Protectionism and the Business Cycle*

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Abstract

We study the consequences of protectionism for macroeconomic fluctuations. First, using high-frequency trade policy data, we present fresh evidence on the dynamic effects of temporary trade barriers. Estimates from country-level and panel VARs show that protectionism acts as a supply shock, causing output to fall and inflation to rise in the short run. Moreover, protectionism has at best a small positive effect on the trade balance. Second, we build a small open economy model with firm heterogeneity, endogenous selection into trade, and nominal rigidity to study the channels through which protectionism affects aggregate fluctuations. The model successfully reproduces the VAR evidence and highlights the importance of aggregate investment dynamics and micro-level reallocations for the contractionary effects of tariffs. We then use the model to study scenarios where temporary trade barriers have been advocated as potentially beneficial, including recessions with binding constraints on monetary policy easing or in the presence of a fixed exchange rate. Our main conclusion is that, in all the scenarios we consider, protectionism is not an effective tool for macroeconomic stimulus.

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1 Introduction

To paraphrase Karl Marx and Friedrich Engels (1848), a specter is haunting the world economy—the specter of protectionism. The outcomes of G-20 and G-7 meetings have been raising the concern that key powers are taking steps away from existing alliances that had been forged also to exorcise this specter. The U.S. administration of President Donald Trump has withdrawn from the Trans-Pacific Partnership (TPP), started renegotiating the North American Free Trade Agreement (NAFTA), and imposed punitive tariffs against a number of trading partners. Like-minded political leaders in other countries have made no secret of their penchant for protectionism.

Since the threat of protectionism started looming in the run-up to the 2016 U.S. presidential election, analysts and pundits everywhere have been debating possible costs and benefits of trade policy as a tool to boost aggregate economic performance, rebalance external accounts, or address distributional effects of trade. Influential scholars have argued that tariffs may be beneficial when countries are mired in a liquidity trap, as the inflationary effect of increased import costs may help lift the economy out of the trap (for instance, Eichengreen, 2016).

This paper contributes to this debate by studying the effects of protectionism on macroeconomic fluctuations. In the first part, we take a fresh look at time series evidence by using vector autoregressions (VARs) to investigate the short-run effects of trade policy on macroeconomic outcomes. We perform two variants of this exercise: one that focuses on individual countries using quarterly or monthly data, and the other that uses annual data in a panel VAR for a larger set of countries. In the first exercise, we use Bown's (2016) Global Antidumping Database (GAD) to construct series of initiations of antidumping investigations, which are usually followed by the imposition of antidumping tariffs. We identify trade policy shocks by exploiting institutional features of antidumping regulation. In particular, the existence of decision lags in the opening of investigations implies that antidumping initiatives are contemporaneously exogenous to macroeconomic variables within a month or a quarter. We consider three countries: the largest user among small-open developed economies (Canada) and the most active users overall (Turkey and India). We combine these time series with series on inflation, GDP, and the trade balance (as a ratio to GDP) to study the consequences of protectionist shocks in structural VAR regressions.

In the second exercise, we use a panel VAR on twenty-one small open economies that addresses the fact that the GAD covers only a limited portion of total imports. In this exercise, we consider the import weighted average of applied tariff rates. This restricts our attention to annual data, but we expand sample size by working with a panel of countries. Important for our analysis that follows, none of the countries in our panel found itself at the zero lower bound (ZLB) on monetary policy interest rates in our sample, and all the countries operated under floating exchange rates.

Three robust conclusions emerge from our empirical exercises (and a variety of checks): protectionism is recessionary, inflationary, and has, at best, a small positive effect on the trade balance/GDP ratio. Essentially, the dynamic effects of protectionism in small open economies are akin to those of negative supply-side shocks that contract output, increase prices, and have a combination of contrasting effects on the trade balance.

In the second part of the paper, we lay down a benchmark small open economy model of international trade and macroeconomic dynamics to delve deeper into the dynamic effects of protectionism. We first show the model replicates the VAR evidence both qualitatively and quantitatively. We then use the model to study the transmission of protectionism, including scenarios where data limitations prevent econometric analysis.

The model builds on Ghironi and Melitz's (2005) dynamic stochastic general equilibrium version of Melitz's (2003) trade model by incorporating the endogenous entry of heterogeneous producers into domestic and export markets. Differently from Ghironi and Melitz, endogenous tradedness in the tradable sector (the fact that only a subset of tradable goods is actually traded in equilibrium) is supplemented by the inclusion of a traditional exogenously non-tradable sector. We also assume that one of the two countries in the model is a small open economy that has no impact on the rest of the world. Finally, we introduce nominal rigidity in the form of sticky nominal wages. We calibrate the model and study the consequences of an increase in protectionism by the small open economy under flexible exchange rates.

The predictions of the model match the robust results of the empirical evidence: Protectionism is inflationary, recessionary, and can generate a small improvement in the trade balance, but at the cost of a recession. The model highlights the importance of both macro and micro forces for the contractionary effects of tariffs. Higher import prices dominate a decline in the price of domestic non-tradables (due to lower aggregate demand) in driving CPI inflation upward. Tariffs induce expenditure switching toward domestic tradable goods, but they also reallocate domestic market share toward less efficient domestic producers, lowering aggregate productivity. In turn, higher domestic prices reduce aggregate real income (expenditure reduction), lowering investment in physical capital and product creation. Intuitively, since physical capital includes both domestic and imported goods, the import tariff increases the price of investment. Moreover, since households spend more of their real income to consume any given amount of imports, the demand for domestic goods declines, reducing the number of producers on the market. In addition to this, the central bank's response to higher inflation further imparts a contractionary impulse.

Lower aggregate demand and monetary policy contraction dominate expenditure switching, causing a recession in the aftermath of an increase in protectionism. The decline in investment propagates the negative effects of higher tariffs over time.[1] Improvement in the trade balance follows from the combination of expenditure switching and the fact that contraction of domestic income reduces the demand for imports. Overall, the model and empirical investigation line up closely in terms of qualitative and quantitative results and implications: In normal times and under a flexible exchange rate, protectionism is not advisable if policymakers want to avoid economic contraction, and, given its recessionary effect, it is at best of dubious value if policymakers want to improve their countries' external accounts.

We then use the model to study counterfactual scenarios where temporary trade barriers have been advocated as potentially beneficial. We first consider the argument that protectionism could be helpful when countries are in a liquidity trap (i.e., when countries are stuck at the ZLB on policy interest rates). Both our empirical evidence and theoretical analysis suggest that protectionism is inflationary. Through this channel, protectionism may indeed be temporarily useful to lift economies out of ZLB situations. We therefore perform the following counterfactual exercise: Suppose the model-home economy is hit by an exogenous, recessionary shock that pushes the central bank against the ZLB constraint. Would the imposition of tariffs on imports in the aftermath of this shock help lift the economy out of the liquidity trap? Since the predictions of the model line up nicely with the evidence when tariffs are imposed under "normal economic conditions"—none of the countries in our empirical analysis found itself at the ZLB in our sample—the counterfactual exercise sheds empirically-relevant light on the issue of interest.

The answer is that any beneficial inflationary effects of protectionism are not sufficient to overcome the unfavorable macroeconomic effects of reduced real income. Moreover, larger or more persistent trade shocks have larger recessionary effects along the transition dynamics when the economy is at the ZLB. The reason is that larger or more persistent tariff increases have a more unfavorable effect on aggregate demand, which reduces the extent to which the trade policy is inflationary. Through this channel, a large or persistent trade policy shock ends up becoming

[1] This finding is consistent with Cavallo and Landry (2018), who show that capital-goods imports have a significant impact on output growth.

deflationary very shortly after its initial inflationary effect, which worsens the liquidity trap instead of ameliorating it.

We then explore the consequences of protectionism for countries that peg the nominal exchange rate. Our interest reflects the widespread diffusion of pegs, crawling pegs, or very narrow bands (Reinhart and Rogoff, 2004). A recent illustration of the issue is the experience of Ecuador—a dollarized economy that applied a broad range of temporary tariffs between 2015 and 2016 to fight a balance-of-payments crisis. Over this period, the trade balance of Ecuador effectively improved, but the growth of real GDP further declined, together with consumption and investment. In contrast to the typical conclusion of textbook models, we find that protectionism remains contractionary even when the exchange rate is fixed: Higher import prices continue to result in lower aggregate income and investment, pushing the economy into a recession.

In sum, the policy conclusion of our paper is that protectionism remains costly—at least for small open economies—even when it is used temporarily, even when economies are stuck in liquidity traps, and regardless of the flexibility of the exchange rate. Detrimental economic effects arise even abstracting from retaliation from trade partners.

Related Literature The paper is related to several literatures. There is a massive amount of work that studies virtually every aspect of the consequences of protectionism in the international trade field, both theoretically and empirically. It is impossible to do this work any justice in the limited space of a non-survey paper.[2] Our research is obviously related to work in the trade field by virtue of using data and concepts that are familiar to trade economists—most notably, Bown (2011) and Bown and Crowley (2013, 2014).[3] To the best of our knowledge, this is the first study to use high frequency trade policy data to identify the short-term macroeconomic effects of protectionism.[4]

The paper also contributes to a growing literature that explores the effects of trade linkages on macroeconomic fluctuations, with particular emphasis on the role of firm dynamics (e.g., di Giovanni, Levchenko, and Mejean, 2014 and 2018; di Giovanni and Levchenko, 2014; Ghironi and Melitz, 2005). We connect to trade research by incorporating rigorous, state-of-the-art trade microfoundations in our macroeconomic model. This allows us to move the frontier set by early analyses of the dynamic effects of protectionism in international macro models closer to the current

[2] See Goldberg and Pavcnik (2016) and references therein for a comprehensive discussion of the effects of trade policy on trade volumes, prices, productivity, and labor market outcomes.

[3] Our analysis also relates to the literature on the aggregate long-run effects of TTBs (Ruhl, 2014) and their implications for aggregate trade volumes (e.g., Lu, Tao, and Zhang, 2013, and Vandenbussche and Zanardi, 2010).

[4] Furceri, Hannan, Ostry, and Rose (2018) estimate the effects of higher tariffs on various macroeconomic outcomes by using local projections and annual data. Their findings are consistent with our panel VAR evidence.

frontier of the trade field, and to use present-day modeling tools to address the connection between protectionism and macroeconomic dynamics that so many analysts and pundits are spilling ink on.

The macroeconomic effects of trade policy were among the topics of Mundell's (1961) seminal analysis of "Flexible Exchange Rates and Employment Policy." Mundell warned against the potential recessionary effects of restrictive trade policies under flexible exchange rates, but highlighted deflationary effects of terms of trade movements. Krugman (1982) showed that Mundell's conclusion is in fact quite robust to various extensions of the basic IS-LM model. Dornbusch, Fischer, and Samuelson (1977) included changes in tariffs among the scenarios they explored in their Ricardian model of international trade and macro dynamics. Eichengreen (1981, 1983) studied the consequences of tariffs in a portfolio balance model of exchange rate and macro dynamics. In contrast to previous work, he found that a tariff can have temporary expansionary effects before reducing output and employment in subsequent periods. In more recent literature on trade and macro dynamics, interest shifted toward understanding the dynamic consequences of trade integration (permanently lower trade costs) rather than temporary increases in protectionism. For instance, see Barattieri's (2014) analysis of global imbalances and asymmetric trade integration in goods versus services, or Cacciatore's (2014) study of trade integration and labor market dynamics with heterogeneous firms and labor market frictions. Farhi, Gopinath, and Itskhoki (2014) pioneered a literature that investigates the ability of policymakers to deliver devaluation-consistent dynamics under a flexible exchange rate by using fiscal policy tools, and a budding literature is exploring the macroeconomic consequences of combinations of trade policy instruments (tariffs-cum-subsidies) or of the border adjustment proposal (Barbiero, Farhi, Gopinath, and Itskhoki, 2017; Erceg, Prestipino, and Raffo, 2017; Lindé and Pescatori, 2017). We restrict attention to tariffs (which would be legal to impose under WTO rules in the context of antidumping procedures) as the benchmark trade policy tool, and—when the exchange rate is fixed—we do not design tariff setting to generate dynamics that mimic any feature of a devaluation.[5] We focus on exogenous increases in tariffs to keep the model-based exercise close to the empirical investigation. Our paper contributes to the literature that reintroduces analysis of protectionism in present-day international macro modeling by using a quantitative trade and macro model with implications in line with the evidence on the issues we focus on.[6]

[5] Auray, Devereux, and Eyquem (2019) study theoretically and empirically the relationship between exchange rate adjustment and trade policy.

[6] By exploring whether protectionism is expansionary at the ZLB, this paper is also related to the study of the possible expansionary effects of negative supply shocks in Wieland (2016) and to the analysis of non-conventional fiscal policy at the ZLB by Correia, Farhi, Nicolini, and Teles (2011).

There is much that this paper does not do: We restrict attention to small open economies, since this is where we find more data to perform empirical investigation of the dynamic effects of protectionism. Given the recent actions by the Trump administration, and the responses by China and the European Union (EU), it will be important to investigate the interaction of protectionism and macro dynamics when economies are large and their policies have non-negligible external effects. The recent papers we mentioned in the previous paragraph make a start at that in models that do not feature the trade microfoundation of our framework. We do not study optimal tariff setting.[7] Finally, we do not address the distributional consequences of protectionism or the dynamic impact it could have on the sectoral structure of the economy. These are all interesting, important topics that we leave for future research.

Outline The rest of the paper is organized as follows. Section 2 presents our empirical exercise. Section 3 lays down the model. Section 4 presents the calibration, Section 5 uses the calibrated model to investigate the effects of imposing tariffs in normal times or at the ZLB. Section 6 studies the effects of protectionism under a fixed exchange rate. Section 7 concludes.

2 Empirical Evidence

In this Section, we study the macroeconomic effects of trade policy shocks by applying structural vector autoregression methods. First, we use quarterly and monthly measures of temporary trade barriers and macroeconomic data for individual countries. Second, we consider annual tariffs and macroeconomic data for a panel of twenty-one small-open economies. We identify trade policy shocks by exploiting decision lags inherent in trade policy decisions. The main conclusion is that protectionism acts as a supply shock, as it is both inflationary and recessionary. At the same time, protectionism has at best a small positive effect on the trade balance.

2.1 Monthly and Quarterly Trade Policy Data

Antidumping duties, global safeguards, and countervailing duties—what Bown (2011) calls temporary trade barriers (TTBs)—are the primary policy exceptions to the trade rules embodied in the GATT/WTO. These are the policies used by both industrial and developing countries to implement

[7] Eaton and Grossman (1981) provide an interesting analysis of the interaction of optimal tariff setting and market incompleteness for a small open economy. They find that incomplete markets motivate the optimality of positive tariffs. Optimal tariff arguments are part of the analysis of monetary policy in Bergin and Corsetti (2015). They use a model with endogenous producer entry in the traded sector, but they do not focus on the consequences of trade policy shocks.

new trade restrictions during the last twenty years. As a result, exporters are simultaneously subject to low (on average) applied import tariffs, while facing frequently changing temporary trade barriers. Among the latter, antidumping initiatives account for the vast majority of trade policy actions—across countries, they account for between 80 and 90 percent of all temporary trade barriers.

The Global Antidumping Database (GAD), maintained by Bown (2016), collects and organizes information on product-level antidumping investigations since the 1980s across country users. The database provides information about the dates in which antidumping investigations are initiated, their outcomes (i.e., the amount of ad-valorem or specific antidumping duties), and the products involved. Given the structure of the dataset, it is possible to build time series data for antidumping policy actions at any time frequency longer than daily.

Following Bown and Crowley (2013), our baseline measure of trade policy corresponds to the number of HS-6 products for which an antidumping investigation begins in a given quarter or month. We construct time series data by matching the initiation dates of each anti-dumping case recorded in the GAD to the number of HS-6 products interested by each investigation. Notice that while the products subject to investigations are typically recorded with HS-6 codes, in some cases the information is available at a more disaggregated level (8- or 10-digits). As in Bown (2011), we record such observations at the HS-6 level whenever at least one sub-product is subject to the investigation.[8]

We focus on Canada in the main text. In the Appendix, we also report the results for Turkey and India. Our choice reflects the importance of temporary trade barriers in these three countries. Canada is the largest and most active user among developed small-open economies; Turkey and India are the largest users in absolute terms (Bown, 2011). For instance, in Turkey, up to 5.3 percent of imported products are subject to temporary trade barriers over the period 1994-2009 (Bown, 2011), amounting to 1 percent of GDP. In Canada, the percent of imported products is 2.2 percent, amounting to 0.4 percent of GDP. A salient feature of TTBs is the predominant use in key sourcing industries such as base metals and metal products, chemicals and allied products, and plastics and rubber products. As a result, in the aggregate, the effects of TTBs also propagate through vertical production linkages.

Figures 1 reports the dynamics of new antidumping initiatives at quarterly frequency together

[8] A very small fraction of observations are recorded at the 4-digit level. Our baseline measure does not include these observations. In Appendix B, we show that our results are robust to an alternative treatment of 4-digit observations.

with the growth rate of real GDP for Canada. The figure shows substantial variation over time in the trade policy measure. Furthermore, the figures highlight the lack of systematic correlation between antidumping investigations and aggregate conditions. The unconditional contemporaneous correlation between GDP growth and new antidumping investigations is 0.04 (the figure is very similar when considering linearly detrended GDP). The three largest spikes in antidumping investigations occur at times of positive economic growth, with a rather modest increase during the Great Recession.

2.1.1 Empirical Strategy

For each country, we estimate a structural VAR: $AY_t = \Theta + \sum_{i=1}^{p} \Phi_i Y_{t-i} + u_t$, where Y_t is a vector that collects the trade policy measure and the macroeconomic variables; u_t is a vector of structural innovations such that $E(u_t u_t') = I_N$; and A contains the structural parameters on the contemporaneous endogenous variables, i.e., A is the matrix that links structural- and reduced-form innovations. We consider both quarterly and monthly time series. Quarterly data allow us to use a comprehensive measure of aggregate economic activity (real GDP rather than industrial production). Monthly data feature a larger number of observations, allowing us to include more series in the VAR.

We identify structural trade policy shocks by exploiting the contemporaneous exogeneity of antidumping investigations with respect to macroeconomic variables. The assumption that antidumping initiatives do not respond to macroeconomic shocks within a month or a quarter reflects the existence of decision lags in the opening of investigations. As summarized in Figure 2, decision lags stem from technical aspects of regulation and coordination issues among producers: The opening of an investigation requires filing a petition (supported by a minimum number of producers) that gathers evidence about dumped imports and a preliminary assessment of compliance.[9]

For these reasons, we order the trade policy measure first in the VAR and impose a recursive ordering of the structural shocks. Since we are not interested in identifying shocks to macroeconomic variables, their ordering (i.e., the corresponding exclusion restrictions) is irrelevant for the purpose of our analysis.

The identifying assumption is valid as long as trade policy actions are not anticipated by economic agents—from an econometric standpoint, anticipation can lead to a non-fundamental moving average VAR representation. Our focus on the initiations of antidumping investigations rather than

[9] For instance, in Canada 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 45 days (Hearn, 2004).

on their final outcome (i.e., the imposed antidumping duties) addresses this issue. First, the opening of an investigation is immediately announced to the public and agents can access the supporting evidence about the margins of dumping. Since antidumping duties are commensurate to the margins of dumping, antidumping tariffs are predictable at the time of the investigation. Second, the application of antidumping duties is in general retroactive (up to the beginning of the investigation). Third, the share of antidumping investigations that end up with the imposition of tariffs is substantial (approximately 75 percent of cases in Canada and more than 85 percent of cases in Turkey and India). For these reasons, our benchmark specification focuses on the initiation of antidumping investigations.[10]

Finally, a few words on the relationship between our identification approach and the countercyclical, lagged response of TTBs to macroeconomic variables (Bown and Crowley, 2013) are in order. First, what matters for the identification of trade policy shocks is the exogeneity of TTBs with respect to contemporaneous macroeconomic shocks—the VAR structure already accounts for the lagged response of antidumping investigations to macroeconomic shocks that occurred in previous periods. Second, our analysis uses monthly and quarterly data. At such frequencies, the decision lags that characterize the opening of an investigation imply that the number of antidumping initiatives is not affected by current macroeconomic shocks. Third, as discussed below, our results are not sensitive to the identifying exclusion restriction.

2.1.2 Results

We now turn to the discussion of macroeconomic variables and results.

Quarterly Data For each country, we estimate a structural VAR with four observables: the number of antidumping initiatives, real GDP growth, the core CPI inflation rate, and real net exports over GDP.[11] The data cover the period 1994:Q1 to 2015:Q4. Appendix A presents the details about the data. We estimate the VAR including two lags of each variable.[12]

Figures 3 reports the impulse responses to a one-standard deviation shock to antidumping

[10] Whether or not the assumption has first-order effects depends on the time elapsing between the beginning and the end of an investigation. For Canada, the median duration of an investigation is 90 days, suggesting that at quarterly frequencies the distinction is less important. Staiger and Wolak (1994) find that the mere opening of an antidumping investigation has effects on imports due both to an exporter pricing mechanism and to an importer reaction to the filing of an investigation.

[11] Core inflation is more appropriate than headline inflation to assess the effects of antidumping investigations, since in practice antidumping policy is never applied to energy products. Results remain robust when considering headline CPI inflation.

[12] The Akaike information criterion suggests this is a plausible choice for both countries.

initiations in Canada. As standard practice in the literature, we report error bands at the 68 and 90 percent confidence level via bootstrapping as in Kilian (1998). The shock implies a 50 percent increase in the average number of HS-6 products subject to new antidumping investigations. Figure 3 shows that inflation increases and the growth rate of GDP declines. There is a modest, albeit significant, increase in the trade balance to GDP ratio. Annualized inflation rises by approximately 0.2 percent at the peak, while GDP growth declines by 0.1 percent at the trough. To understand the magnitude of the responses, we examine the economic significance of antidumping investigations in the largest episodes in our sample. For instance, consider the highest Canadian peak in quarter 2001:Q1. In this episode, the products under investigation were all in the steel sector, accounting for approximately 30 percent of sectoral imports. In turn, the steel sector's contribution to Canadian GDP was 1.1 percent, inclusive of input-output linkages.[13] All these initiatives ended up with the imposition of tariffs, with a median rate equal to 56 percent. The figures are similar when considering the second highest peak in quarter 1998:Q4.

Monthly Data At monthly frequency, we replace real GDP growth with the log-deviations of industrial production from a deterministic trend, and we consider the level of real net exports (measured in 2010 USD billions). We also add the nominal interest rate and the appreciation rate of the effective nominal exchange rate to the list of macroeconomic variables. The period of analysis is 1994:M1-2015:M12.[14]

Figure 4 shows that industrial production declines, and the response remains negative and statistically significant for several months. The annualized inflation rate displays a statistically significant increase after four months (by about 0.3 percent), while the response of the nominal interest rate is statistically insignificant at all horizons. Initially, the response of net exports is positive and statistically significant, followed by a decline, which is however not statistically significant. The nominal exchange rate displays an appreciation, which becomes significant at the fifth month.

2.1.3 Robustness

We conduct several exercises to assess the robustness of our findings. First, we address the possibility that antidumping investigations reflect expectations about future economic conditions that

[13] We sum the share of NAICS-6 digit steel sector's value added over GDP and the share of steel output used as an input in other industries. The steel sector directly accounted for 0.3 percent of Canadian GDP, while the intermediate-input usage was worth 0.8 percent of GDP.

[14] We include 6 lags of each variable in the VAR.

are not captured by past information from the variables included in the VAR. Toward this end, we use projections data published by the Bank of Canada (Champagne, Poulin-Bellisle, and Sekkel, 2018) to construct the expected, quarter-to-quarter growth rate of real GDP and imports. For each quarter t, we take the log difference between real-time data and the next-quarter forecast. We then include both measures in the monthly and quarterly VARs.[15] Consistent with our identification strategy, we assume that current expectations do not affect antidumping initiatives contemporaneously—the results are nevertheless unaffected when considering the alternative possibility of a contemporaneous effect. As shown by the first row in Figure 5 and 6, the impulse responses remain very similar to the baseline specification for both the quarterly and monthly VAR. This result is not surprising, since the nature of TTBs is backward looking—formally, TTBs represent a response to foreign unfair competition.[16]

Second, we include the real price of oil, a control for additional supply-side determinants of GDP and inflation as well as a leading indicator of economic activity.[17] Also in this case, as shown by the second row in Figure 5 and 6, the response of GDP, inflation, and net exports remains very similar to the baseline specification.

Third, we investigate whether the results are sensitive to the assumption that antidumping initiations are exogenous to current economic conditions. In particular, we consider an alternative recursive ordering in which antidumping initiatives respond contemporaneously to all macroeconomic shocks, i.e., we order the trade policy measure last in the VARs. While this alternative identification scheme is not consistent with the presence of institutional delays in the antidumping process, the experiment allows us to understand whether assumptions about the contemporaneous relationship between TTBs and macro variables matter for the results. The third row in Figure 5 and 6 show that this is not the case, since responses do not fundamentally change relative to the baseline VARs.

In Appendix B we perform additional exercises. First, we consider alternative temporary trade policy measures:(i) we construct a measure that exploits information about the outcomes of antidumping investigations, restricting the sample to the initiatives that effectively end up with the imposition of a tariff; (ii) we construct an overall temporary trade barrier measure that includes global safeguards and countervailing duties (in addition to antidumping investigations). Second,

[15] At monthly frequency, we assume the quarterly forecast applies to each month within a quarter.

[16] In Appendix B, we also show that the same forward-looking variables (together with the growth rate of Canadian stock market prices) do not Granger cause the trade policy shocks identified in the baseline VARs. This result provides additional evidence that anticipatory effects are not a key driver of TTBs.

[17] We use the global price of WTI Crude provided by the Federal Reserve Bank of St. Louis.

we verify that our results are not driven by the largest spikes in the dynamics of antidumping investigations. Visual inspection of the time series of our trade policy measure reveals there are three such episodes in Canada (1997:Q4, 1998:Q4, and 2001:Q1). We construct dummy variables for each episode and re-estimate the VAR. The magnitude of the impulse responses is reduced, but the results are qualitatively the same. Finally, we replace the growth rate of real GDP with log-deviations of real GDP from a deterministic trend. Across all the scenarios we consider, the results remain similar to the benchmark specification.

2.1.4 Additional Countries: Turkey and India

To provide additional robustness, we also estimate quarterly and monthly VARs on Turkish and Indian data. These two countries are particularly suited for the analysis since they are the most important users of TTBs.[18] However, the nature of their business cycle dynamics (and data limitation) introduce additional econometric challenges. For instance, in Turkey, annualized inflation averaged at 75 percent percent between 1994 and 2002, and the country experienced both financial and monetary policy reforms in the aftermath of the 2001 crisis. India featured deep structural transformation in the last twenty-five years, including several economic reforms that started in 1991.

Appendix B shows that, qualitatively, the impulse responses following the identified trade-policy shocks are identical to Canada. Real economic activity declines, inflation rises, and net exports increases. The effects are statistically significant. From a quantitative standpoint, the magnitude of the effects is larger relative to Canada, reflecting higher underlying volatility of these two economies—see Appendix B for more discussion.

2.2 Annual Tariff Data: A Panel Structural VAR of Small Open Economies

The Global Antidumping Database makes it possible to construct monthly and quarterly measures of trade policy. However, antidumping investigations only apply to a subset of imports. For this reason, we now consider a more comprehensive trade policy measure, the import-weighted average of the applied tariff rates.[19]

[18] Since 1995, Turkey has a customs union agreement with the EU. Therefore, the temporary trade barriers we focus on represent the country's main discretionary trade policy tool.

[19] We use HS-2 digits tariff rates from WITS. We use the concept of effectively applied tariff, which is defined as the lowest available tariff. If a preferential tariff exists, it is used as the effectively applied tariff. Otherwise, the MFN applied tariff is used. The import-weighted average of applied tariff rates is computed by using fixed weights, with imports fixed at the 1999 level. This addresses the concern that variation in the average may reflect changes in

Since tariff data are only available at annual frequency, we estimate a panel structural VAR using harmonized data for a sample of twenty-one countries over the period 1999-2016.[20] All the countries in the sample had a floating exchange rate regime and none of them hit the zero lower bound on the policy interest rate over the sample period.[21]

Figure 7 plots the tariff data for the twenty-one countries in our sample. Over time, the applied tariff rates show a general decline in all the countries considered. However, there is significant variation around the downward trend in several countries. Given this observation, we measure temporary trade policy interventions by removing a deterministic trend from the tariff series.

Our benchmark VAR specification includes three macroeconomic variables: the growth rate of real GDP, CPI inflation, and net exports over GDP.[22] The data come from the World Development Indicators database (see Appendix A for details). We also include country-fixed effects, accounting for unobserved, time-invariant cross-country heterogeneity, and year fixed effects, accounting for the presence of common shocks across countries. Due to the limited dimension of the dataset, we restrict each equation coefficient to be the same across countries.

We continue to identify trade policy shocks by assuming that trade policy responds with a one-period delay to macroeconomic shocks. As before, the assumption reflects decision lags in trade policy changes. For instance, in the context of the WTO, when tariffs increase above their bound rate, countries have to negotiate with the most concerned trading partners (possibly settling a compensation for the loss of trade). Moreover, various countries in our sample are part of custom unions (Brazil, Colombia, Paraguay, Turkey and Uruguay), and common external tariffs are set at the level of the union. We estimate the VAR including one lag of each variable.

Figure 8 (Panel A) reports the impulse responses to a one-standard deviation tariff increase (around 1.75 percentage points).[23] Inflation rises by 0.3 percentage points, while GDP growth decreases by about 0.2 percent on impact. Net exports over GDP increase by 0.25 percent at the peak, and the effect is statistically significant.[24] We obtain similar results (available upon request),

weights rather than in tariffs.

[20] We choose the sample period to include as many countries as possible in the analysis. The sample includes Australia, Brazil, Canada, Chile, Colombia, Iceland, Indonesia, India, Israel, South Korea, South Africa, Malaysia, Mexico, Norway, New Zealand, Peru, Philippines, Paraguay, Thailand, Turkey, and Uruguay.

[21] Malaysia pegged its currency to the US dollar for part of the sample. However, the exclusion of Malaysia from the sample does not affect our results.

[22] The panel-unit-root tests proposed by Levin, Lin, and Chu (2002) reject at the one percent confidence level the presence of unit roots in the three macroeconomic variables we use (against the alternative that each panel variable is stationary).

[23] As before, the error bands are at 68 and 90 percent confidence level and obtained via bootstrapping as in Kilian (1998). Panel B in Figure 8 presents the responses generated by the model described in the next section.

[24] In Appendix C, we show that the improvement of the trade balance is the result of a decline in imports that

when we include a measure of the short-term interest rate in the VAR. Following a tariff shock, the response of the interest rate is positive and statistically significant.

Overall, the empirical analysis provides evidence of non-negligible macroeconomic effects of temporary trade barriers at frequencies that are relevant for business cycle analysis. In particular, trade policy tends to be inflationary and recessionary in small open economies that operate under flexible exchange rates. At the same time, protectionism has at best a small positive effect on the trade balance.

3 The Model

In this Section, we develop the small open economy model of trade and macroeconomic dynamics that we will use for the exercises in the remainder of the paper. The trade-policy instrument we consider is an ad-valorem import tariff. This approach allows us to relate the model dynamics to the empirical evidence (panel VAR) in a transparent way.

As is now standard practice in the literature, we model the small open economy as a limiting case of a two-country dynamic general equilibrium model in which one country (the small open economy, also referred to as Home) is of measure zero relative to the rest of the world (Foreign henceforth). As a consequence, the policy decisions and macroeconomic dynamics of the small open economy have no impact on Foreign. The small economy's terms of trade fluctuate endogenously in response to aggregate shocks due to the presence of firm monopoly power in both countries. Next we describe in detail the problems facing households and firms in the small open economy.

3.1 Household Preferences

The small open economy is populated by a unit mass of atomistic households. Each household is a monopolistic supplier of one specific labor input. The representative household, indexed by $h \in [0,1]$, maximizes the expected intertemporal utility function

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t(h)^{1-\gamma_C}}{1-\gamma_C} - \frac{L_t(h)^{1+\gamma_L}}{1+\gamma_L} \right), \tag{1}$$

where $\beta \in (0,1)$ is the discount factor, $C_t(h)$ is a consumption basket that aggregates traded and non-traded goods as described below, and $L_t(h)$ is the number of hours worked. In order to simplify

more than offsets a decline in exports.

the notation, we anticipate symmetry of the equilibrium across households and omit the index h below, unless it is necessary for clarity.

Consumption is a C.E.S. composite of tradable and non-tradable baskets, C_t^T and C_t^N:

$$C_t = \left[(1-\alpha_N)^{\frac{1}{\phi_N}} \left(C_t^T\right)^{\frac{\phi_N - 1}{\phi_N}} + \alpha_N^{\frac{1}{\phi_N}} \left(C_t^N\right)^{\frac{\phi_N - 1}{\phi_N}}\right]^{\frac{\phi_N}{\phi_N - 1}},$$

where $\alpha_N \in (0,1]$ is the share of non-tradables and $\phi_N > 0$ denotes the constant elasticity of substitution. The consumption-based price index is $P_t = \left[(1-\alpha_N)\left(P_t^T\right)^{1-\phi_N} + \alpha_N \left(P_t^N\right)^{1-\phi_N}\right]^{\frac{1}{1-\phi_N}}$, where P_t^T is the price of the tradable basket and P_t^N is the price of the non-tradable basket (all prices are in units of Home currency unless noted).

The non-tradable consumption basket C_t^N aggregates consumption varieties $C_t^N(n)$ over a continuum $[0,1]$: $C_t^N = \left[\int_0^1 C_t^N(n)^{(\theta_N-1)/\theta_N} dn\right]^{\theta_N/(\theta_N-1)}$, where $\theta_N > 1$ is the symmetric elasticity of substitution across non-tradable goods. The corresponding consumption-based price index is $P_t^N = \left[\int_0^1 P_t^N(n)^{1-\theta_N} dn\right]^{1/(1-\theta_N)}$, where $P_t^N(n)$ is the price of product n.

We use the subscript D to denote quantities and prices of a country's own tradable goods consumed domestically, and the subscript X to denote quantities and prices of exports. The tradable consumption basket C_t^T aggregates consumption sub-baskets of Home tradables and Foreign exports in Armington form with elasticity of substitution $\phi_T > 0$:

$$C_t^T = \left[(1-\alpha_X)^{\frac{1}{\phi_T}} \left(C_{D,t}^T\right)^{\frac{\phi_T - 1}{\phi_T}} + \alpha_X^{\frac{1}{\phi_T}} \left(C_{X,t}^{T*}\right)^{\frac{\phi_T - 1}{\phi_T}}\right]^{\frac{\phi_T}{\phi_T - 1}}, \quad 0 < \alpha_X < 1,$$

where $1-\alpha_X$ is the weight attached to the country's own good. Preferences for tradables are biased in favor of domestic goods whenever $\alpha_X < 1/2$. The price index that corresponds to the basket C_t^T is given by $P_t^T = \left[(1-\alpha_X)\left(P_{D,t}^T\right)^{1-\phi_T} + \alpha_X P_{X,t}^{T*1-\phi_T}\right]^{\frac{1}{1-\phi_T}}$.

Domestic tradable consumption, $C_{D,t}^T$, aggregates consumption varieties $C_{D,t}^T(\omega)$ over a continuum Ω: $C_{D,t}^T = \left[\int_{\omega\in\Omega} C_{D,t}^T(\omega)^{(\theta_T-1)/\theta_T} d\omega\right]^{\theta_T/(\theta_T-1)}$, where $\theta_T > 1$ is the symmetric elasticity of substitution across goods. A similar basket describes the imported consumption bundle: $C_{X,t}^{T*} = \left[\int_{\omega\in\Omega^*} C_{X,t}^{T*}(\omega)^{(\theta_T-1)/\theta_T} d\omega\right]^{\theta_T/(\theta_T-1)}$. As in Ghironi and Melitz (2005), at any given point in time, only a subset of goods $\Omega_t \in \Omega$ is available to consumers. Hence, the price index for the domestic tradable bundle is $P_{D,t}^T = \left[\int_{\omega\in\Omega_t} P_{D,t}^T(\omega)^{1-\theta_T} d\omega\right]^{1/(1-\theta_T)}$, where $P_{D,t}^T(\omega)$ is the nominal price of good $\omega \in \Omega_t$. The price index for the imported bundle is $P_{X,t}^{T*} = \left\{\int_{\omega\in\Omega_t} \left[\left(1+\tau_t^{IM}\right) P_{X,t}^{T*}(\omega)\right]^{1-\theta_T} d\omega\right\}^{1/(1-\theta_T)}$, where $\tau_t^{IM} \geqslant 0$ is an ad-valorem import tariff and $P_{X,t}^{T^*}(\omega)$ is the dock price of the imported variety (denominated in Home currency). We assume that the government rebates the tariff revenue to households in lump-sum fashion.[25]

3.2 Production

In each country, there are two vertically integrated production stages. At the upstream level, perfectly competitive firms use capital and labor to produce a non-tradable intermediate input. At the downstream level, two sectors use the intermediate input to produce tradable and non-tradable final consumption goods. In the benchmark version of the model, we consider flexible prices in both tradable and non-tradable sectors.

3.2.1 Homogeneous Intermediate Input Production

There is a unit mass of perfectly competitive intermediate producers. The representative intermediate firm produces output $Y_t^I = Z_t K_t^{\alpha} L_t^{1-\alpha}$, where Z_t is exogenous aggregate productivity, K_t is physical capital, and L_t is a bundle of the labor inputs supplied by individual households. The composite labor input aggregates in Dixit-Stiglitz form the differentiated labor inputs provided by domestic households: $L_t \equiv \left[\int_0^1 (L_t(h))^{(\eta-1)/\eta} dh\right]^{\eta/(\eta-1)}$, where $\eta > 0$ is the elasticity of substitution between the different labor inputs, and $L_t(h)$ denotes the labor hired from household h. The total wage bill is $w_t^n \equiv \left[\int_0^1 (w_t^n(h))^{1-\eta} dh\right]^{1/(1-\eta)}$, where $w_t^n(h)$ is the nominal wage rate paid to household h. Each household sets $w_t^n(h)$ acting as a monopolistic supplier of its differentiated labor input. We discuss wage determination when presenting the household's optimal decisions.

The Home intermediate sector firm chooses L_t and K_t to maximize per-period profit: $d_t^I \equiv \varphi_t Y_t^I - (w_t^n/P_t) L_t - r_{K,t} K_t$, where φ_t is the real price (in units of final consumption) of the intermediate input, and $r_{K,t}$ is the real rental rate of capital.

3.2.2 Non-Tradable Sector

Our model will feature Melitz-type selection of tradable producers into exporting. However, the Melitz model is best thought of as a model of the *tradable* sector, part of which turns out to be *non-traded* in equilibrium (thus, the model is naturally suited to capture the evidence that

[25] Our assumptions about preferences over consumption sub-bundles imply standard demand functions that depend on the relevant relative prices and quantities. We omit them for brevity and just note that the ad-valorem tariff acts as an import demand shifter: all else given, higher tariffs increase the relative price of Foreign exports and shift demand away from Foreign products.

many manufacturing producers do not export—see Bernard, Eaton, Jensen, and Kortum, 2003). We address the fact that economies include sectors that produce truly non-tradable output by augmenting the framework with an exogenously non-tradable sector.

This sector is populated by a continuum of monopolistically competitive firms, each producing a different non-traded variety n.[26] Production uses intermediate inputs in linear fashion. Optimal price setting implies that the real price of product n is equal to a markup over marginal cost: $\rho_t^N(n) \equiv P_t^N(n)/P_t = [\theta_N/(\theta_N - 1)]\varphi_t$.

3.2.3 Tradable Sector

There is a continuum of monopolistically competitive firms, each producing a different tradable consumption good variety that can be sold domestically and abroad. Firms are heterogeneous since they produce with different technologies indexed by relative productivity z. The number of firms serving the domestic and export market is endogenous. Prior to entry, firms face a sunk entry cost $f_{E.t}$ (in units of intermediate input), representing the real costs of regulation and the technological investment associated with market entry. Upon entry, Home and Foreign firms draw their productivity level z from a common distribution $G(z)$ with support on $[z_{\min}, \infty)$. This relative productivity level remains fixed thereafter. There are no fixed costs of production. Hence, all firms that enter the tradable sector produce in every period until they are hit by a "death" shock, which occurs with probability $\delta \in (0,1)$ in every period. Exporting is costly and involves both a per-unit iceberg trade cost $\tau_t > 0$ and a per-period fixed cost $f_{X,t}$ in units of the intermediate input.

Let $P_{D,t}^T(z)$ and $P_{X,t}^T(z)$ denote, respectively, the nominal domestic price (in Home currency) and the export price (in Foreign currency) set by Home producer z. Notice that $P_{X,t}^T(z)$ is the dock export price, i.e., $P_{X,t}^T(z)$ does not include Foreign import tariffs (if any). All firms set flexible prices that reflect the same proportional markup $\theta_T/(\theta_T - 1)$ over marginal cost. Let $\rho_{D,t}^T(z) \equiv P_{D,t}^T(z)/P_t$ and $\rho_{X,t}^T(z) \equiv P_{X,t}^T(z)/P_t^*$ denote real prices relative to the consumer price index in the destination market. The optimal prices are then given by: $\rho_{D,t}^T(z) = [\theta_T/(\theta_T - 1)]\varphi_t/z$ and $\rho_{X,t}^T(z) = (1+\tau_t)\rho_{D,t}^T(z)/Q_t$, where $Q_t \equiv \varepsilon_t P_t^*/P_t$ is the consumption-based real exchange rate (units of Home consumption per unit of Foreign) and ε_t is the nominal exchange rate (units of Home currency per unit of Foreign).

Due to the fixed export cost, a firm exports in a given period if and only if the export profit,

[26] We abstract from producer heterogeneity and endogenous producer entry in the non-tradable sector, since these mechanisms are not central to understanding the short-run effects of protectionism. See Cacciatore, Duval, Fiori, and Ghironi (2016) for a model with endogenous producer entry in the non-tradable sector.

$d^T_{X,t}(z)$, is non-negative. This will be the case as long as productivity z is above a cutoff level $z_{X,t}$ such that: $z_{X,t} = \inf\{z : d^T_{X,t}(z) > 0\}$—see Appendix D for the analytical details. Firms with productivity below 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.

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 an average productivity level $\tilde{z}_D$ for all producing firms that serve the domestic market and an average $\tilde{z}_{X,t}$ for all Home exporters. We relegate the details to Appendix D and only note here that, in every period, there is a mass $N_{D,t}$ of tradable-sector firms that produce in the Home country. Among these firms, there are $N_{X,t} = [1 - G(z_{X,t})] N_{D,t}$ exporters. For future reference, we follow Melitz (2003) in defining the average productivity of Home firms in the tradable sector as: $\tilde{z}_t = \left\{\tilde{z}_D^{\theta_T - 1} + [\tilde{z}_{X,t}/(1+\tau_t)]^{\theta_T - 1}(N_{X,t}/N_{D,t})\right\}^{1/(\theta_T - 1)}$.

Firm Entry and Exit In every period there is an unbounded mass of prospective entrants in both countries. Entrants at time t start producing only at $t+1$, a plausible assumption given the quarterly calibration we will pursue. The exogenous exit shock hits incumbents and new entrants with equal probability at the end of each period. Hence, the law of motion for the number of producing firms is $N_{D,t} = (1-\delta)(N_{D,t-1} + N_{E,t-1})$. The expected post-entry value, $\tilde{e}_t$, that a prospective entrant computes in taking the entry decision is given by the expected present discounted value of the stream of per-period average profits: $\tilde{e}_t \equiv E_t\left[\sum_{s=t+1}^{\infty} \beta_{t,s}(1-\delta)^{s-t}\tilde{d}^T_s\right]$, where $\beta_{t,t+s} \equiv \beta^s (C_{t+s}/C_t)^{-\gamma_C}$ is the stochastic discount factor and $\tilde{d}^T_s$ the average total profits, returned to households as dividends.[27] Entry occurs until average firm value equals the entry cost, leading to the free-entry condition $\tilde{e}_t = \varphi_t f_{E,t}$.

3.3 Household Budget Constraint and Intertemporal Decisions

International asset markets are incomplete, as non-contingent nominal bonds denominated in Foreign currency are the only internationally traded asset. The representative household can also invest in non-contingent nominal bonds denominated in Home currency, which are traded only domestically. Let $A_{t+1}(h)$ and $A_{*,t+1}(h)$ denote, respectively, nominal holdings of Home and Foreign bonds for the representative Home household h. To ensure a determinate steady-state equilibrium

[27] The average profit from domestic sales in period t is $\tilde{d}^T_{D,t} \equiv d^T_{D,t}(\tilde{z}_D)$, while the average export profit is $\tilde{d}^T_{X,t} \equiv d^T_{X,t}(\tilde{z}_{X,t})$. Thus, the average total profit of each Home firm is given by $\tilde{d}^T_t = \tilde{d}^T_{D,t} + (N_{X,t}/N_{D,t})\,\tilde{d}^T_{X,t}$.

and stationary responses to temporary shocks in the model, we follow Turnovsky (1985), and, more recently, Benigno (2009), and assume a quadratic cost of adjusting Foreign bond holdings $\psi \left[A_{*,t+1}(h)/P_t\right]^2/2$.[28] These costs are paid to financial intermediaries which rebate the revenue to households in lump-sum fashion in equilibrium.

In addition to bonds, the representative household can invest also in shares in a mutual fund of the domestic firms producing in the tradable sector. This is the mechanism through which household savings are made available to prospective entrants to cover their entry costs. The mutual fund pays a total real dividend in each period that is equal to the average total profit of all home firms in the tradable sector that produce in that period, $N_{D,t}\tilde{d}_t^T$. During period t, the representative household buys $x_{t+1}(h)$ shares in a mutual fund of $N_{D,t}+N_{E,t}$ firms. Even though only $1-\delta$ of these firms will produce and pay dividends in $t+1$, the household does not know which firms will be hit by the death shock. Hence, it finances operations by all incumbents and new entrants, with exit risk affecting the equilibrium price of equity. The date-t price of a claim to the future profit stream of the mutual fund is equal to the average price of claims to future profits of Home firms, $\tilde{e}_t$.

The household also accumulates physical capital and rents it to intermediate input producers in a competitive capital market. Investment in the physical capital stock, $I_{K,t}$, requires use of the same composite of all available varieties as the basket C_t. Physical capital obeys a standard law of motion: $K_{t+1}(h) = (1-\delta_K) K_t(h) + I_{K,t}(h)$, where $\delta_K \in (0,1)$ denotes the depreciation rate of capital.

Households set the nominal wage $w_t^n(h)$ subject to a quadratic adjustment cost $(\nu_w/2)\,\pi_{w,t}^2 w_t^n(h)\,L_t(h)$, where $\pi_{w,t}(h) = w_t^n(h)/w_{t-1}^n(h) - 1$ denotes nominal wage inflation. Wages are flexible if $\nu_w = 0$. In real terms, the adjustment cost can be interpreted as units of final consumption that the household needs to purchase when implementing a wage change. The size of this cost is assumed to be larger when the household's labor income increases.

The representative Home household's period budget constraint is:

$$A_{t+1}(h) + \varepsilon_t A_{*,t+1}(h) + \frac{\psi}{2}\varepsilon_t P_t^* \left(\frac{A_{*,t+1}(h)}{P_t^*}\right)^2 + P_t C_t(h) + P_t I_{K,t}(h) + \tilde{e}_t (N_{D,t}+N_{E,t}) x_{t+1}(h) =$$
$$(1+i_t) A_t(h) + (1+i_t^*) A_{*,t}(h)\,\varepsilon_t + \left[1 - \frac{\nu_w}{2}\pi_{w,t}^2(h)\right] w_t^n(h)\,L_t(h) +$$
$$+ P_t r_{K,t} K_t(h) + (\tilde{d}_t^T + \tilde{e}_t) N_{D,t} x_t(h) + T_t(h), \qquad (2)$$

[28] Since only Foreign bonds are traded across borders, defining an adjustment cost for Foreign bond holdings is sufficient to pin down a unique steady state and ensure stationarity of the model.

where i_{t+1} and i_{t+1}^* are, respectively, the nominal interest rates on Home and Foreign bond holdings between t and $t+1$, known with certainty as of t. Moreover, $T_t(h)$ aggregates lump-sum rebates of the cost of adjusting bond holdings, the profits from non-tradables producers, and the revenue that the government receives from tariffs.

The first-order condition for $w_t^n(h)$ implies that the real wage, $w_t(h) \equiv w_t^n(h)/P_t$, is a time-varying markup, $\mu_{w,t}(h)$, over the marginal rate of substitution between hours and consumption. Eliminating the household-identifier h, since symmetric households make identical choices: $w_t = \mu_{w,t} L_t^{\gamma_L}/C_t^{-\gamma_C}$. The endogenous wage markup is given by:

$$\mu_{w,t} \equiv \frac{\eta}{(\eta-1)\left(1-\frac{\nu_w}{2}\pi_{w,t}^2\right)+\nu_w\left\{\begin{array}{c}\pi_{w,t}(h)(1+\pi_{w,t}) \\ -E_t\left[\beta_{t,t+1}\pi_{w,t+1}\frac{(1+\pi_{w,t+1})^2}{1+\pi_{C,t+1}}\frac{L_{t+1}}{L_t}\right]\end{array}\right\}}.$$

Intuitively, households change their markups over time in order to smooth wage changes across periods.

The Euler equation for capital accumulation requires $1 = E_t\left[\beta_{t,t+1}\left(r_{K,t+1}+1-\delta_K\right)\right]$, while the Euler equation for share holdings implies $\tilde{e}_t = (1-\delta)E_t\left[\beta_{t,t+1}\left(\tilde{d}_{t+1}^T+\tilde{e}_{t+1}\right)\right]$. Finally, the Euler equations for bond holdings are:

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

$$1+\psi a_{*,t+1}+\Lambda_{at} = \left(1+i_{t+1}^*\right)E_t\left(\frac{\beta_{t,t+1}}{1+\pi_{C,t+1}^*}\frac{Q_{t+1}}{Q_t}\right),$$

where $a_{*,t+1} \equiv A_{*,t+1}/P_t$. The term Λ_{at} captures a risk-premium shock that we append to the Euler equations for bond holdings and that affects the household's demand for risk-free assets. We assume that Λ_{at} follows a zero-mean autoregressive process: $\Lambda_{at} = \rho_{\varepsilon_a}\Lambda_{at-1}+\epsilon_{at}$, where $\epsilon_{at} \overset{i.i.d.}{\sim} N\left(0,\sigma_{\epsilon_a}^2\right)$.[29]

We present the details of the symmetric equilibrium in Appendix D, and we limit ourselves to presenting the law of motion for net foreign assets below. Home bonds are in zero net supply and shares in the mutual fund of tradable producers are fully held domestically, which implies the

[29] We follow Smets and Wouters (2007) and subsequent literature in specifying this shock as an exogenous term appended to the Euler equations for bonds. Nevertheless, as shown by Fisher (2015), the shock Λ_{at} can be interpreted as a structural shock to the demand for safe and liquid assets, i.e., Λ_{at} captures, in reduced form, stochastic fluctuations in household preferences for holding one-period nominally risk-free assets. Notice that the risk-premium shock is isomorphic to a discount factor shock (a "beta shock") only up to a first-order approximation.

equilibrium conditions $a_{t+1} = a_t = 0$ and $x_{t+1} = x_t = 1$ in all periods. Home net foreign assets are determined by: $Q_t a_{*,t+1} = Q_t (1 + r_t^*) a_{*,t} + TB_t$, where r_t^* is the foreign real interest rate, defined by $1 + r_t^* = (1 + i_t^*)/(1 + \pi_{C,t}^*)$ and $\pi_{C,t}^* \equiv P_t^*/P_{t-1}^* - 1$, and $TB_t \equiv N_{X,t} Q_t \tilde{\rho}_{X,t}^T C_{X,t}^T - N_{X,t}^* \tilde{\rho}_{X,t}^* C_{X,t}^{T*}$ is the trade balance. The change in net foreign assets between t and $t+1$ is determined by the current account: $Q_t (a_{*,t+1} - a_{*,t}) = CA_t \equiv Q_t r_t^* a_{*,t} + TB_t$.

3.4 Monetary Policy

To close the model, we specify a rule for monetary policy. Our benchmark policy specification considers a flexible exchange rate. We explicitly take into account the possibility that the nominal interest rate i_{t+1} cannot fall below some lower bound i^{zlb}, so that, in each period, the interest rate is constrained to be such that $i_{t+1} \geqslant i^{zlb}$. We set i^{zlb} equal to zero in our simulations. Thus, the monetary authority sets the nominal interest rate following a feedback rule of the form $1 + i_{t+1} = \max \left\{ 1 + i^{zlb}, (1 + i_t)^{\varrho_i} \left[(1 + i) (1 + \tilde{\pi}_{Ct})^{\varrho_\pi} \left(\tilde{Y}_{gt} \right)^{\varrho_Y} \right]^{1-\varrho_i} \right\}$, where i is the steady-state nominal interest rate. Since gains from variety are mostly unmeasured in CPI data (Broda and Weinstein, 2010), we assume that the central bank responds to data-consistent measures for CPI inflation and the output gap, $\tilde{\pi}_{Ct}$ and $\tilde{Y}_{gt}$ respectively.[30] Following Ghironi and Melitz (2005), we obtain a data-consistent price index, $\tilde{P}_t$ that removes the pure product variety effect from the welfare-consistent index P_t as explained in Appendix E. In turn, $\tilde{\pi}_{Ct} = \tilde{P}_t/\tilde{P}_{t-1} - 1$ and $\tilde{Y}_{gt} = P_t Y_{gt}/\tilde{P}_t$, where the GDP gap, Y_{gt}, measures deviations of GDP, $Y_t \equiv C_t + I_{Kt} + TB_t$, from the flexible-wage outcome.

Table A.1 in the Appendix summarizes the equilibrium conditions of the model. Since we do not focus on the consequences of changes in entry costs and iceberg trade costs, we assume $f_{E,t} = f_E$, $f_{X.t} = f_X$, and $\tau_t = \tau$ in all periods. Moreover, we keep aggregate productivity constant at its steady-state value, $Z_t = Z_t^* = Z$. Eight Foreign variables directly affect macroeconomic dynamics in the small open economy: Y_t^*, i_{t+1}^*, $\pi_t^{C^*}$, $\rho_t^{T^*}$, $\rho_{X,t}^{T*}$, $\tilde{\rho}_{X,t}^{T*}$, $\tilde{Y}_{X,t}^{T^*}$, 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. To determine price and quantities related to Foreign exports, we assume that Foreign producers solve a profit maximization problem that is equivalent to that faced by Home producers (see Appendix D).

[30] In the presence of endogenous producer entry and preferences that exhibit "love for variety," the welfare-consistent aggregate price index P_t can fluctuate even if product prices remain constant.

4 Calibration

We interpret periods as quarters. We set the discount factor β equal to 0.99, the share of capital in the Cobb-Douglas production function of the upstream intermediate sector, α, equal to 0.33, the capital depreciation rate δ_K equal to 0.025, and risk aversion, γ_C, equal to 2. We calibrate the elasticity of substitution between tradable and non-tradable goods, ϕ_N, equal to 0.5, consistent with the estimates for industrialized countries in Mendoza (1991). We set the elasticity of substitution between tradable goods produced in Home and Foreign, ϕ_T, equal to 1.5, the standard value in the international business cycle literature. We set the elasticity of substitution of non-tradable varieties such that $\theta_N = 6$ to generate a 20 percent markup in steady state. Following Ghironi and Melitz (2005), we set the elasticity of substitution of tradable varieties θ_T equal to 3.8. We assume that firm-level productivity z is drawn from a Pareto distribution with lower bound $z_{\min}$ and shape parameter $\kappa > \theta_T - 1$. We set κ equal to 3.4, and we normalize $z_{\min}$ and f_E to 1.[31] We choose the fixed export cost f_X such that, in steady state, 21 percent of tradable-sector firms export output abroad (Bernard, Eaton, Jensen, and Kortum, 2003). Using the results in Born and Pfeifer (2016), we map the Rotemberg wage adjustment cost, ν_w, into an average duration of nominal wage contracts. Consistent with Christiano, Eichenbaum, and Evans (2005), we assume that nominal wages are fixed for approximately 3 quarters on average, which implies $\nu_w = 116$. We set the elasticity of substitution of differentiated labor inputs $\eta = 11$, which implies a wage markup equal to 10 percent under flexible wages. We set the Frisch elasticity of labor supply, $1/\gamma_L$, equal to 1, a conventional value in the literature. Finally, to ensure steady-state determinacy and model stationarity, we set the adjustment cost parameter for foreign bond holdings, ψ, to 0.0025.

We calibrate the parameters that directly affect trade volumes and monetary policy to match Canadian data. We calibrate the degree of home bias, α_N, and the size of the tradable sector, α_T, to match a steady-state trade-to-GDP ratio of 50 percent and a steady-state output share of 30 percent in manufacturing (the tradable sector). We set iceberg trade costs, τ and τ^*, equal to 0.3, and we set average import tariffs, τ^{IM} and τ^{IM^*}, equal to 2 percent, in line with Canadian and U.S. tariffs. Finally, we parametrize the interest rate rule consistent with the estimates in Kichian (2015): $\varrho_i = 0.5$, $\varrho_\pi = 2.80$, $\varrho_Y = 0$.

[31] This calibration ensures that the lower-bound productivity $z_{\min}$ is low enough relative to the export costs that $z_{X,t}$ is above $z_{\min}$.

5 Protectionism and Business Cycle Dynamics under a Flexible Exchange Rate

The theoretical literature on the macroeconomic effects of tariffs has long been dominated by Mundell's (1961) conclusion that, under flexible exchange rates, a tariff is contractionary. In Mundell's static model, the imposition of a tariff improves the terms of trade, which increases saving via the Harberger-Laursen-Metzler effect. This rise in saving reduces aggregate demand, and aggregate supply falls to clear the goods market.[32] Chan (1978) and Krugman (1982) showed that Mundell's result is indeed robust with respect to various extensions of the basic IS-LM model. In addition, Krugman (1982) argued that the imposition of tariffs can lead to a deterioration of the current account balance. In contrast with these results, the first analysis of tariffs in a dynamic setting by Eichengreen (1981) showed that the short-run output contraction depends upon the extent to which the domestic currency appreciates in the short run, emphasizing the intertemporal tradeoffs involved in a tariff.

In this Section, we re-assess the classic question about the consequences of import tariffs under a flexible exchange rate. We first investigate the consequences of protectionism by assuming that the economy is at the deterministic steady state. This exercise allows us to evaluate the prediction of the model against the data. Next, we study the short-run effects of protectionism when the economy faces major slack (induced by a risk-premium shock) and binding constraints on monetary policy easing (the ZLB). Notice that in our analysis, we abstract from export subsidies, since those are forbidden under WTO rules.

We study macroeconomic dynamics following a temporary increase in Home import tariffs, τ_t^{IM}.[33] We consider a perfect foresight environment: The policy shock comes as an initial surprise to agents, who then have perfect foresight from that moment on. We solve the model as a nonlinear, forward-looking, deterministic system using a Newton-Raphson method, as described in Laffargue (1990). This method solves simultaneously all equations for each period, without relying on low-order, local approximations.

[32] According to the Harberger-Laursen-Metzler effect, a terms of trade deterioration reduces real income, which in turn increases the real expenditure needed to maintain the same standard of living. As a result, saving declines and the current account deteriorates.

[33] In the model, a tariff increase has allocative effects for various reasons: trade is not balanced, there are non-traded goods, we focus on a temporary shock, and we abstract from export subsidies. For this reason Lerner's symmetry does not hold.

5.1 Protectionism in Normal Times

We assume that a tariff shock in the model corresponds to the tariff shock identified in the panel VAR. Therefore, we parametrize τ_t^{IM} consistent with the stochastic process estimated in Section 2. This requires setting the quarterly persistence of the shock equal to 0.56, with a standard deviation of innovations equal to 0.034.[34]

Figure 9 (continuous lines) shows the effects of a temporary increase in τ_t^{IM} at time 0, assuming that the economy was at the deterministic steady state until time -1. Consistent with the VAR evidence, output falls and inflation increases in the aftermath of the tariff shock. Moreover, the ratio of net exports over GDP increases.[35] In order to assess the quantitative fit of the model, we construct model-based, annualized measures of the macroeconomic variables included in the panel VAR (GDP growth, inflation, and net exports over GDP). Panel B in Figure 8 shows that the impulse responses from the model are quantitatively in line with the panel VAR estimates.[36]

The inflationary effect of the trade policy shock is easily understood. The (welfare-consistent) CPI index, P_t, can be written as:

$$P_t = \left\{ (1-\alpha_N) \left[\varpi_{D,t}^T \left(\tilde{P}_{D,t}^T \right)^{1-\phi_T} + \varpi_{X,t}^{T*} \left(\varepsilon_t \frac{\tilde{P}_D^{T*}}{\tilde{z}_{X,t}^*} \left(1+\tau_t^{IM}\right) \right)^{1-\phi_T} \right]^{\frac{1-\phi_N}{1-\phi_T}} + \alpha_N \left(P_t^N \right)^{1-\phi_N} \right\}^{\frac{1}{1-\phi_N}}, \quad (3)$$

where $\varpi_{D,t}^T = (1-\alpha_X) N_{D,t}^{(1-\phi_T)/(1-\theta_T)}$ and $\varpi_{X,t}^{T*} = \alpha_X \left[(1+\tau)\, \tilde{z}_D^* \right]^{1-\phi_T} N_{X,t}^{*(1-\phi_T)/(1-\theta_T)}$ are time-varying weights on prices of Home and Foreign tradable goods that depend on producer dynamics.[37] Higher tariffs increase import prices faced by Home consumers, raising, other things equal, this price index. In addition, Home market share is reallocated from relatively more productive Foreign exporters to relatively less productive domestic producers, which implies an increase in $\varpi_{D,t}^T$ relative to $\varpi_{X,t}^{T*}$. The reallocation of market share lowers the average productivity content of goods sold to Home consumers, raising the price index other things equal.[38] Higher import prices and lower efficiency of production prevail on a decline in the price of domestic non-tradables (due to lower

[34] This implies that τ_t^{IM} increases by 1.75 percent in the first year, returning to its initial level after 1 year as in Figure 8 Panel A.

[35] Consistent with the data, net exports increase because imports fall by more than exports.

[36] Appendix E shows that results are similar when constructing measures for real GDP and inflation using the data-consistent price index $\tilde{P}_t$.

[37] Equation (3) combines the definition of the Home price index, with the equilibrium conditions $P_{D,t}^T = N_{D,t}^{1/(1-\theta_T)} \tilde{P}_{D,t}^T$, $P_{X,t}^T = N_{DX,t}^{*1/(1-\theta_T)} \tilde{P}_{X,t}^{T*}$ and $\tilde{P}_{X,t}^{T*} = (1+\tau_t)\, \varepsilon_t \tilde{P}_{D,t}^{T*} \tilde{z}_D^* / \tilde{z}_{X,t}^*$. Notice that $\tilde{P}_{D,t}^{T*} = \tilde{P}_D^{T*}$ because Home protectionism has no effect on the rest of the world. Moreover, $\tau_t = \tau$.

[38] Notice that, in absolute terms, even $\varpi_{D,t}^T$ declines initially, since the number of domestic producers, $N_{D,t}$, falls.

aggregate demand, as explained below) in pushing inflation upward.

The output response depends on the relative importance of three margins of adjustment: (i) expenditure-switching toward domestic goods (an expansionary force); (ii) a reduction in real income that dampens aggregate consumption and investment; and (iii) a contractionary monetary policy response. Expenditure-switching towards Home goods—which, other things equal, boosts domestic demand and output—stems from the increase in the average price of imported varieties, $\left(1+\tau_t^{IM*}\right)\tilde{P}_{X,t}^T$, which is only partly mitigated by the appreciation of the nominal exchange rate.[39]

At the same time, higher tariffs reduce aggregate real income (expenditure reduction).[40] The reason is again a combination of macroeconomic and microeconomic forces. At the macro level, the increase in the price of imports makes investment in physical capital—which combines both Home and Foreign goods—more costly. As a result, $I_{K,t}$ declines, reducing output over time. Moreover, since households also consume a mix of both domestic and foreign goods, households find themselves having to spend more of their reduced real income to consume any given amount of imports and any given amount of the bundle of less-efficiently-produced domestic tradables. At the micro level, the appreciation of the domestic currency lowers Home exports (both the number of exporting firms and their average output decline), reducing the average productivity of domestic firms—a decline in $N_{X,t}/N_{D,t}$ in the definition of $\tilde{z}_t$, reflecting the shift of market share towards relatively less productive non-exporting firms.[41] Lower real income causes imports to decline, so net exports increase, and Home experiences a current account surplus. But this improvement comes at the cost of a recession.

Finally, since the trade shock acts as a supply shock, the central bank faces a trade-off between stabilizing output and inflation. When the response to inflation is sufficiently aggressive (as implied by our calibration), the policy rate increases, further depressing current demand. Both nominal and real exchange rates appreciate.[42] To isolate the role of contractionary monetary policy, Figure 9 (dashed lines) plots the dynamics in an economy without nominal rigidities. The contractionary effects of protectionism remain similar to the benchmark model, although the decline in output is one-third smaller.

In equilibrium, lower real income and the contractionary response of monetary policy push the

[39] Notice that the Foreign domestic price $\rho_{D,t}^{T^*}$ and the iceberg trade cost τ_t^* are not affected by Home protectionism.

[40] The effects we describe are only partially mitigated by the increase in the tariff revenue that the government rebates to households.

[41] Notice that $\tilde{z}_t$ declines even if the average productivity of exporters increases (due to the increase in the export-productivity cutoff $z_{X,t}$).

[42] Notice that the real exchange rate appreciation holds true both when considering the welfare-consistent exchange rate, Q_t, and its data consistent counterpart, $\tilde{Q}_t = \varepsilon_t \tilde{P}_t^*/\tilde{P}_t$.

small open economy into a recession: consumption, investment, employment, and GDP decline. Overall, these findings represent a combination of the results in Mundell (1961), Krugman (1982), and Eichengreen (1981). The contractionary effect of the tariff is as in Mundell and Krugman, but is contrary to the short-run expansionary effect discussed by Eichengreen. On the other hand, the initial current account surplus is consistent with Eichengreen but in contrast to Krugman. In Appendix F, we show that the contractionary effects of protectionism are larger the higher and more persistent the tariff increase.

To understand the relative importance of macro and micro forces in accounting for the recessionary effects of protectionism, Figure 10 presents impulse responses for three simplified versions of the model. The first version assumes financial autarky (i.e., no international trade in bonds); the second version abstracts from firm-level dynamics (by assuming a constant number of symmetric producers in the tradable sector); the third version abstracts from both firm dynamics and physical capital. Each margin of adjustment plays an important role in propagating the initial recession. Under financial autarky, the appreciation of the real exchange rate is stronger, since relative prices adjust more to preserve external balance. In turn, the stronger appreciation reduces the impact of the trade policy shock. The absence of firm-level dynamics removes the hump-shaped response of output, making the recession less persistent. This happens because with a constant number of symmetric producers there are no micro-level reallocations in the tradable sector.[43] Finally, the absence of both endogenous producer entry and physical capital accumulation results in a much smaller initial decline of economic activity, since the reduction in real income no longer translates in a reduction of investment in both physical capital and firm creation.

To assess the empirical support for the model transmission, we estimate an additional version of the panel VAR that also includes measures of investment in physical capital and labor productivity. The impulse responses (presented in Appendix G) 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. In addition, Appendix G shows that the model cannot reproduce the VAR impulse responses absent physical capital accumulation and endogenous producer dynamics.

Overall, the model accounts for the inflationary and recessionary effects of protectionism under a flexible exchange rate. The analysis shows that the macroeconomic impact of tariffs on output

[43] Notice that the initial decline in output is lower in the presence of endogenous producer entry and firm heterogeneity. This stems from the fact that the number of producers is predetermined, implying that production declines more slowly.

and inflation is smaller with a closed capital account. Furthermore, firm and investment dynamics are key ingredients in the negative macroeconomic effects of protectionism.

5.1.1 The Role of Price Stickiness

In Appendix H, we extend the model to include nominal price rigidities following Cacciatore and Ghironi (2012). We consider the empirically-motivated case of dollar pricing in the tradable sector, in which both export and import prices in the small open economy are sticky in U.S. dollars (see Goldberg and Tille, 2008, Gopinath and Rigobon, 2008, and Gopinath, Itskhoki, and Rigobon, 2010). In addition, we also consider producer currency pricing and local currency pricing in the tradable sector as well as price stickiness in the non tradable sector. Qualitatively, the results are not affected by the introduction of price-setting frictions.

5.2 Protectionism in a Liquidity Trap

We now turn to the short-run transmission of protectionism when the economy is in a recession that pushed the central bank against the ZLB constraint. Our interest reflects the observation that macroeconomic applications of restrictive trade policy typically come to the forefront of public debate when domestic production is buffeted by shocks. In our crisis scenarios, we follow the recent literature and assume that a risk-premium shock $\Lambda_{a,t}$ hits the small open economy, depressing output and generating deflation. We assume that at quarter 0 the Home economy is hit by the risk-premium shock.[44] Next, we assume that at quarter 1 the small open economy increases trade barriers. As before, we treat this policy shock as unanticipated.[45]

From a theoretical standpoint, there are two key differences relative to protectionism in normal times. First, the increase in tariffs occurs when aggregate income and demand are already low (because of the recession). Second, the monetary policy response is constrained by the zero lower bound on the nominal interest rate. In such a circumstance, an inflationary shock (such as protectionism) lowers the real interest rate other things equal, boosting aggregate demand and output. Ultimately, whether temporary protectionism can be expansionary at the ZLB is a quantitative issue.

[44] We calibrate the size of the shock so that responses reproduce a peak-to-trough decline of output of about 4 percent, a value consistent with the experience of several small open economies following the collapse of Lehman Brothers in September 2008. We set the persistence of the shock such that it takes about 3 years for the Home economy to exit the ZLB in the absence of protectionism.

[45] This amounts to considering an unanticipated trade policy shock assuming that all the state variables of the model take the value implied by the impact response to the risk-premiumy shock.

The first two rows of Figure 11 present the responses to the risk premium shock in the absence of protectionism (solid lines) and the responses to the same risk premium shock when tariffs increase (dashed lines). The last two rows of Figure 11 compare the net effects of the temporary increase in τ_t^{IM} in the recession (solid lines) to the effect of the same tariff increase in normal times (dashed lines). The net effect of protectionism in a recession corresponds to the difference between the dynamics implied by the risk premium shock followed by the increase in tariffs and the dynamics of the risk premium shock alone.[46] Figure 11 conveys two main messages. First, protectionism is not an effective tool to boost economic activity in a liquidity trap (first two rows), since GDP is lower when the recession is followed by higher tariffs. Second, protectionism has more detrimental economic effects in a liquidity trap relative to normal times (last two rows).

The increase in trade barriers remains recessionary, i.e., the inflationary pressure is not sufficient to boost consumption and output. Once again, the result depends on the interdependence between capital accumulation and producer dynamics. In particular, higher tariffs continue to reduce real income (even more so when protectionism is implemented at times of low aggregate demand), reducing investment and product creation other things equal. In turn, the reduction in aggregate demand mitigates the inflationary pressure, and in equilibrium the policy shock is contractionary. The inflationary boost from the imposition of tariffs is extremely short lived, and the extra contraction imposed by protectionism on an already weak economy quickly prevails and turns the net inflation effect of the tariff to negative—since agents expect deflation already after one quarter, the expected real interest rate $E_0(1 + r_1)$ that determines time-0 decisions increases. (Home's real interest rate is defined by $1 + r_t = (1 + i_t)/(1 + \pi_{C,t})$ and $\pi_{C,t} \equiv P_t/P_{t-1} - 1$.) This worsens the ZLB problem instead of ameliorating it. Notice that the net effect of protectionism on inflation is very similar in the liquidity trap relative to normal times. Since at the ZLB the central bank does not offset the inflationary effects of the trade policy shock, this result may seem surprising. The explanation is that our parameterization implies a short-lived tariff increase. In such a circumstance, the deflationary pressure brought about by the contractionary effects of higher tariffs dominates. In Appendix F, we show that the results are not sensitive to the size and persistence of the trade shock: Protectionism remains contractionary in a liquidity trap. Nevertheless, with more persistent tariff shocks, the response of inflation at the ZLB becomes larger relative to normal

[46] The responses to protectionism at the ZLB and protectionism in normal times are aligned so the impact response to protectionism at the ZLB (which happens in period 1) is aligned with the impact response to protectionism in normal times (which happens in period 0). To show transparently the differences in responses in the same diagram, we are shifting the impulse responses to protectionism at the ZLB to the left by one period.

times.

6 Protectionism and Business Cycle Dynamics under a Fixed Exchange Rate

A long-standing argument in the literature is that, when the exchange rate is fixed, temporary tariffs are expansionary (at least in the absence of retaliation from trading partners). The textbook argument relies on two channels: First, the lack of appreciation of the nominal exchange rate results in stronger expenditure switching toward Home goods. Second, the response of the domestic central bank is expansionary to maintain exchange-rate parity, sustaining aggregate demand in the short run. We now re-evaluate these conclusions in the context of our model.

Our interest stems from the observation that pegs, crawling pegs, or very narrow bands feature prominently in the international monetary system (Reinhart and Rogoff, 2004). A recent illustration of the issue is the experience of Ecuador. Following the halving of oil prices in the second half of 2014, Ecuador—a dollarized economy—slipped into recession, accumulating a large trade deficit. In March 2015, the Ecuadorian government started to apply tariffs on roughly a third of its imports, ranging from 5 percent (capital goods) to 45 percent (final goods). The tariff increase was explicitly temporary (lasting 15 months). During the following quarters, in 2015 and early 2016, the trade balance of Ecuador effectively improved, but real GDP dropped even more, with a significant decline in consumption and investment.[47]

Figure 12 presents the dynamic adjustment to the same temporary increase in tariffs discussed in the previous section when the Home economy pegs the nominal exchange rate to Foreign. It also presents the results for the three alternative versions of the model already discussed in the previous section—financial autarky, no firm dynamics, and no firm dynamics and physical capital accumulation. The key message is that protectionism remains contractionary in the benchmark model. In particular, GDP declines, inflation increases, and the trade balance improves. By contrast, Figure 12 shows that the standard argument about the expansionary effects of tariffs under a peg holds true when the model abstracts from endogenous producer entry and capital accumulation, or when the capital account is closed.

What can explain these findings? In the benchmark model, the lack of exchange-rate appreciation is not sufficient to ensure an expansionary response of the economy because higher import prices continue to result in lower investment and producer entry, pushing the economy into re-

[47] The protectionist measures were implemented under the provisions of Article XVII of the WTO, which allows exceptional measures to respond to balance of payment crises in developing countries.

cession. Moreover, with an open capital account, the Home policy rate is tied to the (constant) Foreign interest rate—under our perfect foresight scenario, it is straightforward to verify that $1 + i_{t+1} = (1 + i^*) / (1 + \psi a_{*,t+1})$, where ψ is the (very small) bond adjustment cost. As a result, the response of the Home central bank to protectionism is muted. Not surprisingly, the tariff shock becomes expansionary under financial autarky. In this case, the monetary authority lowers the policy rate to keep the exchange rate fixed, providing additional stimulus to the economy.[48]

7 Conclusions

We studied the consequences of protectionism for macroeconomic fluctuations. Using trade-policy data at different frequencies, we estimated country-level and panel structural VARs finding that temporary trade barriers act as a supply shock, causing output to fall and inflation to rise in the short run. Protectionism has at best a small positive effect on the trade balance. Next, we built a small-open economy model with firm heterogeneity, endogenous tradability, and nominal rigidity to study the channels through which protectionism affects aggregate fluctuations. The model successfully reproduces the VAR evidence and highlights the importance of both macro and micro forces for the contractionary effects of tariffs. We then used the model to study scenarios where temporary trade barriers have been advocated as potentially beneficial, including recessions with binding constraints on monetary policy easing or in the presence of a fixed exchange rate. The main policy conclusion of our paper is that protectionism remains costly—at least for small open economies—even when it is used temporarily, even when economies are stuck in liquidity traps, and regardless of exchange rate arrangements.

References

[1] Auray, S., M. B. Devereux, and & A. Eyquem (2019): "Endogenous Trade Protection and Exchange Rate Adjustment," NBER WP 25517.

[2] Barattieri, A. (2014): "Comparative Advantage, Service Trade, and Global Imbalances," *Journal of International Economics* 92: 1-13.

[3] Barbiero, O., E. Farhi, G. Gopinath, and O. Itskhoki (2017): "The Economics of Border Adjustment Tax," *mimeo*, Harvard University and Princeton University.

[4] Benigno, P. (2009): "Price Stability with Imperfect Financial Integration," *Journal of Money, Credit and Banking*, 41: 121–149.

[48] The presence of price stickiness does not affect these results, as the dynamics are only marginally stronger relative to the flexible-price scenario. Details are available upon request.

[5] Bergin, P. R and G. Corsetti (2015): "Beyond Competitive Devaluations: The Monetary Dimensions of Comparative Advantage," CEPR DP 10718.

[6] Bernard, A. B., J. Eaton, J. B. Jensen, and S. Kortum (2003): "Plants and Productivity in International Trade," *American Economic Review* 93: 1268-1290.

[7] Born, B. and Pfeifer, J. (2016): "The New Keynesian Wage Phillips Curve: Calvo vs. Rotemberg," Dynare WP 51, CEPREMAP.

[8] Bown, C. P. (2011): "Taking Stock of Antidumping, Safeguards and Countervailing Duties, 1990?2009," *The World Economy* 34: 1955-1998.

[9] Bown, C. P. (2016): "Global Antidumping Database," available at http://econ.worldbank.org/ttbd/gad/.

[10] Bown, C. P. and M. A. Crowley (2013): "Import Protection, Business Cycles, and Exchange Rates: Evidence from the Great Recession," *Journal of International Economics* 90: 50-64.

[11] Bown, C. P. and M. A. Crowley (2014): "Emerging Economies, Trade Policy, and Macroeconomic Shocks," *Journal of Development Economies* 111: 261-273.

[12] Broda, C., and D. E. Weinstein (2010): "Product Creation and Destruction: Evidence and Price Implications," *American Economic Review* 100: 691-723.

[13] Cacciatore, M. (2014): "International Trade and Macroeconomic Dynamics with Labor Market Frictions," *Journal of International Economics* 93: 17-30.

[14] Cacciatore, M., R. Duval, G. Fiori, and F. Ghironi (2016): "Market Reforms at the Zero Lower Bound," *mimeo*, HEC Montréal, International Monetary Fund, North Carolina State University, and University of Washington.

[15] Cacciatore, M., and F. Ghironi (2012): "Trade, Unemployment, and Monetary Policy," *mimeo*, HEC Montréal and University of Washington.

[16] Cavallo, M., and A. Landry (2018): "Capital-Goods Imports and US Growth," Bank of Canada Staff Working Paper 2018-01.

[17] Champagne, J., G. Poulin-Bellisle, and R. Sekkel (2018): "Evaluating the Bank of Canada Staff Economic Projections Using a New Database of Real-Time Data and Forecasts," Staff Working Papers 18-52, Bank of Canada.

[18] Chan, K. S. Y. (1978): "The employment effects of tariffs under a free exchange rate regime : A monetary approach," *Journal of International Economics,* 8: 415-423.

[19] Christiano, L. J., M. Eichenbaum, and C. L. Evans (2005): "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy," *Journal of Political Economy* 113: 1-45.

[20] Correia, I., E. Farhi, J. P. Nicolini, and P. Teles (2011): "Unconventional Fiscal Policy at the Zero Lower Bound," *American Economic Review* 103: 1172-1211.

[21] di Giovann and J. and A.A. Levchenko (2014): "Country Size, International Trade, and Aggregate Fluctuations in Granular Economies," *Journal of Political Economy* 120: 1083-1132.

[22] di Giovann, J., A.A. Levchenko, and I. Mejean (2014): "Firms, Destinations, and Aggregate Fluctuations," *Econometrica* 82: 1303-1340.

[23] di Giovann, J., A.A. Levchenko, and I. Mejean (2014): "The Micro Origins of International Business Cycle Comovement," *American Economic Review* 108: 82-108.

[24] Dornbusch, R., S. Fischer, and P. A. Samuelson (1977): "Comparative Advantage, Trade, and Payments in a Ricardian Model with a Continuum of Goods," *American Economic Review* 67: 823-839.

[25] Eaton, J., and G. M. Grossman (1981): "Tariffs as Insurance: Optimal Commercial Policy when Domestic Markets Are Incomplete," NBER WP 797.

[26] Eichengreen, B. (1981): "A Dynamic Model of Tariffs, Output and Employment under Flexible Exchange Rates," *Journal of International Economics* 11: 341-359.

[27] Eichengreen, B. (1983): "Effective Protection and Exchange-Rate Determination," *Journal of International Money and Finance* 2: 1-15.

[28] Eichengreen, B. (2016): "What's the Problem with Protectionism?" *Project Syndicate*, July 13.

[29] Erceg, C., A. Prestipino, and A. Raffo (2017): "The Macroeconomic Effects of Trade Policy," *mimeo*, Board of Governors of the Federal Reserve System.

[30] Farhi, E. Gopinath. G. and O. Itskhoki (2014): "Fiscal Devaluations," *Review of Economic Studies,* 81(2): 725-760.

[31] Fisher, J. D. M. (2015): "On the Structural Interpretation of the Smets–Wouters Risk Premium Shock," *Journal of Money, Credit and Banking* 47: 511-516.

[32] Furceri, D., S.A. Hannan, J.D. Ostry, and A.K. Rose (2018): "Macroeconomic Consequences of Tariffs," *mimeo.*

[33] Ghironi, F., and M. J. Melitz (2005): "International Trade and Macroeconomic Dynamics with Heterogeneous Firms," *The Quarterly Journal of Economics* 120: 865–915.

[34] Goldberg, P. and N. Pavcnik (2016): "The Effects of Trade Policy," prepared for the *Handbook of Commercial Policy*, edited by K. Bagwell and R. Staiger, Jan. 2016.

[35] Goldberg, L. S., and C. Tille (2008): "Vehicle Currency Use in International Trade," *Journal of International Economics* 76: 177–192.

[36] Gopinath, G., O. Itskhoki, and R. Rigobon (2010): "Currency Choice and Exchange Rate Pass-Through," *American Economic Review* 100: 306–336.

[37] Gopinath, G., and R. Rigobon (2008): "Sticky Borders," *Quarterly Journal of Economics* 123: 531–575.

[38] Hearn, B. (2004): "A Guide to the Canadian Anti-Dumping System," McMillan LLP.

[39] Kichian, M. (2015): "Identification-Robust Estimates Of The Canadian Natural Rate Of Interest," *L'Actualité Economique* 91: 161-176.

[40] Kilian, L. (1998): "Small-Sample Confidence Intervals For Impulse Response Functions," *The Review of Economics and Statistics* 80(2): 218-230.

[41] Kilian, L. (2009): "Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market," *American Economic Review* 99: 1053-1069.

[42] Kilinc, M. and C. Tunc (2014): "Identification of Monetary Policy Shocks in Turkey: A Structural VAR Approach," Turkish Central Bank WP 14/23.

[43] Krugman, P. (1982): "The Macroeconomics of Protection with a Floating Exchange Rate," *Carnegie-Rochester Conference Series on Public Policy* 16: 141-182.

[44] Laffargue, J.-P. (1990): "Résolution d'un Modèle Macroéconomique avec Anticipations Rationnelles," *Annales d'Economie et de Statistique* 17: 97-119.

[45] Levin, A., Lin, C. F. and J. C. S. Chu (2002): "Unit root tests in panel data: asymptotic and finite-sample properties," *Journal of Econometrics,* 108(1): 1-24.

[46] Lindé, J., and A. Pescatori (2017): "The Macroeconomic Effects of Trade Tariffs: Revisiting the Lerner Symmetry Result," *mimeo*, International Monetary Fund.

[47] Lu, Y., Z. Tao, and Y. Zhang (2013): "How Do Exporters Respond to Antidumping Investigations?," *Journal of International Economics*, 91: 290–300.

[48] Marx, K., and F. Engels (1848): *The Communist Manifesto.*

[49] Melitz, M. J. (2003): "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica* 71: 1695-1725.

[50] Mendoza, E. G. (1991): "Real Business Cycles in a Small Open Economy," *American Economic Review* 81: 797–818.

[51] Mundell, R. (1961): "Flexible Exchange Rates and Employment Policy," *Canadian Journal of Economics and Political Science* 27: 509-517.

[52] Reinhart, C. M. and K. S. Rogoff (2004): "The Modern History of Exchange Rate Arrangements: A Reinterpretation," *The Quarterly Journal of Economics* 119: 1-48.

[53] Rhul, K. J. (2014): "The Aggregate Impact of Antidumping Policy," *mimeo.*

[54] Smets, F., and R. Wouters (2007): "Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach," *American Economic Review* 97: 586-606.

[55] Staiger, R. W. and F. A. Wolak (1994): "Measuring Industry-Specific Protection: Antidumping in the United States," *Brookings Papers on Economic Activity. Microeconomics* 1994: 51-118.

[56] Turnovsky, S. J. (1985): "Domestic and Foreign Disturbances in an Optimizing Model of Exchange Rate Determination," *Journal of International Money and Finance* 4: 151-171.

[57] Vandenbussche, H., and M. Zanardi (2010): "The Chilling Trade Effects of Antidumping Proliferation," *European Economic Review*, 54: 760–777.

[58] Wieland, J. (2016): "Are Negative Supply Shocks Expansionary at the Zero Lower Bound?" *mimeo*, University of California-San Diego.

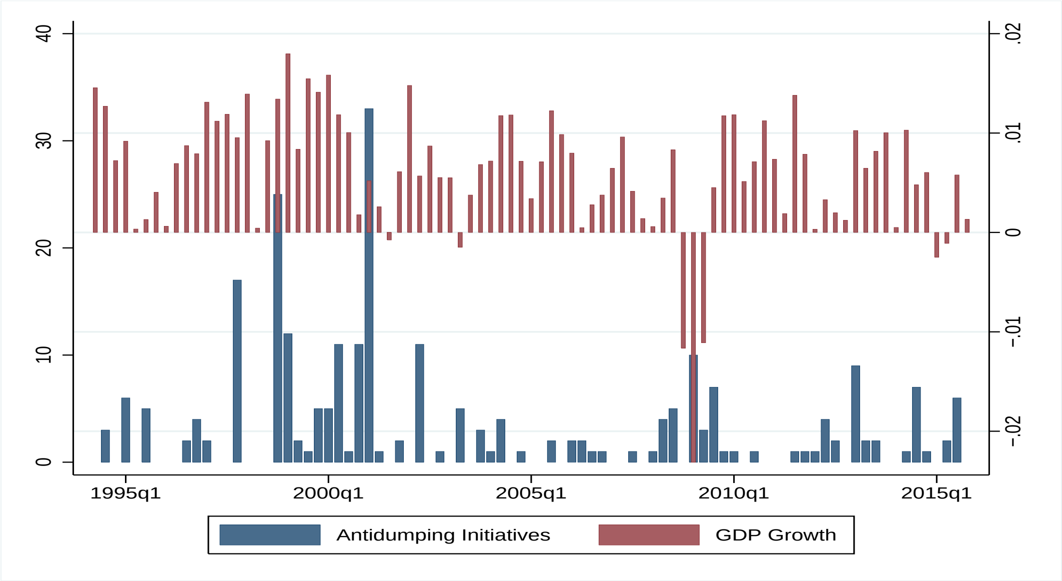

Figure 1: Anti-dumping initiatives and real GDP growth, Canada

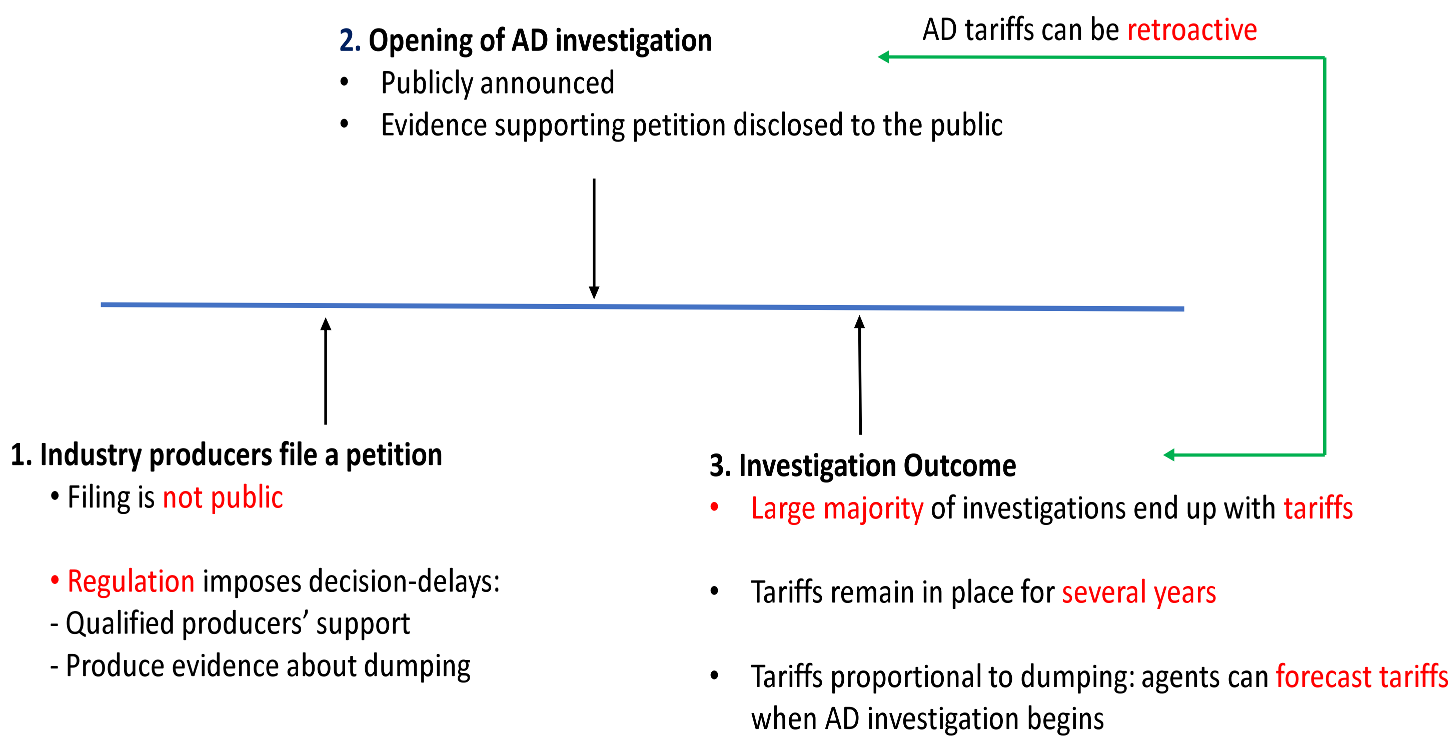

Figure 2: Institutional details about antidumping investigations and applied antidumping tariffs.

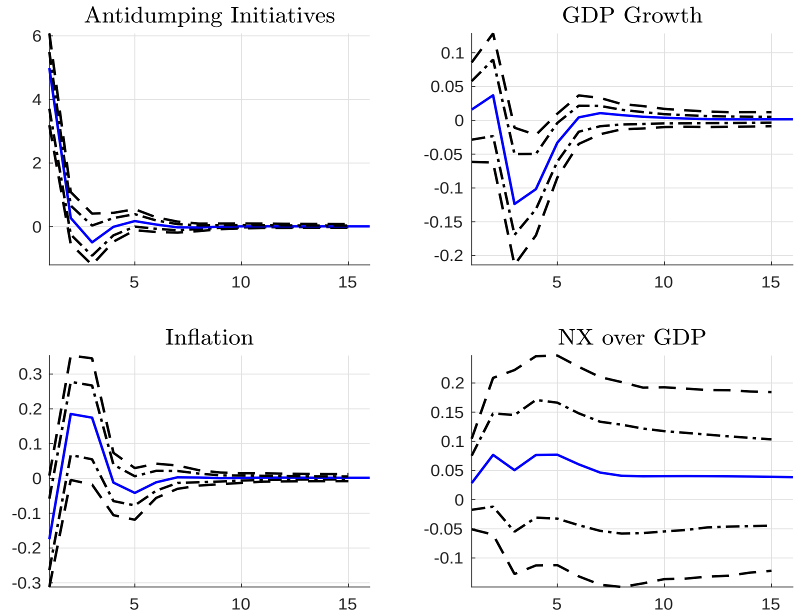

Figure 3: Quarterly VAR, one-standard deviation increase in antidumping initiatives in Canada. GDP growth and net exports over GDP are in percentage points. The inflation rate is annualized.

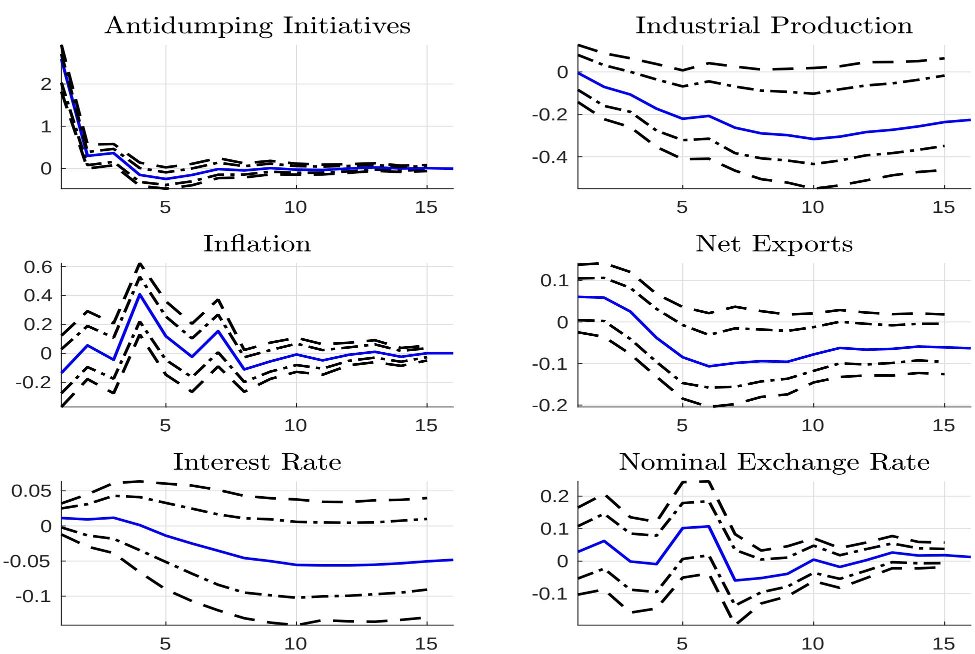

Figure 4: Monthly VAR, one-standard deviation increase in antidumping initiatives in Canada. Industrial production, net exports, and nominal exchange rate are in percentage points. The inflation rate and the interest rate are annualized.

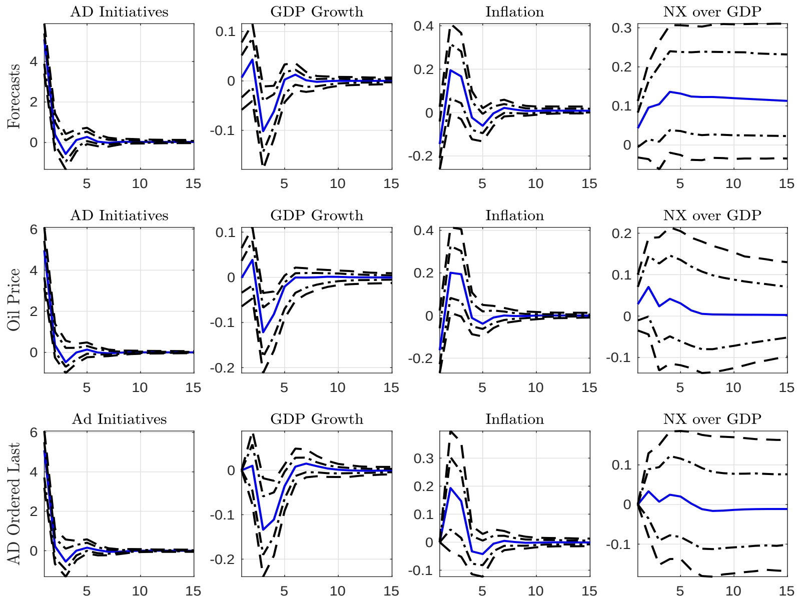

Figure 5: Quarterly VAR, sensitivity analysis. One-standard deviation increase in antidumping initiatives in Canada. GDP growth and net exports over GDP are in percentage points. The inflation rate is annualized. First row: VAR includes real GDP and imports forecast growth; second row: VAR includes the real price of oil; third row: antidumping initiatives ordered last in the VAR.

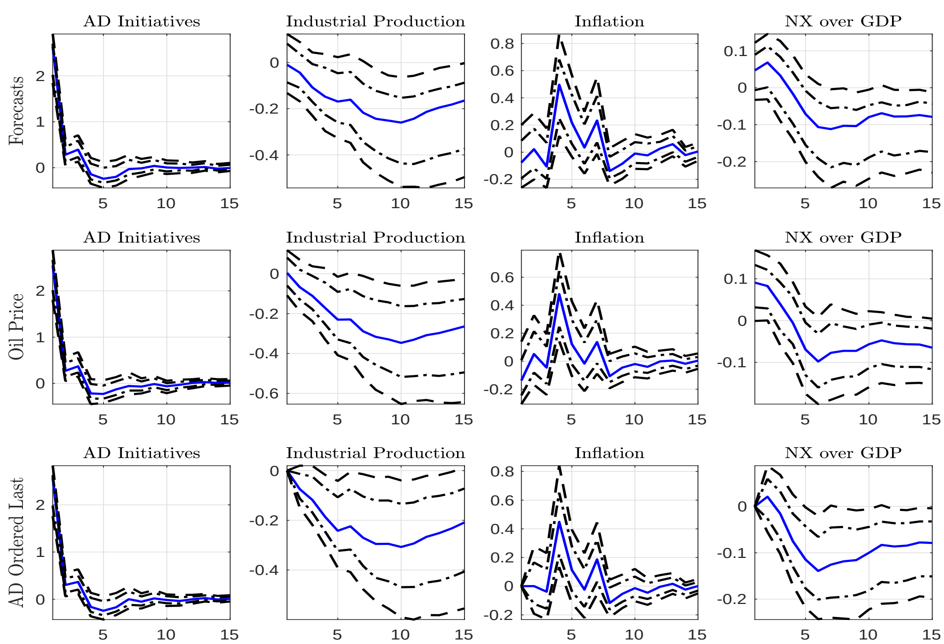

Figure 6: Monthly VAR, sensitivity analysis. One-standard deviation increase in antidumping initiatives in Canada. Industrial production, net exports, and nominal exchange rate are in percentage points. The inflation rate and the interest rate are annualized. First row: VAR includes real GDP and imports forecast growth; second row: VAR includes the real price of oil; third row: antidumping initiatives ordered last in the VAR.

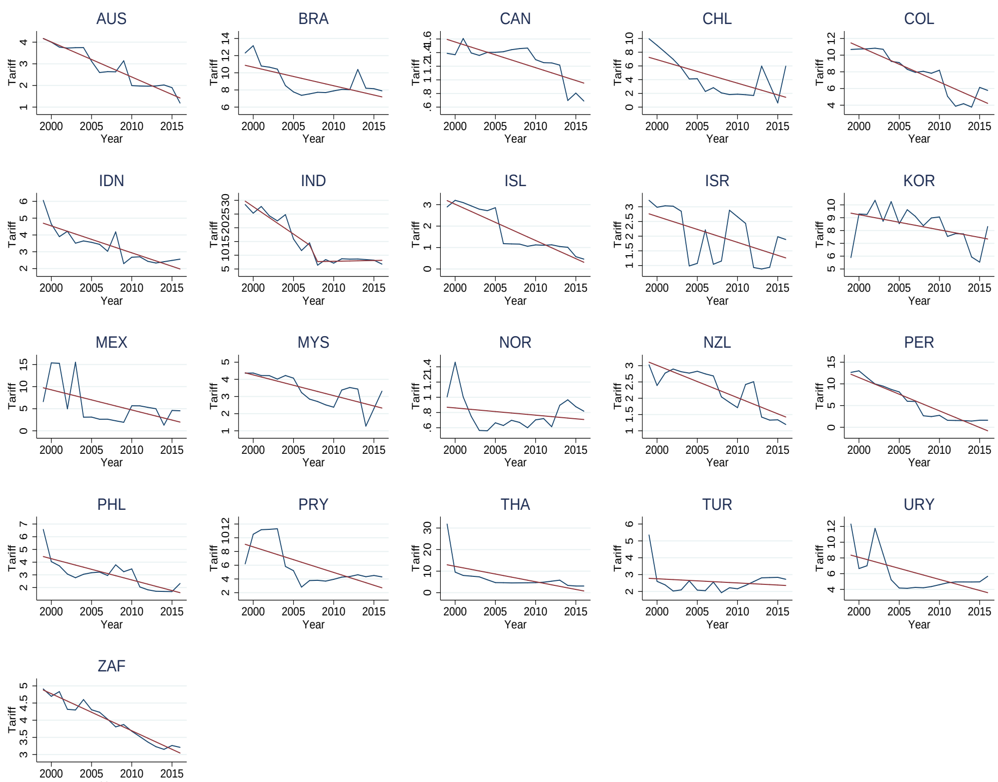

Figure 7: Weighted average of applied tariffs, 1999-2016.

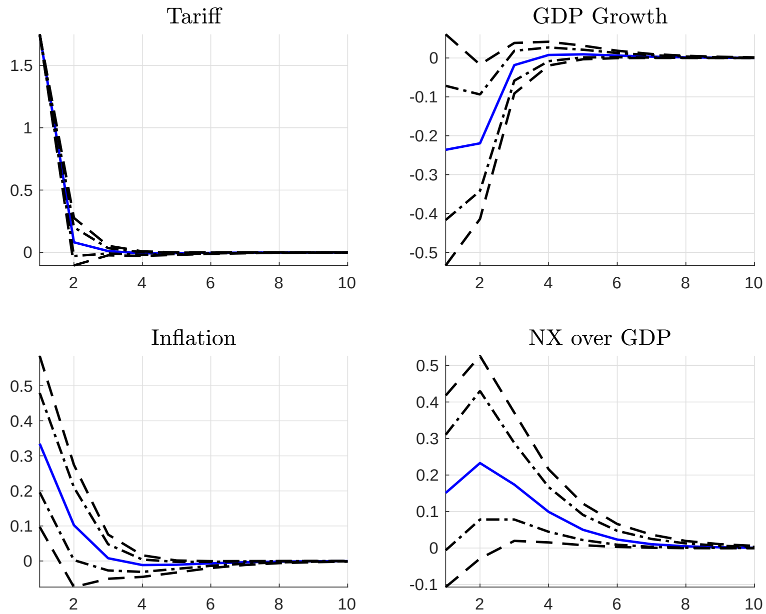

Figure 8, Panel A: Panel-VAR, impulse responses to a one-standard deviation increase in detrended tariffs. Tariffs, GDP growth, and net exports over GDP are in percentage points.

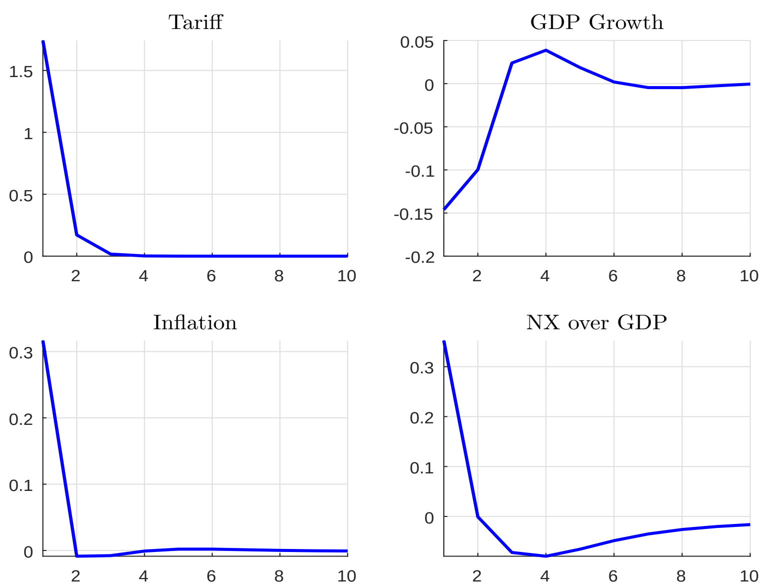

Figure 8, Panel B: Model-implied, annualized impulse responses to a tariff increase. The tariff shock matches size and persistence of the equivalent shock in the panel VAR (Figure 9A). Tariffs, GDP growth, and net exports over GDP are in percentage points.

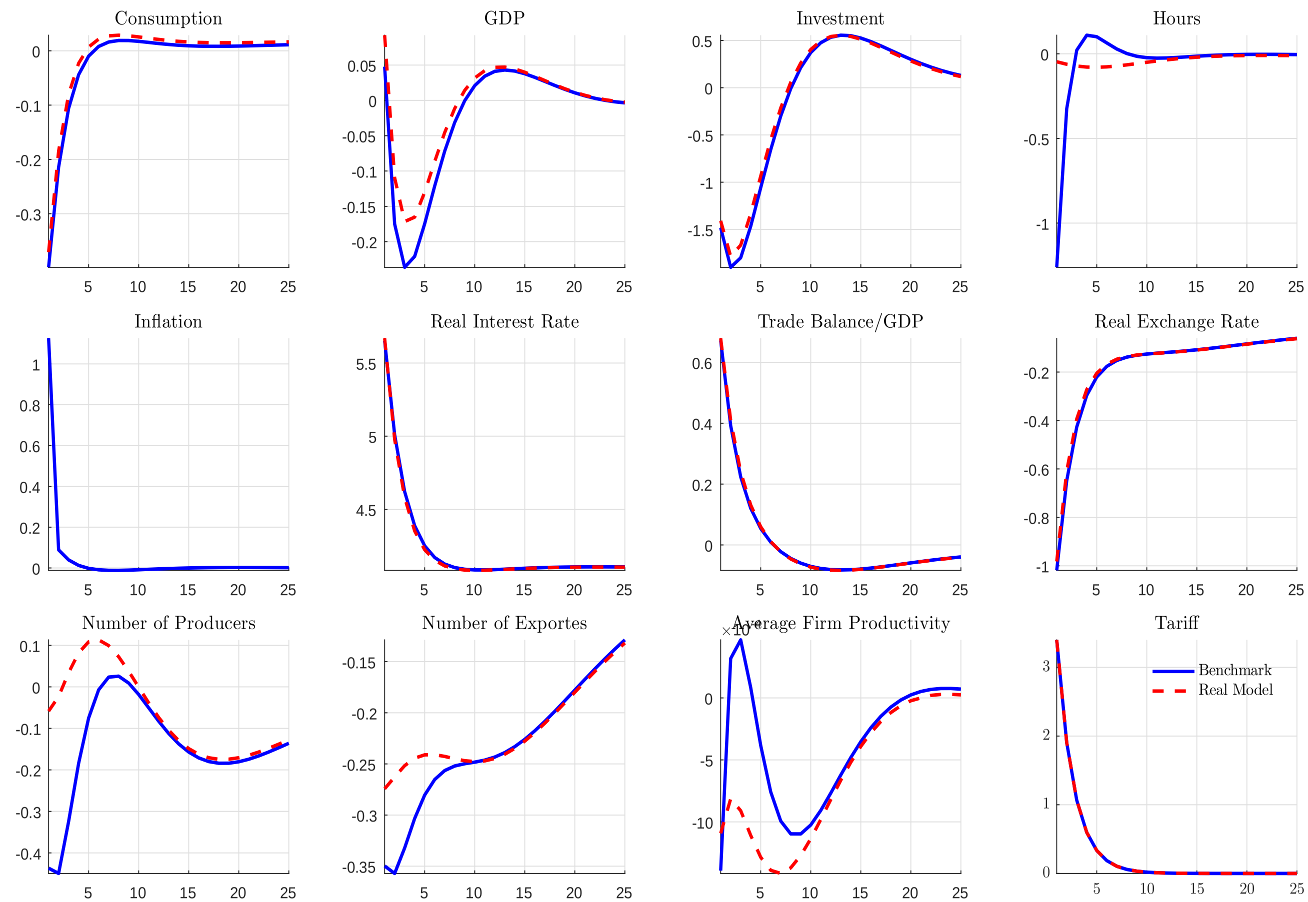

Figure 9: Responses to a temporary increase in Home trade barriers in normal times, benchmark model (continuos lines) and an alternative version without nominal rigidities (dashed lines). Responses show percentage deviations from the steady state. The inflation rate is annualized.

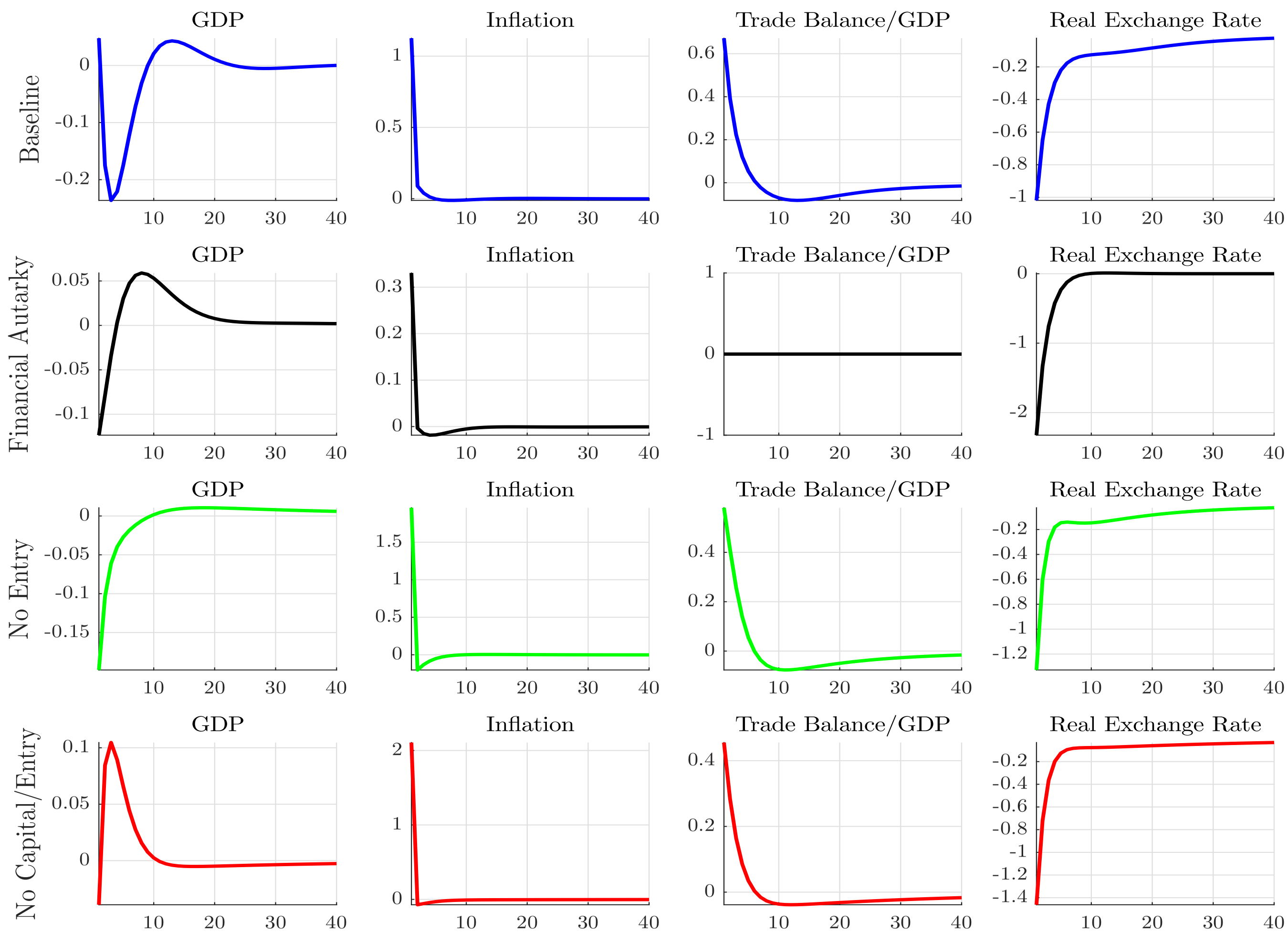

Figure 10: Responses to a temporary increase in Home tariffs in normal times, flexible exchange rate. The top raw: baseline model; second raw: baseline model under financial autarky; third raw: baseline model without firm dynamics; fourth raw: baseline model without firm dynamics and physical capital accumulation. Responses show percentage deviations from the steady state. The inflation rate is annualized.

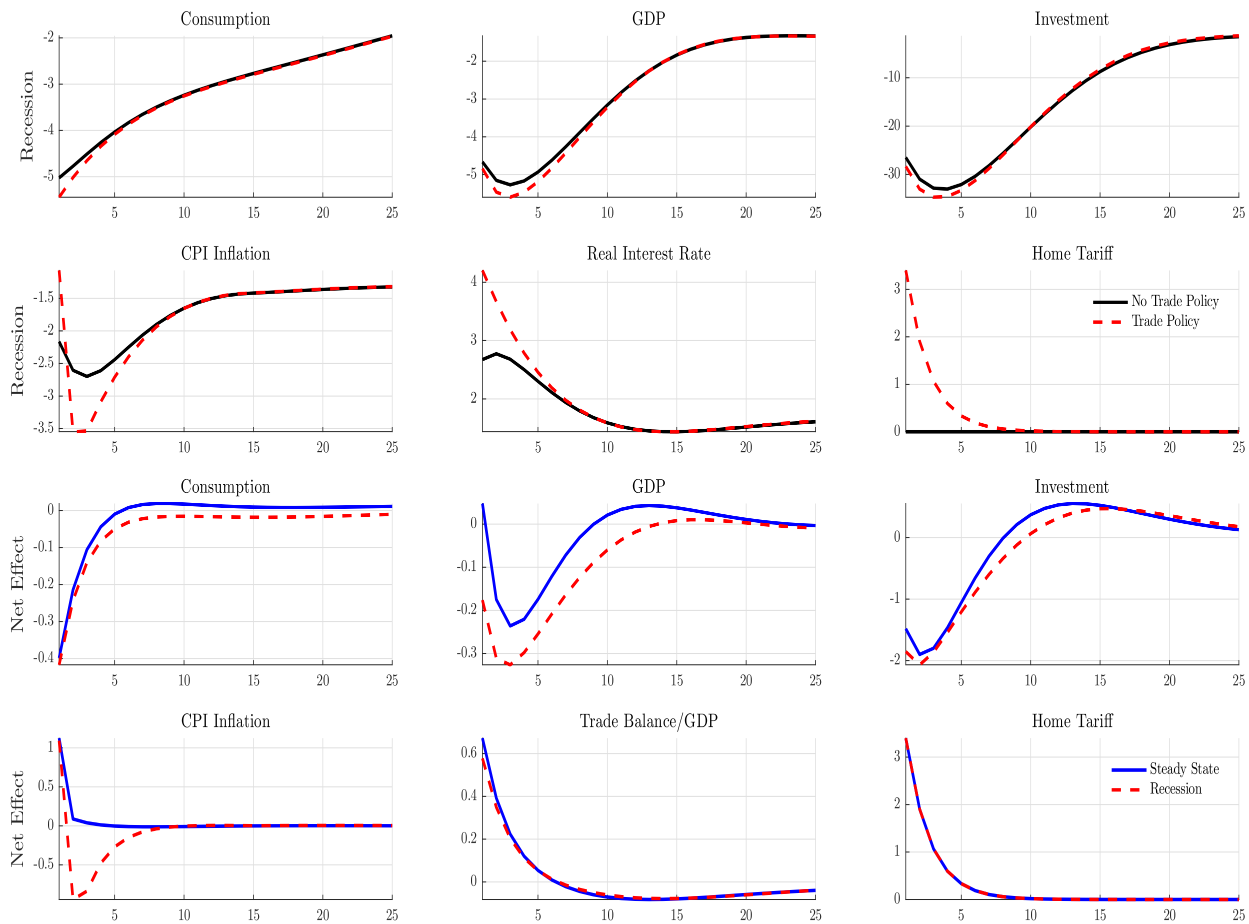

Figure 11: Top two panels: recession (continuous lines) versus recession followed by higher Home tariffs (dashed lines); Bottom two panels: net effect of higher Home tariffs in normal times (continuous lines) and in a recession with binding ZLB (dashed lines). Responses show percentage deviations from the initial steady state. The inflation rate is annualized.

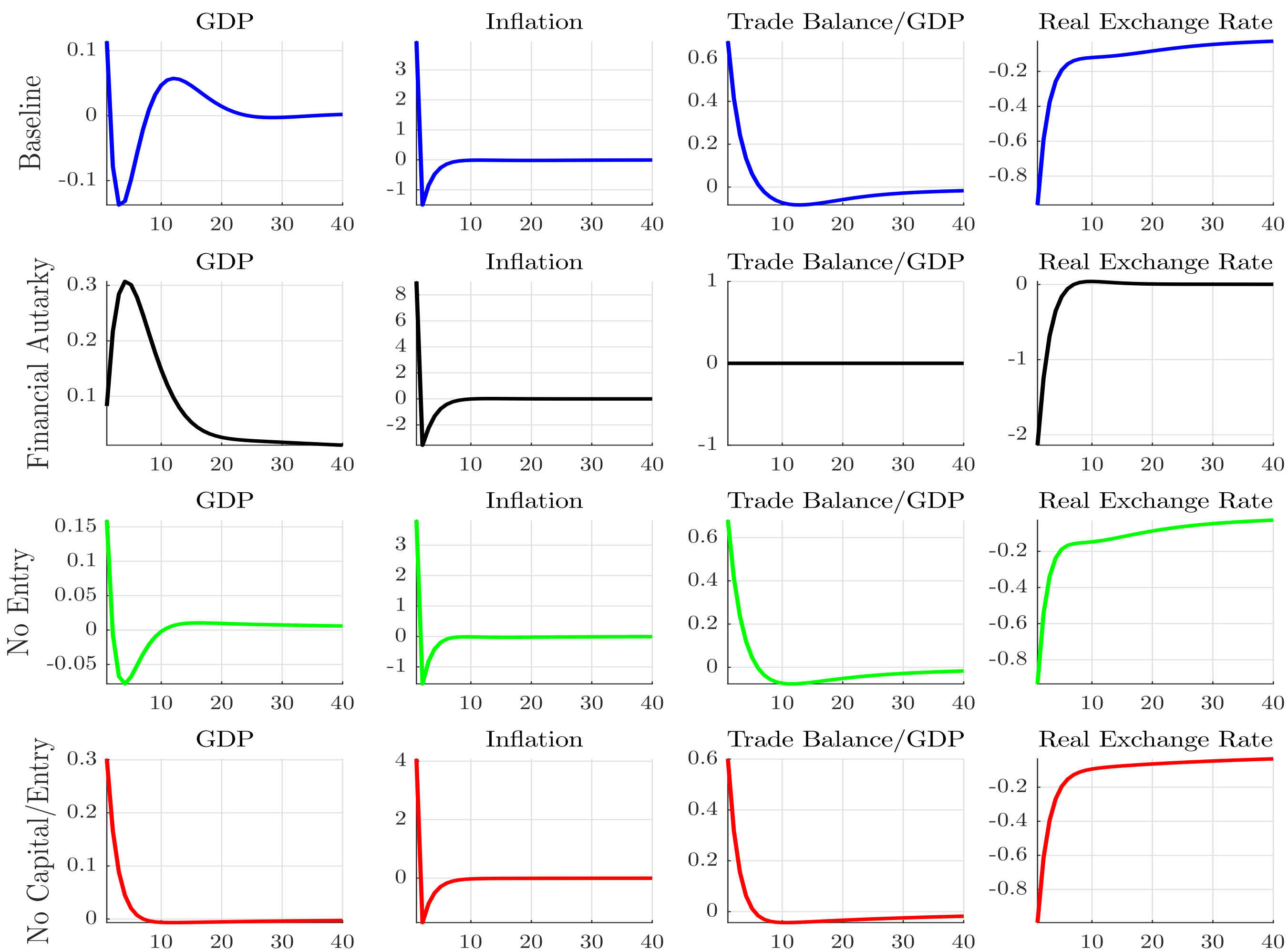

Figure 12: Responses to a temporary increase in Home tariffs in normal times, fixed exchange rate. The top raw: baseline model; second raw: baseline model under financial autarky; third raw: baseline model without firm dynamics; fourth raw: baseline model without firm dynamics and physical capital accumulation. Responses show percentage deviations from the steady state. The inflation rate is annualized.