\theta_N}{(\theta_N - 1) \left[ 1 - \frac{\nu_N}{2} (\pi_{N,t} (i))^2 \right] + \nu_N \left\{ (1 + \pi_{N,t} (i)) \pi_{N,t} (i) - E_t \left[ \beta_{t,t+1} \pi_{N,t+1} (i) \frac{(1+\pi_{N,t+1}(i))^{2} Y_{t+1}^N (i)}{Y_{t+1}^N (i)} \right] \right\}},
\]

where \( \pi_{N,t} (i) \equiv (P_t^N (i) / P_{t-1}^N (i)) - 1 \). Price stickiness introduces endogenous markup variation as the cost of adjusting prices gives firms an incentive to change their markups over time in order to smooth price changes across periods.

Notice that in equilibrium, \( Y_t^N = \left[ 1 - (\nu / 2) (\pi_{N,t})^2 \right]^{-1} C_t^N \), where \( C_t^N = \alpha_N (\rho_t^N)^{-\phi_t} Y_t \).

** Tradable Sector **

We introduce costly price adjustment in the tradable sector by following Cacciatore and Ghironi (2014). To preserve model tractability in the presence of producer heterogeneity, Cacciatore and Ghironi assume that tradable consumption goods are produced by symmetric monopolistically competitive multi-product firms. Each firm purchases intermediate input and produces differentiated varieties of its sectoral output. In equilibrium, some of these varieties are exported while the others are sold only domestically. With flexible prices, the tradable sector is isomorphic to the benchmark model (i.e., to Ghironi and Melitz, 2005).\(^7\) We now present the details of this alternative model, considering three alternative cases: producer currency pricing (PCP), local currency pricing (LCP), and the empirically relevant scenario for small open economies of dollar currency pricing (i.e., export prices are set in U.S. dollar everywhere).

As in the benchmark model, the tradable consumption basket \( C_t^T \) aggregates Home and Foreign tradable consumption sub-baskets in Armington form:

\[
C_t^T = \left[ (1 - \alpha_X)^{\frac{1}{\phi_T}} (C_{D,t}^T)^{\phi_T^{-1} \phi_T^{-1}} + \alpha_X^{\frac{1}{\phi_T}} \left( C_{X,t}^T \right)^{\phi_T^{-1} \phi_T^{-1}} \right]^{\frac{\phi_T}{\phi_T^{-1}}}.\]

\(^7\)This is true as long as the elasticity of substitution across differentiated varieties (denoted with \( \theta_\omega \) below) is equal to the elasticity of substitution of tradable consumption goods (\( \theta_T \)) in the benchmark model.
The price index that corresponds to the basket $C^T_t$ is given by

$$P^T_t = \left\{ (1 - \alpha_X) (P^T_{D,t})^{1-\phi_T} + \alpha_X \left[ (1 + \tau^i_t) P^T_{X,t} \right]^{1-\phi_T} \right\}^{1/\phi_T}. $$

In contrast to the benchmark model, there is a continuum $(0, 1)$ of symmetric tradable sectors. The domestic tradable consumption $C^T_{D,t}$ aggregates sectoral consumption goods $C^T_{D,t}(i)$:

$$C^T_{D,t} = \left[ \int_0^1 C^T_{D,t}(i)^{(\theta_T-1)/\theta_T} di \right]^{\theta_T/(\theta_T-1)}. $$

A similar basket describes Foreign tradable consumption: $C^T_{X,t} = \left[ \int_0^1 C^T_{X,t}(i)^{(\theta_T-1)/\theta_T} di \right]^{\theta_T/(\theta_T-1)}$. The corresponding price indexes are $P^T_{D,t} = \left[ \int_0^1 P^T_{D,t}(i)^{1-\theta_T} di \right]^{1/(1-\theta_T)}$ and $P^T_{X,t} = \left[ \int_0^1 P^T_{X,t}(i)^{1-\theta_T} di \right]^{1/(1-\theta_T)}$, both expressed in Home currency.

In each tradable consumption sector $i$, there is a representative, monopolistically competitive firm that produces the sectoral output bundle $Y^T_t(i)$, sold to consumers in Home and Foreign. Producer $i$ is a multi-product firm that produces a set of differentiated product varieties, indexed by $\omega$ and defined over a continuum $\Omega$: $Y^T_t(i) = \left( \int_{\omega \in \Omega} Y^T_t(\omega, i)^{(\theta_T-1)/\theta_T} d\omega \right)^{\theta_T/(\theta_T-1)}$, where $\theta_T > 1$ denotes the symmetric elasticity of substitution across product varieties.\(^8\) We assume that $\theta_T = \theta_T$.

Each product variety $Y^T(\omega, i)$ is created and developed by the representative producer $i$. The number of products (or features) created and commercialized by each producer is endogenous. At each point in time, only a subset of varieties $\Omega_t \subset \Omega$ is actually available to consumers. To create a new product, the producer needs to undertake a sunk investment, $f_{E,t}$, in units of intermediate input. Product creation requires each producer to create a new plant that will be producing the new variety.\(^9\) Plants produce with different technologies indexed by relative productivity $z$. To save notation, we identify a variety with the corresponding plant productivity $z$, omitting $\omega$. Upon product creation, the productivity level of the new plant $z$ is drawn from a common distribution $G(z)$ with support on $[z_{\min}, \infty)$. This relative productivity level remains fixed thereafter. Each plant uses the intermediate input to produce its differentiated product variety, with real marginal

\(^8\)Sectors (and sector-representative firms) are of measure zero relative to the aggregate size of the economy. Notice that $Y^T_t(i)$ can also be interpreted as a bundle of product features that characterize the final product $i$.

\(^9\)Alternatively, we could decentralize product creation by assuming that monopolistically competitive firms produce product varieties (or features) that are sold to final producers, in this case interpreted as retailers. The two models are isomorphic. Details are available upon request.
cost:

\[ \varphi^T_t(z) = \frac{\varphi_t}{z}. \quad (A-1) \]

At time \( t \), the tradable Home produce \( i \) commercializes \( N_{D,t}(i) \) varieties and creates \( N_{E,t}(i) \) new products that will be available for sale at time \( t + 1 \). New and incumbent plants can be hit by a “death” shock with probability \( \delta \in (0, 1) \) at the end of each period. The law of motion for the stock of producing plants is \( N_{D,t+1}(i) = (1 - \delta)(N_{D,t}(i) + N_{E,t}(i)) \).

When serving the Foreign market, each producer faces per-unit iceberg trade costs, \( \tau_t > 0 \), and fixed export costs, \( f_{X,t} \). Fixed export costs are denominated in units of intermediate input and paid for each exported product. Thus, the total fixed cost is \( N_{X,t}(i)f_{X,t}(i) \), where \( N_{X,t}(i) \) denotes the number of product varieties (or features) exported to Foreign. Absent fixed export costs, each producer would find it optimal to sell all its product varieties in Home and Foreign. Fixed export costs imply that only varieties produced by plants with sufficiently high productivity (above the cutoff level \( z_{X,t} \), determined below) are exported.\(^\text{10}\)

Define two special “average” productivity levels (weighted by relative output shares): an average \( \bar{z}_D \) for all producing plants and an average \( \bar{z}_{X,t} \) for all plants that export:

\[ \bar{z}_D = \left[ \int_{z_{\min}}^{\infty} z^{\theta - 1} G(z) \right]^{\frac{1}{\theta - 1}}, \quad \bar{z}_{X,t}(i) = \left[ \frac{1}{1 - G(\bar{z}_{X,t}(i))} \right] \left[ \int_{z_{X,t}(i)}^{\infty} z^{\theta - 1} G(z) \right]^{\frac{1}{\theta - 1}}. \]

Assume that \( G(\cdot) \) is Pareto with shape parameter \( k_p > \theta - 1 \). As a result, \( \bar{z}_D = \alpha^{1/(\theta - 1)} z_{\min} \) and \( \bar{z}_{X,t} = \alpha^{1/(\theta - 1)} z_{X,t} \), where \( \alpha \equiv k_p / (k_p - \theta + 1) \). The share of exporting plants is given by:

\[ N_{X,t}(i) \equiv [1 - G(z_{X,t}(i))] N_{D,t}(i) = \left( \frac{z_{\min}}{z_{X,t}(i)} \right)^{-k_p} \alpha^{k_p \theta_{X,t} - 1} N_{D,t}(i). \quad (A-2) \]

The output bundles for domestic and export sale, and the corresponding unit costs, are defined as follows:

\[ Y^T_{D,t}(i) = \left[ \int_{z_{\min}}^{\infty} Y^T_{D,t}(z, i) \frac{1}{\theta - 1} dG(z) \right]^{\frac{1}{\theta - 1}}, \quad Y^T_{X,t}(i) = \left[ \int_{z_{X,t}(i)}^{\infty} Y^T_{X,t}(z, i) \frac{1}{\theta - 1} dG(z) \right]^{\frac{1}{\theta - 1}}, \quad (A-3) \]

\[ \varphi^T_{D,t}(i) = \left[ \int_{z_{\min}}^{\infty} (\varphi^T_t(z))^{1 - \theta - \theta} dG(z) \right]^{\frac{1}{1 - \theta - \theta}}, \quad \varphi^T_{X,t}(i) = \left[ \int_{z_{X,t}(i)}^{\infty} (\varphi^T_t(z))^{1 - \theta - \theta} dG(z) \right]^{\frac{1}{1 - \theta - \theta}}. \quad (A-4) \]

\(^{10}\)Notice that \( z_{X,t} \) is the lowest level of plant productivity such that the profit from exporting is positive.
Notice that using equations (A-1) and (A-4), the real costs of producing the bundles $Y_{D,t}(i)$ and $Y_{X,t}(i)$ can be expressed as:

$$\varphi_{D,t}(i) = [N_{D,t}(i)]^{1-\alpha} \varphi_t z_{D}, \quad \varphi_{X,t}(i) = [N_{X,t}(i)]^{1-\alpha} \varphi_t z_{X,t}(i).$$

(A-5)

Denote with $P_{D,t}(i)$ the price (in Home currency) of the product bundle $Y_{D,t}(i)$ and let $P_{X,t}(i)$ be the price (in Foreign currency) of the exported bundle $Y_{X,t}(i)$. Each producer $i$ faces the following domestic and foreign demand:

$$Y_{D,t}(i) = \left( \frac{P_{D,t}(i)}{P_{D,t}} \right)^{-\theta_F} Y_{D,t},$$

$$Y_{X,t}(i) = \left[ (1 + \tau_t i_t) \frac{P_{X,t}(i)}{P_{X,t}} \right]^{-\theta_F} Y_{X,t},$$

where $Y_{D,t}$ and $Y_{X,t}$ are aggregate demands of the Home tradable consumption basket in Home and Foreign, respectively.

Prices in the tradable sector are sticky: Tradable producers must pay quadratic price adjustment costs when changing domestic and export prices. We consider to alternative assumptions about the currency denomination of export prices: producer currency pricing (PCP) and local currency pricing (LCP).

**Producer Currency Pricing (PCP)**

Each producer sets $P_{D,t}(i)$ and the domestic currency price of the export bundle, $P_{X,t}^{T,h}(i)$, letting the price in the foreign market be $P_{X,t}(i) = P_{X,t}^{T,h}(i) / \varepsilon_t$, where $\varepsilon_t$ is the nominal exchange rate. Absent fixed export costs, the producer would set a single price $P_{D,t}(i)$ and the law of one price (adjusted for the presence of trade costs) would determine the export price as $P_{X,t}(i) = (1 + \tau_t) P_{D,t}(i) / \varepsilon_t$. With fixed export costs, however, the composition of domestic and export bundles is different, and the marginal costs of producing these bundles are not equal. Therefore, producers choose two different prices for the Home and Foreign markets even under PCP.

The nominal costs of adjusting domestic and export price are, respectively

$$\frac{\nu_t}{2} \left( \frac{P_{D,t}(i)}{P_{D,t-1}(i)} - 1 \right)^2 P_{D,t}(i) Y_{D,t}(i),$$
and

\[
\frac{\nu_T}{2} \left( \frac{P_{X,t}^{T,h} (i)}{P_{X,t-1}^{T,h} (i)} - 1 \right)^2 P_{X,t}^{T,h} (i) Y_{X,t}^T (i),
\]

where \(\nu_T \geq 0\) determines the size of the adjustment costs (domestic and export prices are flexible if \(\nu_T = 0\)). Per-period (real) profits are given by:

\[
d_t^T (i) = \left\{ \begin{array}{l}
\left[ 1 - \frac{\nu_p}{2} \left( \frac{P_{D,t}^{T,h} (i)}{P_{X,t-1}^{T,h} (i)} - 1 \right)^2 \right] P_{D,t}^{T,h} (i) - \varphi_{D,t}^T (i) \left( \frac{P_{D,t}^{T,h} (i)}{P_{X,t}^{T,h} (i)} \right)^{-\theta_T} Y_{D,t}^T \\
- \varphi_t \left[ N_{E,t} (i) f_{E,t} + N_{X,t} f_{X,t} (i) \right]
\end{array} \right. 
\]

The representative producer chooses \(P_{D,t}^{T,h} (i), P_{X,t}^{T,h} (i), N_{E,t} (i), \) and \(z_{X,t} (i)\) in order to maximize the expected present discounted value of the stream of real profits, \(E_t \left[ \sum_{\tau=1}^{\infty} \beta_\tau d_\tau^T (i) \right]\), subject to the constraints (A-2), (A-5), and \(z_{X,t} (i) = \alpha^{1/(\theta_\omega - 1)} z_{X,t} (i)\).

Since tradable consumption-producing sectors are symmetric in the economy, from now on we omit the index \(i\) to simplify notation when presenting the first-order conditions. The first-order condition with respect to \(z_{X,t}\) yields:

\[
\frac{k_p - (\theta_\omega - 1)}{(\theta_\omega - 1)k_p} \varphi_{X,t} Y_{X,t}^T N_{X,t} (1 + \tau_t) = f_{X,t} \varphi_t.
\]

The above conditions states that, at the optimum, marginal revenue from adding a variety with productivity \(z_{X,t}\) to the export bundle has to be equal to the fixed cost. Thus, varieties produced by plants with productivity below \(z_{X,t}\) are distributed only in the domestic market. The composition of the traded bundle is endogenous and the set of exported products fluctuates over time with changes in the profitability of export.

The first-order condition with respect to \(N_{D,t+1}\) determines product creation:

\[
\varphi_t f_{E,t} = E_t \left\{ (1 - \delta) \beta_{t,t+1} \left[ \varphi_{t+1} \left( f_{E,t+1} - \frac{N_{X,t+1}}{N_{D,t+1}} f_{X,t+1} \right) + \frac{1}{\beta_{t,t+1}} \left( \frac{Y_{D,t+1}^T}{N_{D,t+1}} + \frac{Y_{X,t+1}^T}{N_{X,t+1}} \frac{N_{X,t+1}}{N_{D,t+1}} T_{t+1} \right) \right] \right\}.
\]

In equilibrium, the cost of producing an additional variety, \(\varphi_t f_{E,t}\), must be equal to its expected benefit (which includes expected savings on future sunk investment costs augmented by the marginal revenue from commercializing the variety, net of fixed export costs, if it is exported).

\[^{11}\text{Equation (A-2) implies that by choosing } z_{X,t} \text{ the producer also determines } N_{X,t}.\]
The (real) price of Home output for domestic sales is a time-varying markup $\mu_{D,t}^T$ over the domestic marginal cost, $\varphi_{D,t}^T$:

$$\rho_{D,t}^T \equiv \frac{P_{D,t}}{P_t} = \mu_{D,t}^T \varphi_{D,t}^T.$$  

The time-varying domestic markup, $\mu_{D,t}^T$, is given by:

$$\mu_{D,t}^T = \frac{\theta_T}{(\theta_T - 1) \left[ 1 - \frac{\nu_T}{2} \left( \pi_{D,t}^T \right)^2 \right] + \nu_T \left\{ \frac{(1 + \pi_{D,t}^T) \pi_{D,t}^T}{1 + (1 + \pi_{D,t+1}^T)^2 \pi_{D,t+1}^T Y_{D,t+1}^T Y_{D,t}^T} \right\}},$$

where $1 + \pi_{D,t}^T \equiv P_{D,t}^T / P_{D,t-1}^T$. The (real) price of Home output for export sales (in units of Home consumption) is a time-varying markup $\mu_{X,t}^T$ over the marginal cost of the export bundle, $\varphi_{X,t}^T$:

$$\rho_{X,t}^T \equiv \frac{P_{X,t}^*}{P_t^*} = \mu_{X,t}^T \frac{(1 + \tau_t) \varphi_{X,t}^T}{Q_t}.$$  

The time-varying export markup, $\mu_{X,t}^T$, is given by:

$$\mu_{X,t}^T = \frac{\theta_T}{(\theta_T - 1) \left[ 1 - \frac{\nu_T}{2} \left( \pi_{X,t}^T \right)^2 \right] + \nu_T \left\{ \frac{(1 + \pi_{X,t}^h) \pi_{X,t}^h}{1 + (1 + \pi_{X,t+1}^h)^2 \pi_{X,t+1}^h Y_{X,t+1}^h Y_{X,t}^h} \right\}},$$  

where

$$1 + \pi_{X,t}^h = \frac{P_{X,t}^h}{P_{X,t-1}^h} = \frac{Q_t}{Q_{t-1}} \rho_{X,t}^T (1 + \pi_{C,t}).$$

As expected, price stickiness introduces endogenous markup variations both in the domestic and export markets. In equilibrium,

$$Y_{D,t}^T = \left[ 1 - (\nu/2) \left( \pi_{D,t}^T \right)^2 \right]^{-1} C_{D,t}^T,$$

and

$$Y_{X,t}^T = \left[ 1 - (\nu/2) \left( \pi_{X,t}^h \right)^2 \right]^{-1} C_{X,t}^T.$$  

**Local Currency Pricing (LCP)**

Under LCP, the export price is set in Foreign currency. The nominal costs of adjusting the
export price is now given by:

\[ \frac{\nu_T}{2} \left( \frac{P_{X,t}^T(i)}{P_{X,t-1}^T(i)} - 1 \right)^2 \varepsilon_t P_{X,t}^T(i) Y_{X,t}^T(i). \]

Therefore, each producer chooses \( P_{X,t}^T(i) \) to maximize:

\[
d_t^T(i) = \begin{cases} 
\left( \left( \frac{P_{D,t}^T(i)}{P_{D,t-1}^T(i)} - 1 \right)^2 \varphi_{D,t}^T(i) \right) \left( \frac{P_{D,t}^T(i)}{P_{D,t}^T(i)} \right)^{-\theta_T} Y_{D,t}^T \\
+ \left( \left( \frac{P_{X,t}^T(i)}{P_{X,t}^T(i)} - 1 \right)^2 \varepsilon_t P_{X,t}^T(i) \right) (1 + \tau_t) \varphi_{X,t}^T(i) \left( \frac{P_{X,t}^T(i)}{P_{X,t}^T(i)} \right)^{-\theta_T} Y_{X,t}^T \\
- \varphi_t \left[ N_{E,t}^T(i) f_{E,t} + N_{X,t} f_{X,t}^T(i) \right]. \end{cases}
\]

In the symmetric equilibrium, the time-varying markup, \( \mu_{X,t}^T \), is now given by:

\[
\mu_{X,t}^T = \frac{\theta_T}{(\theta_T - 1) \left( 1 - \frac{\nu_T}{2} \left( \pi_{X,t}^T \right)^2 \right) + \nu_T \left\{ (1 + \pi_{X,t}^T) \pi_{X,t}^T \right\}^{-\theta_T} Y_{X,t}^T} - E_t \left[ \beta_{t+1} Q_{t+1} \left( \frac{1 + \pi_{X,t}^T}{1 + \pi_{C,t+1}} \right)^2 \pi_{X,t}^T Y_{X,t+1}^T \right].
\]

where \( 1 + \pi_{X,t}^T = \frac{P_{X,t}^T}{P_{X,t-1}^T} \).

Notice that with a fixed exchange rate, there would be no difference in the equilibrium allocation between PCP and LCP. To see this, recall that under PCP \( P_{X,t}^T(i) = P_{X,t}^{T,h} \) (constant). Therefore, the adjustment cost under PCP can be written as

\[
\frac{\nu_T}{2} \left( \frac{P_{X,t}^T(i) \varepsilon_t}{P_{X,t-1}^T(i) \varepsilon_{t-1}} - 1 \right)^2 P_{X,t}^T(i) \varepsilon_t Y_{X,t}^T(i).
\]

With a fixed exchange, \( \varepsilon_t/\varepsilon_{t-1} = 1 \). Therefore, the adjustment cost under PCP becomes:

\[
\frac{\nu_T}{2} \left( \frac{P_{X,t}^T(i)}{P_{X,t-1}^T(i)} - 1 \right)^2 P_{X,t}^T(i) \varepsilon_t Y_{X,t}^T(i),
\]

which is identical to the cost under LCP. Furthermore, \( P_{X,t}^T(i) = P_{X,t}^{T,h} \) in deviations from steady state, since \( \varepsilon_t = \varepsilon^* \) (constant).\(^{12}\)

**Dollar Currency Pricing (DCP)**

\(^{12}\) Absent firm heterogeneity, the exact equivalence between LCP and PCP would no longer hold, since there would be a single Rotemberg adjustment cost for total sales under PCP. Nevertheless, the equilibrium allocations remain very similar.
In this case, Home export prices are determined as under LCP, while U.S. exporters set prices under PCP.

**Impulse Responses**

Figure A.14 presents the impulse responses following a temporary increase in tariffs under PCP, Figure A.15 considers LCP, while Figure A.16 plots dynamics under DCP. In all scenarios, we assume that the exchange rate is flexible. As in the main text, we consider four model specifications: the baseline model (first row), the baseline model under financial autarky (second row), the baseline model without endogenous firm dynamics (third row), and the baseline model without firm dynamics and endogenous physical capital accumulation. In the three scenarios, the recessionary effects are initially stronger relative to the flexible price scenario, since price stickiness increases the tariff pass through on final consumers. Not surprisingly, the contractionary effects of tariffs are larger under LCP. This happens because the appreciation of the exchange rate does not pass-through on import prices under LCP, implying that the higher tariff results in higher import prices. While this effect increases expenditure switching toward Home goods, it also reduces real income (and thus investment) by more. As a result, the recession is stronger.\(^{13}\)

\(^{13}\) Results are similar when considering a fixed exchange rate. Notice that in this case, the equilibrium allocation implied by the model is identical under producer currency pricing and local currency pricing. While the exact equivalence depends on the existence of producer heterogeneity, allocations remain nearly identical even in the absence of endogenous producer entry.
## Table A.1: Granger Causality Test

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<tr>
<th>Dependent Variable: $\hat{u}_{\tau,t}$</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
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<tbody>
<tr>
<td>$\hat{u}_{\tau,t-1}$</td>
<td>-0.004</td>
<td>0.002</td>
<td>-0.008</td>
<td>-0.040</td>
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<tr>
<td></td>
<td>(0.118)</td>
<td>(0.118)</td>
<td>(0.112)</td>
<td>(0.115)</td>
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<tr>
<td>$\hat{u}_{\tau,t-2}$</td>
<td>-0.017</td>
<td>-0.021</td>
<td>-0.018</td>
<td>-0.016</td>
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<tr>
<td></td>
<td>(0.116)</td>
<td>(0.117)</td>
<td>(0.112)</td>
<td>(0.111)</td>
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<tr>
<td>$\Delta Y_{t-1}^*$</td>
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<td>(206.157)</td>
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<td>$\Delta Y_{t-2}^*$</td>
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<tr>
<td>$\Delta IM_{t-1}^*$</td>
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<td>$\Delta IM_{t-2}^*$</td>
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<td>(58.033)</td>
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<tr>
<td>$P_{oil,t-1}$</td>
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<td>(0.058)</td>
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<tr>
<td>$P_{oil,t-2}$</td>
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<td></td>
<td>(0.058)</td>
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<td>\textit{pval F test}</td>
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<td>0.69</td>
<td>0.95</td>
<td>0.33</td>
</tr>
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</table>

OLS regressions where the dependent variable is the estimated structural trade-policy shock in the quarterly VAR ($\hat{u}_{\tau,t}$). The regressors include:

1. the forecast of real GDP growth ($\Delta Y_t^*$),
2. the forecast of real imports growth ($\Delta IM_t^*$),
3. the real price of oil ($P_{oil,t}$) and
4. the growth rate of Canadian stock prices ($\Delta Stock_t$).

\textit{pvalFtest} denotes the p-value of a F-test of joint significance of the coefficients.
TABLE A.2: MODEL EQUATIONS

\[
1 = (1 - \alpha_N) (\rho_T^0)^{1-\phi_N} + \alpha_N (\rho_T^N)^{1-\phi_N}
\]

\[
\rho_T^{1+1} = (1 - \alpha_X) (\rho_D^{1+1})^{1-\phi_T} + \alpha_X (\rho_X^{1+1})^{1-\phi_T}
\]

\[
\rho_T^{D,t} = N_{D,t}^{1/(1-\theta_T)} \rho_D^{D,t}
\]

\[
\rho_T^{X,t} = N_{X,t}^{1/(1-\theta_T)} \rho_X^{X,t}
\]

\[
Z_t K^{\alpha} L^{-\alpha}_t = Y_t = N_{D,t}^{1+1} + N_{X,t}^{1+1} + N_{E,t} f_{E,t} + N_{X,t} f_{X,t}
\]

\[
Y_t = C_t + I_{K,t} + \left[ 1 - \frac{\theta}{2} (\pi_{w,t})^2 \right] w_t L_t
\]

\[
Y_t^N = \alpha_N (\rho_T^N)^{-\phi_N} Y_t
\]

\[
\rho_T^N = \frac{\theta}{(\theta N-1)} \varphi_t
\]

\[
Y_{D,t} = N_{D,t}^{\varphi_t} \tilde{Y}_{D,t}
\]

\[
Y_{X,t} = N_{X,t}^{\varphi_t} \tilde{Y}_{X,t}
\]

\[
\tilde{Y}_{D,t} = (1 - \alpha_X) (1 - \alpha_N) \left( \tilde{\rho}_{D,t}^{1-\phi_T} \right) N_{D,t}^{\varphi_t} \left( \varphi_t \right)^{-\phi_T} Y_t
\]

\[
\tilde{Y}_{X,t} = \alpha_X (1 - \alpha_N) \left( \tilde{\rho}_{X,t}^{1-\phi_T} \right) N_{X,t}^{\varphi_t} \left( \varphi_t \right)^{-\phi_T} Y_t
\]

\[
N_{D,t} = (1 - \delta) (N_{D,t-1} + N_{E,t-1})
\]

\[
N_{X,t} = \left( \frac{\varphi_t}{\varphi_t} \right) \tilde{Y}_{X,t}^{\varphi_t} N_{X,t}^{\varphi_t} \tilde{Y}_{X,t}^{\varphi_t} = f_{X,t} \varphi_t
\]

\[
\varphi_t f_{E,t} = E_t \left( 1 - \delta \right) \beta_{t,t+1} + \left[ \varphi_{t+1} \left( f_{E,t+1} - \frac{N_{X,t+1} + 1}{N_{D,t+1} + 1} f_{X,t+1} \right) \right]^{\frac{\varphi_t}{\varphi_t}}^{\varphi_t}
\]

\[
w_t = \frac{\eta}{(\eta - 1) (1 - \theta (1 + \pi_{w,t}(h)) + \pi_{w,t}(1 + \pi_{w,t}) - \delta_t \left( 1 + \pi_{w,t} \right) \frac{L_{t+1}}{L_{t+1}})}
\]

\[
1 + \Lambda_{at} = (1 + i_{t+1}) E_t \left( \frac{\beta_{t,t+1}}{1 + \pi_{C,t+1}} \right)
\]

\[
Q_t a_{t+1} = Q_t \frac{1 + \pi_{C,t+1}}{1 + \pi_{C,t+1}} a_{t+1} + N_{X,t} Q_t \tilde{\rho}_{X,t}^{\varphi_t} Y_{X,t} - N_{X,t} \tilde{\rho}_{X,t}^{\varphi_t} Y_{X,t}^{*}
\]

\[
(1 + i_t) = \max \left\{ 1, (1 + i_{t-1}) \beta_t \left( 1 + (1 + \pi_{C,t}) \beta_t \left( Y_{gt} \right)^{\beta_t} \right) \right\}
\]

\[
(1 + \pi_{w,t}) = \frac{1 + \pi_{w,t}}{(1 + \pi_{C,t})}
\]

\[
(1 + \pi_{N,t}) = \frac{\pi_{N,t}}{\pi_{C,t}}
\]
Figure A.1: Quarterly VAR, alternative trade policy measures. First panel: baseline measure; Second panel: antidumping initiatives include products recorded at 4-digits; Third panel: only initiatives that end up with the imposition of antidumping tariffs; Fourth panel: only initiatives that end up with the imposition of antidumping tariffs including products recorded at 4-digits. One-standard deviation increase in antidumping initiatives in Canada. GDP growth and net exports over GDP are in percentage points. The inflation rate is annualized.
Figure A.2: Quarterly VAR, one-standard deviation increase in temporary trade barriers initiatives in Canada. GDP growth and net exports over GDP are in percentage points. The inflation rate is annualized.

Figure A.3: Quarterly VAR, one-standard deviation increase in antidumping initiatives in Canada. Linearly detrended GDP. GDP and net exports over GDP are in percentage points. The inflation rate is annualized.
Figure A.4: Anti-dumping initiatives and real GDP growth, Turkey.

Figure A.5: Quarterly VAR, one-standard deviation increase in antidumping initiatives in Turkey. GDP and net exports over GDP are in percentage points. The inflation rate is annualized.
Figure A.6: Monthly VAR, one-standard deviation increase in antidumping initiatives in Turkey. Industrial production, net exports, and nominal exchange rate are in percentage points. The inflation rate and the interest rate are annualized.
Figure A.7: Anti-dumping initiatives and real GDP growth, India.

Figure A.8: Quarterly VAR, one-standard deviation increase in antidumping initiatives in India. GDP and net exports over GDP are in percentage points. The inflation rate is annualized.
Figure A.9: Monthly VAR, one-standard deviation increase in antidumping initiatives in India. Industrial production, net exports, and nominal exchange rate are in percentage points. The inflation rate and the interest rate are annualized.
Figure A.10: Panel-VAR, impulse responses to a one-standard deviation increase in detrended tariffs. Tariffs, GDP growth, exports, and imports are in percentage points.
Figure A.11: Panel-VAR confidence bands (dashed lines) and annualized, model-based, impulse responses. Continuous lines plot welfare-consistent variables, while dashed lines plot data-consistent variables. The response of tariffs and net exports over GDP is not affected by the specific price deflator we consider.
Figure A.12: Responses to a temporary increase in Home tariffs, shocks with different size (5, 10, and 15 percent) and different initial conditions: steady state (first row) and a recession with binding ZLB (second row). The third row plots the difference between the first and the second row for each variable. Responses show percentage deviations from the initial steady state. The inflation rate is annualized.
Figure A.13: Responses to a temporary increase in Home tariffs, shocks with persistence (0.56, 0.65, and 0.75) and different initial conditions: steady state (first row) and a recession with binding ZLB (second row). The third row plots the difference between the first and the second row for each variable. Responses show percentage deviations from the initial steady state. The inflation rate is annualized.
Figure A.14: Effects of a temporary increase in Home trade barriers in normal times, sticky prices (producer currency pricing). The top raw: baseline model; second raw: baseline model under financial autarky; third raw: baseline model without firm dynamics; fourth raw: baseline model without firm dynamics and physical capital accumulation. Responses show percentage deviations from the steady state. The inflation rate is annualized.
Figure A.15: Effects of a temporary increase in Home trade barriers in normal times, sticky prices (local currency pricing). The top raw: baseline model; second raw: baseline model under financial autarky; third raw: baseline model without firm dynamics; fourth raw: baseline model without firm dynamics and physical capital accumulation. Responses show percentage deviations from the steady state. The inflation rate is annualized.
Figure A.16: Effects of a temporary increase in Home trade barriers in normal times, sticky prices (dollar currency pricing). The top raw: baseline model; second raw: baseline model under financial autarky; third raw: baseline model without firm dynamics; fourth raw: baseline model without firm dynamics and physical capital accumulation. Responses show percentage deviations from the steady state. The inflation rate is annualized.
Figure A.17: Annualized responses to a temporary increase in Home tariffs in normal times. Continuous line: augmented panel-VAR (including the growth rate of investment and labor productivity); Dashed lines: baseline model; dash-dot lines: baseline model without firm dynamics; long-dash lines: baseline model without firm dynamics and physical capital accumulation. The grey area denotes confidence bands for the panel-VAR estimates. Model responses show percentage deviations from the steady state. The inflation rate is annualized.