Trade Policy is Real News: Theory and Evidence

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Abstract

We evaluate the aggregate effects of changes in trade barriers when these changes can be implemented slowly over time and trade responds gradually to changes in trade barriers because firm-level trade costs make exporting a dynamic decision. Our model shows how expectations of changes in trade barriers affect the economy. We find that while decreases in trade barriers increase economic activity, expectations of lower *future* trade barriers temporarily decrease investment, hours worked, and output. Furthermore, canceling an expected decline in future trade barriers raises investment and output in the short run but substantially lowers medium-run growth. These effects are larger when the expected reform is bigger. In the data, we find that countries with more trade growth after the General Agreement on Tariffs and Trade (GATT) rounds decreased investment and hours worked in the years leading to the tariff cuts, as predicted by our model.

Keywords: Trade Policy, Business Cycles, Sunk Costs, Gains from Trade
JEL classification: E31, F12

1   Introduction

Understanding the role of news about future technology or policy on the current state of the economy is a long running and contentious issue (Pigou (1927), Keynes (1936), and Beaudry and Portier (2014)). One challenge for work on this topic, particularly as relates to news about future productivity, is to identify these future changes in technology. This challenge has led to important and creative empirical methods that beget differing interpretations of the data. These differing interpretations have led researchers to focus more on how pre-announced policies can affect economic activity today. In this paper we argue that the tendency for trade policy to be pre-announced, implemented gradually, and closely linked to productivity makes it the ideal policy to revisit the effect of news on the business cycle. Using cross-country evidence from the GATT reforms, we show that news about trade reforms is contractionary even as the implementation is expansionary.

Changes in trade policy often follow long negotiations between countries. When negotiations conclude successfully, the changes in policy occur gradually according to a well-defined schedule, often called a phaseout. Both the negotiations and the phaseouts are public knowledge, so the future policy changes are anticipated by consumers and firms. Because the policy changes affect future productivity, income, and prices, news about future changes in trade barriers influences consumers' and firms' current behavior through large wealth effects, leading to a different aggregate response than if the changes are unanticipated.

We study the aggregate effects of past, present, and future changes in trade barriers in a two country heterogeneous firm dynamic general equilibrium model. The model nests the standard international real business cycle model (Backus et al. (1994)) and the heterogeneous firm model for trade policy analysis (Melitz (2003) and Alessandria and Choi (2014)). We specify a stochastic process for trade costs that allows for both anticipated and unanticipated changes. Consumers make forward-looking decisions about consumption and labor supply, and firms, which pay a large sunk cost to begin exporting, make forward-looking decisions about investment as well as their production and export status. Expectations of future

changes in trade barriers can therefore affect consumers' and firms' current behavior. The sunk cost assumption also implies that changes in trade costs affect trade gradually as the share of firms exporting grows slowly. Thus, both past and future trade barriers matter for the current economy. The model also captures the composition of trade in consumption, investment, and material goods so that changes in trade costs – whether past, present, or future – induce substitution effects between goods. The interaction between trade dynamics and capital accumulation with capital intensive trade leads to rich transitions that are absent in other models.

In the model, a permanent surprise decrease in trade costs increases trade and economic activity through standard efficiency channels. Because consumers have higher wages and goods prices are lower, they substitute toward consumption and away from leisure, increasing labor supply and gross domestic product (GDP). Even with balanced growth preferences, this substitution effect dominates the income effect. Because trade is intensive in capital goods, cheaper imports decrease the price of capital goods relative to consumption goods and firms invest more, which in turn increases the marginal product of labor and leads to an even larger boost in economic activity in the long-run.

News of future reductions in trade costs decreases investment and hours worked and increases consumption and exporting capacity. Consumers still expect to be richer in the future, and the wealth effect that makes them want to consume more and work less has no offsetting substitution effect until trade costs actually change. Therefore, agents work less and consume more before trade costs fall. Furthermore, firms delay investment in physical capital until trade costs fall and the price of capital is lower. Meanwhile, lower future trade costs increase the future value of being an exporter, so firms invest more in exporting capacity and the number of exporters increases. Therefore, the economy starts the trade liberalization with more consumption and exporters and less investment, labor, and GDP than if the liberalization is unexpected.

In summary, the transition of the economy depends on whether the changes in trade

costs are expected or unexpected. Consider, for example, a decreasing path of trade costs where agents either know the complete path at the beginning or are constantly surprised by unanticipated reductions. Because the expectation of lower barriers decreases investment, a gap between the investment response under the two cases forms immediately and persists for many periods as firms continue to expect even lower capital prices in the future. GDP, consumption, and labor also differ along the transition.

The model also tells us what happens when expected changes in trade costs are not realized. What should we have expected in the U.S. economy, for example, when the U.S. pulled out of the Trans-Pacific Partnership (TPP) after the agreement had been signed? Or when it withdrew from the negotiations of the Transatlantic Trade and Investment Partnership (TTIP)? The theory predicts that U.S. consumers were already consuming more and firms were already investing in greater export market access. At the same time, consumers were working less because they expected higher future wages, and firms were investing less in physical capital because they expected lower future costs. Canceling the agreement decreased expected wealth for consumers and raised the future price of investment for firms. Therefore, consumers worked more and consumed less, and firms invested more in physical capital and less in exporting capacity. Overall, GDP increased: Canceling an agreement once it is expected raises activity in the short run. Of course, the model also predicts that by canceling the agreement, the U.S. is missing out on medium-run growth during the liberalization period.

Having sorted out the rich interactions between trade barriers and the aggregate economy, we next turn to the data for evidence concerning the aggregate predictions of the model for expected trade liberalizations. Specifically, we consider the dynamics of GDP, consumption, investment, and hours worked of the Organization for Economic Co-operation and Development (OECD) countries both before and after GATT round implementations. GATT rounds are useful because they are multilateral agreements that affect each member country's trade flows and the negotiation and phase out periods are well documented. Furthermore, because

the agreements include a large number of countries, the timing of the agreements is exogenous to any one country's business cycle. The data exercise suggests that GDP, investment, and hours worked fell in the years directly preceding tariff cuts while consumption increased. Thus, the data outcomes are qualitatively consistent with our stylized model.

The idea that past and expected future changes in trade policy affect current trade and other aggregate variables casts doubt on traditional static trade models, in which changes in trade and real income are proportional to changes in trade barriers. Our model implies that the effect of changing trade barriers on the economy is more nuanced. Building on our work here, Alessandria and Mix (2018) estimate time-varying expectations of US inward and outward trade policies and quantify their aggregate effects over the past 60 years on the U.S. economy.

1.1   Relevant Literature

Our paper relates to several strands of the literature on business cycles and international trade. Our paper contributes to the literature on the delayed effects of aggregate shocks on trade. A large branch of this work, focuses on the gradual expansion of trade following trade agreements. Baier and Bergstrand (2007) show that the full impact of free trade agreements (FTAs) on trade can take up to 10 to 15 years to be realized. Baier et al. (2014), Alessandria and Choi (2014), and Besedes et al. (2020) show that most of this delayed effect comes from the dynamics of the extensive margin of trade as one would expect if exporting involves a durable investment in foreign market access. In addition, a large literature in international macroeconomics focuses on the slow adjustment of trade and the trade balance to movements in the terms of trade and the real exchange rate.[1] The model we develop captures both of these observations and therefore allows for the impacts of a liberalization episode to become stronger over time.

Several papers have examined the quantitative impact of changes in trade barriers or trade

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[1]See Ruhl et al. (2008), Rabanal and Rubio-Ramirez (2015), and Alessandria and Choi (2019b).

policy on business cycle fluctuations.[2] Crucini and Kahn (1996) show that the increases in tariffs during the Great Depression could have reduced economic activity in the U.S. by more than 2 percent per year from 1931 to 1935. Similarly, Perri and Quadrini (2002) find the increases in tariffs in Italy reduced output by 7 to 10 percent in the 1930s, with the higher reductions depending on wage rigidities. The larger effects in Italy than in the U.S. can be attributed to Italy being more open and raising barriers by more. For a cross-section of small economies, Barattieri et al. (2021) document that temporary increases in tariffs are contractionary. Caldara et al. (2020) show that changes in trade policy uncertainty can be recessionary for the U.S. with most of the impact arising from a reduction in investment. They show these effects of trade policy uncertainty arise in a dynamic exporting model with nominal rigidities. Our focus is on future, permanent shocks for which nominal rigidities are unlikely to be important. Alessandria and Choi (2019b) show that changes in inward and outward US trade barriers have had a large impact on the dynamics of the US trade balance since the 1980s. Here we consider a richer process of trade integration and a richer model of business cycle fluctuations. Alessandria and Mix (2018) build on our framework and study the contribution of shocks to past, current, and future inward and outward trade barriers to U.S. aggregate fluctuations over the period 1965 to 2020.

Our paper also contributes to the literature that explores how news about future changes in policy or the aggregate economy can be a source of business cycle fluctuations. Most work in this spirit has considered either predictable changes in productivity or fiscal policy, with much debate about how to identify future changes in these variables.[3] There is little doubt that trade agreements (and disagreements) contain important predictable components and that changes in trade barriers will feed into productivity. We use generalized information

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[2]A very large literature studies the long-run effects of changes in trade barriers. See Irwin (2019) for a summary of this work.

[3]See, for example, Beaudry and Portier (2006), Barsky and Sims (2012), Schmitt-Grohé and Uribe (2012), Ramey (2011), Mertens and Ravn (2010) and Mertens and Ravn (2012). For a full survey of the literature, see Beaudry and Portier (2014). House and Shapiro (2006) show that the phase-in of the Bush tax cut in 2001 may have contributed to slow economic growth and that the sunset in 2008 may have contributed to the contraction in 2008-09.

about tariff phaseouts to discipline trade policy news in our model.

News about the future has also featured quite prominently in the analysis of business cycles in the open economy. Backus et al. (1994) show that spillovers in technology across countries can lead to very low international comovement. Aguiar and Gopinath (2007) show that the high volatility of consumption and countercyclicality of the current account in emerging markets relative to industrialized countries can be explained if emerging economies are characterized by more persistent shocks to the growth rate of total factor productivity (TFP). More recently, Colacito et al. (2018) identify news shocks about productivity from price–earnings ratios and show the dynamics of borrowing and lending to these news shocks are quite different empirically. Perhaps closest in spirit to our paper is recent work by Arezki et al. (2017) that shows that in response to large oil discoveries there is a contractionary effect of news on economic activity. We find quite similar contractionary effects in response to future trade reforms.

In Section 2, we discuss frequently observed patterns of changes in trade costs and trade. In Section 3, we describe the model in detail. In Section 4, we describe our calibration of parameters. In Section 5, we explore the impact of trade policy shocks on the aggregate economy. In Section 6, we turn to the data to validate the predictions of the model regarding the aggregate implications of future changes in trade costs. Finally, we conclude in Section 7.

2   Trade and Trade Cost Patterns

To set ideas we discuss four key features of trade and trade policy. First, trade has grown dramatically over a long period. Second, even though this growth has been a bit uneven, with periods of fast and slow growth, there was generally sustained and gradual growth from the mid-1960s to the mid 2010s. Third, this gradual growth reflects both gradual reductions in trade barriers and gradual expansion in trade, particularly on the extensive margin. And

fourth, there is a large forward-looking component to trade policy from negotiations and agreed-upon phase-outs of trade restrictions.

Since the mid-1960s, global trade as a share of global GDP has almost tripled.[4] This growth has been much larger for some countries and when one adjusts for changes in the relative price of traded and non-traded goods. For instance, Figure 1 plots the path of average real trade flows (exports plus imports) as a share of GDP for the United States. From 1967 to 2007, the trade share more than tripled, from just under 8 percent to 27 percent. Since the recovery from the Great Recession the growth in trade integration has slowed precipitously falling far below the pre–Great Recession trend.

While trade growth has varied across periods, overall, the adjustment has been gradual. The gradual adjustment of the trade-to-GDP ratio over time arises from two well-known features of trade policy and trade: (1) The response of trade to changes in trade policy or trade costs is gradual, and (2) trade policy changes gradually. As evidence of the first feature, Baier and Bergstrand (2007) show that a trade agreement triples bilateral trade but that this growth takes between 10 and 15 years. Baier et al. (2014) and Alessandria and Choi (2014) find that the adjustment of trade is more gradual at the extensive margin of products or firms. Jung (2012) and Besedes et al. (2020) confirm that trade expansion is delayed beyond the slow phaseouts in tariffs. Using product-level tariffs and trade flows from the North American Free Trade Agreement (NAFTA), Khan and Khederlarian (2019) find that the trade response to a tariff change in eight years is nearly three times the impact effect. We capture the gradual adjustment of trade in our model by assuming exporters face a relatively high cost to begin exporting and a smaller cost to continue exporting, as first proposed by Baldwin and Krugman (1989). This formulation of trade costs makes exporting a dynamic decisions so that the extensive margin of trade adjusts slowly in response to changes in trade costs or other aggregate shocks. Since Baldwin and Krugman (1989), this framework has been called the sunk cost model of exporting.

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[4]Using Penn World Tables 10.0 (PWT) data the share of trade rose from 9.2 percent of world GDP in 1967 to 26.2 percent in 2007.

Evidence that trade policy changes have occurred gradually is clear in Figure 2, which plots several measures of tariffs and a trade restrictiveness index (TRI) since 1960. In general, the series tell a similar story for aggregate trade policy barriers in the past 60 years: They have trended downward at a gradual pace. The trade-weighted measure of tariffs shows that they have fallen from about 7 percent in the 1960s to about 2.5 percent before to the U.S.–China trade war.[5] The declines in this rate are related to the three GATT rounds and the two FTAs with Canada and Mexico. A more direct measure of tariffs comes from Yi (2003) for manufacturing goods and shows that average tariffs in manufacturing were close to 14 percent before the first GATT round and fell gradually with each subsequent round. We also plot a TRI that incorporates more of the product-level heterogeneity of the tariffs and adjust for the average tariffs to understate the size of trade barriers. It shows a similar gradual decline. The gradual decline in tariffs is even more pronounced in U.S. trading partners position vis-à-vis the U.S. (see Trefler (2004)).

The declines in trade policy barriers have a large predictable component related to the negotiation and implementation. Table 1 reports the years that GATT member countries were negotiating during the Kennedy Round, the Tokyo Round, and the Uruguay Round and the years over which tariffs phased out (linearly) after an agreement was made. The table also gives the tariff phaseout period for the Agreement on Textiles and Clothing (ATC) implemented in the Uruguay Round.[6] Negotiations were no shorter than three years, during which consumers and firms likely anticipated that trade costs would decline. Following an agreement, there was usually a short delay before implementation and then tariffs phased out over no less than five years. The tariff phase out schedule and implementation date were both known by consumers and firms even before implementation. Agents were able to fully anticipate the changes in policy in each year following the agreement.

This pattern of long negotiation and extended phase outs in global trade agreements

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[5]The spikes in the tariff series correspond to the Nixon import surcharge of 10 percent imposed with the fall of Bretton Woods in 1971 and the Ford import fee on crude oil starting in 1975.

[6]The ATC itself was the last step in a series of short-run agreements in textile and clothing that started in the early 1960s.

is also a common feature of bilateral liberalizations. The bottom two panels of Table 1 show that two bilateral trade agreements, NAFTA and the U.S.-Korea Free Trade Agreement (KORUS FTA), followed extended negotiation periods with long phase outs of tariffs.[7] Besedes et al. (2020) look at NAFTA's scheduled phase outs at the Harmonized System 10-digit product level. Of the products they consider, 18 percent were already duty free at the commencement of NAFTA and an additional 42 percent were made duty free on impact. All other products took at least five years for tariff cuts to phase in, and about 7 percent of all products became duty free in 10 equal annual tariff cuts. Less than 1 percent of all products had a tariff phaseout longer than 10 years.

Figure 3 shows the world export weighted and simple average weighted scheduled US tariff phase outs on Korean goods resulting from the KORUS FTA. The scheduled tariffs dictate, at the aggregate level, a very smooth decrease in bilateral tariffs. Figure 4 shows tariffs for autos shipped between the US and Korea. This picture clearly demonstrates that tariff phaseouts differ in both their duration and the timing of when they begin. The US, for example, secured a 25% tariff on Korean trucks that would not begin to phase out until 2018, 6 years after the agreement. In the fall of 2018, the renegotiated US-Korea FTA pushed out this phaseout once again, currently scheduled to begin in 2041. The 10% tariff on Korean cars, on the other hand, was scheduled to drop immediately. Korean tariffs on US cars were cut in half at the beginning of the agreement, held constant over the next three years, and then dropped to zero. Importantly, all these tariff schedules for individual products are publicly available.

These phaseouts combined with the long negotiations highlight the predictable aspect of trade policy. The long negotiations also suggest that the outcome of these negotiations has an unpredictable aspect. Sorting out the predictable and unpredictable components of trade policy is challenging, but consumers and firms are clearly not completely surprised by these policy changes and have an opportunity to adjust behavior along many dimensions in

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[7]The Canadian U.S. Free Trade Agreement enacted in 1988 was the culmination of many discussion and followed up on the Auto Pact in 1965 that eliminated auto tariffs.

anticipation of the future path of trade policy barriers.

3   Model

We now develop a two-country dynamic stochastic general equilibrium model with heterogeneous firms to study the short- and long-run effects of current and future changes in trade barriers. We extend the international real business cycle model with heterogeneous firms and a sunk cost of exporting of Alessandria and Choi (2007) and firm entry of Alessandria and Choi (2019a) to include trade intensive in durable and capital goods, material inputs in production, and most importantly, anticipated and unanticipated changes in trade costs. The high trade intensity in durable and intermediate goods is necessary to capture the industry structure of trade and the propagation of shocks. The changes in trade costs are needed to match the growth of trade and changes in trade policy over time. The entry margins and material inputs in production are necessary to capture the aggregate effects of changes in trade barriers most accurately.[8]

Two symmetric countries, Home and Foreign, are each populated by a continuum of identical and infinitely lived consumers.[9] Consumers make consumption and labor decisions and trade a non-contingent bond across countries. In each period t, the economy experiences an event s_t that determines exogenous variables such as productivity and trade costs. The history of these events is denoted $s^t \equiv (s_0, ..., s_t)$ where s_0 is given. We denote the probability of a history s^t as $\pi(s^t, s_0)$.

Each country has a continuum (mass N_t) of monopolistically competitive firms that produce differentiated intermediate goods. The firms are indexed by $i \in [0, N_t]$. Intermediate goods producers use capital, labor, and material inputs to produce. Firm productivity is subject to idiosyncratic and aggregate shocks.

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[8] Atkeson and Burstein (2010) and Alessandria and Choi (2014) show that transition following a change in tariffs or trade costs depends on having a firm entry decisions and firm or exporter lifecycle.

[9] Mix (2020) develops a multi-country variation of this model and shows that many bilateral effects of trade reforms can be captured in the two country model.

All intermediate goods firms sell their variety in the domestic market, but only some export. To export a firm pays an iceberg cost and a fixed cost which depends on the firm's export status in the previous period. Non-exporters pay a higher fixed cost to export than continuing exporters, as is common in the literature on firm dynamics and trade. The fixed costs are denominated in units of labor. We hold fixed costs constant, but allow iceberg costs to vary over time in unanticipated and anticipated ways. We consider the effect of changes in tariffs as well.

The mass of intermediate goods available is endogenous. Each period an unbounded mass of potential firms can enter the market by paying a fixed cost denominated in labor. Firms enter until the expected profits net of fixed costs of entering the market is zero (a free entry condition). Among existing firms, firms face a fixed probability of survival n_s from one period to the next. With probability 1-n_s, a firm must exit and receives the value of its capital stock at current investment prices.

Competitive final goods producers in each country use intermediate goods produced in the domestic and foreign market to produce consumption and investment goods. Use of intermediates in production follows the familiar constant elasticity of substitution (CES) structure. To capture the empirical observation noted by Boileau (2002), Engel and Wang (2011), Eaton et al. (2016), and others that trade is intensive in durable goods, we assume that the bias in production for home goods is different for consumption and investment goods.

3.1 Variable Trade Costs

As we are interested in the response to a range of expected and unexpected paths for trade policies, it is useful to discuss trade costs first. As is common, we assume the exports of Home and Foreign intermediate goods producers are subject to an iceberg cost. A key part of our model is that this iceberg cost is stochastic with both a trend and less persistent component. The trend component captures gradual changes in bilateral trade barriers, such

as a trade agreement. We model both shocks as following first-order autoregressive processes as in the work of Aguiar and Gopinath (2007), which studies the effects of changes in trend productivity growth.[10] We assume that shocks to the trend are known one period in advance while transitory shocks are contemporaneous. Because the model is solved by linearization, we choose a stochastic process for trade costs such that a trend shock to trade costs will still eventually return to the steady state, but it will take a long time. The process for the trade cost is

$$\xi(s^t) = (1 - \rho_\xi)\bar{\xi} + \rho_\xi \xi(s^{t-1}) + \Delta(s^{t-k}) + \varepsilon_\xi \tag{1}$$

$$\Delta(s^t) = \rho_\Delta \Delta(s^{t-1}) + \varepsilon_\Delta \tag{2}$$

and $\varepsilon_a \sim N(0, \sigma_a^2)$ for all $a \in \{\xi, \Delta\}$. For generality we write the effect of the trend that affects current trade costs as being determined in state s^{t-k}. In our benchmark we assume $k = 1$ so that agents know one period in advance how trade barriers will begin to change. We vary the strength of the phase-out with the persistence of the trend shock, ρ_Δ. When $\rho_\Delta = 0$ there is no phase-out but the shock is known one period in advance. As we raise ρ_Δ the length of the phase-out increases, as does the magnitude of the shock. Notice that all trade cost shocks are assumed to be symmetric for ease of exposition. Introducing differential movements in trade costs is straightforward, as in Alessandria and Choi (2019b) or Alessandria and Mix (2018).

3.2   Consumers

Consumers are endowed with one unit of time that they can use for leisure or labor $L(s^t)$. Consumers choose labor, consumption, and holdings of a one-period non-contingent bond to maximize welfare subjective to a budget constraint. The representative consumer's objective

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[10]An alternative approach is to introduce a rich set of shocks to future trade barriers indexed by the current and future dates. For instance, a five-year linear phase out would involve five equal steps in tariffs over the next five years. Our approach captures these linear phase outs in a tractable manner.

function is[11]

$$\max \sum_{t=0}^{\infty} \sum_{s^t} \beta^t \pi(s^t|s_0) U\left(C(s^t), 1 - L(s^t)\right)$$

where $C(s^t)$ denotes aggregate consumption at time t given history s^t, β is the discount factor, and $\pi(s^t|s_0)$ is the probability of a history s^t at time t given state s_0 at $t = 0$. The budget constraint is

$$P_C(s^t)C(s^t) + Q(s^t)B(s^{t+1}) + \frac{\phi_b}{2}B(s^t)^2 \leq P_C(s^t)W(s^t)L(s^t) + B(s^t) + \Pi(s^t)$$

where $P_C(s^t)$ is the price of consumption goods relative to the home currency, $W(s^t)$ is the real wage, $Q(s^t)$ is the price of a bond (relative to a numeraire) $B(s^{t+1})$ that pays one unit of the home currency in the next period, and $\Pi(s^t)$ denotes profits from home intermediate goods producers. There is also a portfolio adjustment cost determined by the parameter ϕ_b. Notice that the budget constraint is written in terms of the home currency. The foreign budget constrainst is similar:

$$P_C^*(s^t)C^*(s^t) + Q(s^t)B^*(s^{t+1}) + \frac{\phi_b}{2}B^*(s^t)^2 \leq P_C^*(s^t)W^*(s^t)L^*(s^t) + B^*(s^t) + \Pi^*(s^t),$$

where asterisks denote prices and allocations in Foreign.

From now on, we abstract from state dependence and write all variables with only time subscripts unless it is likely to be confusing. The first order conditions from the Home consumer's problem are

$$-\frac{U_{L,t}}{U_{C,t}} = \frac{W_t}{P_C} \tag{3}$$

$$Q_t = \beta \mathbb{E}_t \frac{U_{C,t+1}}{U_{C,t}} \frac{P_{C,t}}{P_{C,t+1}} (1 - \phi_b B_{t+1}) \tag{4}$$

where U_x denotes the marginal utility with respect to $x \in (C, L)$.

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[11]With our focus on global shocks and symmetric countries there is no need for the bond. We write it this way to allow us to consider asymmetric shocks and borrowing and lending with asymmetric countries.

3.3 Final Goods Producers

Each country has many final goods producers that engage in perfect competition. Home final goods producers use all Home-produced and a subset of Foreign-produced intermediate goods as inputs to create consumption C^p, investment I^p, and material input M^p goods with CES production technologies. Let $X \in \{C^p, I^p, M^p\}$, then

$$X(s^t) = \left[\int_0^N y_h^X(i, s^t)^\theta di^{\frac{\rho}{\theta}} + \omega_X^{1-\rho} \left(\int_0^{N^*} y_f^X(i, s^t)^\theta di^{\frac{1}{\theta}} \right)^\rho \right]^{\frac{1}{\rho}}, \tag{5}$$

where $y_n^X(i, s^t)$ is the quantity of intermediate goods produced by firm i in country n used in the production of good X, N is the number of firms at Home and N^* is the number of firms at Foreign. Parameter θ determines the elasticity of substitution between within-country varieties while ρ determines the elasticity of substitution between Home- and Foreign-produced goods. ω_X captures home bias in production of final good X. It is equivalent to allowing for a different shipping cost for goods depending on their final use. We allow the weight in production to differ for individual final goods, and in particular we impose $\omega_I, \omega_M > \omega_C$ to capture the empirical observation that trade is more common for durable goods and materials.

Final goods producers produce consumption, investment, and material goods separately and maximize profits over each type of final good. That is, they choose intermediates to maximize the following profit function for each final good X:

$$P_{Xh}(s^t)X(s^t) - \int_0^N p_h(i, s^t)y_h^X(i, s^t)di - \int_0^{N^*} p_f(i, s^t)y_f^X(i, s^t)di \tag{6}$$

subject to the good-specific aggregation technology. The firm treats the problem for each final good as distinct. Notice that while final goods producers buy intermediates for the production of all types of final goods separately, the intermediate goods producers only produce one type of intermediate and charge the same price for it, regardless of its final use.

Demand for an individual firm i's output for use in production of final good $X \in$

$\{C, I, M\}$ in the Home market can be expressed as

$$y_h^{X,d}(i, s^t) = \left(\frac{p_h(i, s^t)}{P_h(s^t)}\right)^{\frac{1}{\theta-1}} \left(\frac{P_h(s^t)}{P_{Xh}(s^t)}\right)^{\frac{1}{\rho-1}} X_h(s^t) \tag{7}$$

and the demand for the same firm's output for use in Foreign is

$$y_h^{*X,d}(i, s^t) = \left(\frac{p_h(i, s^t)}{P_h(s^t)}\right)^{\frac{1}{\theta-1}} \left(\frac{P_h(s^t)}{P_{Xf}(s^t)}\right)^{\frac{1}{\rho-1}} \omega_X X_f(s^t) \tag{8}$$

where prices of bundles P_h and final goods prices P_{Xh} are the usual Dixit-Stiglitz price indices:

$$P_h(s^t) = \left(\int_0^1 p_h(i, s^t)^{\frac{\theta}{\theta-1}} di\right)^{\frac{\theta-1}{\theta}}$$

$$P_{Xh}(s^t) = \left(P_h^{\frac{\rho}{\rho-1}} + \omega_X P_f^{\frac{\rho}{\rho-1}}\right)^{\frac{\rho-1}{\rho}}.$$

3.4 Intermediate Goods Producers

Each country has a continuum of intermediate goods producers that survive to the next period with probability n_s. These firms each produce a unique variety and engage in monopolistic competition. Intermediate goods producers produce with capital, labor, and intermediate inputs. Firm productivity has an aggregate and idiosyncratic component.

The production technology of the firm is

$$y_h(i, s^t) + \xi^*(s^t) y_h^*(i, s^t) n(i, s^t) = e^{\eta(i, s^t)} \left(k(i, s^{t-1})^\alpha l(i, s^t)^{1-\alpha}\right)^{1-\alpha_m} m(i, s^{t-1})^{\alpha_m} \tag{9}$$

where $y_h(i, s^t)$ and $y_h^*(i, s^t)$ represent domestic and export sales of intermediates for the production of final goods, $k(i, s^t)$, $l(i, s^t)$, $m(i, s^t)$ and $e^{(1-\alpha)\eta(i, s^t)}$ represent firm specific capital stock, labor, material inputs, and productivity, respectively, ξ^* represents the stochastic iceberg cost of exporting to the Foreign market, and $n(i, s^t)$ is an indicator variable taking value 1 if i exports at time t and 0 otherwise.

Firm productivity is heterogeneous across firms. Each period, firms draw productivity $\eta(i, s^t)$ from a distribution that is independent and identically distributed (iid) across both firms and time with $\eta(i, s^t) \sim N(0, \sigma_\eta^2)$. Alessandria and Choi (2007) show that the aggregate properties of this model are similar when the idiosyncratic shock is persistent.

Firms own the capital and choose investment $x(i, s^t)$ every period. The law of motion for capital is

$$k(i, s^t) = (1 - \delta)k(i, s^{t-1}) + x(i, s^t). \tag{10}$$

At the beginning of a period, a firm is identified by its idiosyncratic productivity $\eta(i, s^t)$, undepreciated capital stock $k(i, s^{t-1})$ from the previous period, and the previous period's export status $n(i, s^{t-1})$. The firm then chooses investment $x(i, s^t)$, labor $l(i, s^t)$, material inputs $m(i, s^t)$, current export status $n(i, s^t)$, and prices $p_h(i, s^t)$ and $p_h^*(i, s^t)$ to maximize the present discounted value of profits. Firm i's Bellman equation is [12]

$$V(\eta, k, m, s^t) = \max_{x, l, m', p_h, p_h^*,} \pi(i) + n'(i)\pi^*(i) \tag{11}$$

$$+ \sum_{s_{t+1}|s^t} D_h' \left(n_s \int V(\eta', k', n'(i))dF(\eta') + (1 - n_s)P_{Ih}' \Xi' k(i) \right)$$

where

$$\pi(i) = p_h y_h(i) - P_C W l - \Xi P_I x - P_M m \tag{12}$$

$$\pi^*(i) = en\left[p_h^* y_h^*(i) - P_C W(n\tau_1 + (1 - n)\tau_0)\right] \tag{13}$$

and D_h' is the subjective discount factor $\beta \frac{u_{Ch}'}{u_{Ch}} \frac{P_{Ch}}{P_{Ch}'}$ subject to the production technology (9), the law of motion for capital (10), and the downward-sloping demand curves (7 and the Foreign analog of 8) with the condition that $y_h(i) = y_h^C(i) + y_h^I(i) + y_h^M(i)$ and similar for demand by foreign final goods producers. $F(\eta)$ is the cumulative distribution function of the normal distribution with variance σ_η^2. Ξ introduces capital adjustment costs in the model by

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[12]Dependence on the state s^t is not shown explicitly in the following exposition for convenience.

taking the form

$$\Xi = 1 + \omega_{ac}\left(\frac{\bar{I}}{\bar{K}} - \delta\right),$$

where $\bar{I}$ and $\bar{K}$ denote aggregate investment and capital so that agents do not internalize the effect of their personal investment on the aggregate adjustment costs. The adjustment cost makes the price higher when aggregate net investment is positive and lower when net investment is negative, making adjustment in either direction more costly.

Let $V_1(\eta, k, m, s^t)$ be the value of a firm that chooses $n' = 1$ (that is, the firm chooses to export in the current period). Similarly, let $V_0(\eta, k, m, s^t)$ be the value of a firm that chooses $n' = 0$. Then we can rewrite the value of a firm as

$$V(\eta, k, n, s^t) = \max\{V_1(\eta, k, n, s^t), V_0(\eta, k, n, s^t)\}.$$

V_1 and V_0 are both increasing functions of η, and V_1 crosses V_0 only once for given (k, n, s^t). Thus, there exists a cutoff productivity level at which the firm is indifferent between exporting and not exporting. Above that level, the firm exports, and below that level, it does not. Because the fixed cost of exporting depends on the firm's export status in the previous period, the cutoff also depends on the exporters previous export status. Let η_0 be the cutoff productivity level for firms that did not export in the previous period and η_1 be the cutoff productivity for firms that did export. Then η_0 and η_1 satisfy

$$V_1(\eta_0, k, 0, s^t) = V_0(\eta_0, k, 0, s^t) \tag{14}$$

$$V_1(\eta_1, k, 1, s^t) = V_0(\eta_1, k, 1, s^t). \tag{15}$$

Because $\tau_0 > \tau_1$, we know that $\eta_0 > \eta_1$–that is, beginning to export requires a higher productivity shock than continuing to export.

To make clear the role of expectations in the firm's export decision it is useful to rewrite

the indifference condition of the marginal exporters $n = 0, 1$ as

$$W\tau_n - \Delta\pi\left(\eta_n\left(\xi\right), k_n, \xi\right) = n_s ED'_h\left[\Delta V'\left(\eta', \xi', \Delta'\right); \eta_n\right] \tag{16}$$

The left-hand side is the cost of exporting today net of the extra profit from exporting today. The right-hand side measures the discounted expected change in future firm value. It depends on the path of future trade barriers, summarized here by (ξ', Δ'), as well as the discount factor, which depends on the aggregate savings decisions of the consumers. Recall that an important part of the iceberg cost is known in advance because of the phaseout.

With iid idiosyncratic firm productivity shocks over time, all firms have the same expectations over their productivity in the next period. Then, the only thing that determines a firms choice of capital for the next period is its export status in the current period. The distribution of capital is then determined by two mass points, weighted by the share of exporters and nonexporters.

The percentage of nonexporters that begin exporting in state s^t is just $1 - F(\eta_0(s^t))$. Similarly, the percentage of exporters that continue exporting is $1 - F(\eta_1(s^t))$. Let $N_x(s^t)$ be the measure of exporters in state s^t and $N(s^t)$ be the number of firms. Then we have

$$N_x(s^t) = (N(s^{t-1}) - N_x(s^{t-1}))[1 - F(\eta_0(s^t))] + N_x(s^{t-1})[1 - F(\eta_1(s^t))]. \tag{17}$$

Let $\Phi(s^t)$ $(\Phi^*(s^t))$ represent the set of Home (Foreign) firms that export. Then the measure of $\Phi(s^t)$ is $N_x(s^t)$, the number of exporters. The labor hired in Home for the purpose of paying the fixed cost L_{fc} is

$$L_{fc}(s^t) = \int_{i \in \Phi(s^t)} \tau_1 n(i, s^{t-1}) + \tau_0(1 - n(i, s^{t-1}))di. \tag{18}$$

3.5 Firm Entry

Each period, new firms may pay a fixed cost τ_e and invest in capital to start producing as non-exporters in the next period. If firms survive to produce, they have value V_0. Otherwise, they can sell their capital that they bought in the previous period. The free entry condition for entering firms is

$$P_C W \tau_e + P_I K_0 = \sum_{s_{t+1}|s^t} D_h'[n_s V_0' + (1 - n_s) P_I' \Xi' K_0].$$

The mass of entrants is denoted N_e.

3.6 Equilibrium

In equilibrium, several market clearing conditions must be met. We must have $C^{(*)p}(s^t) = C^{(*)}(s^t)$, $I^{(*)p}(s^t) = \int_0^{N^{(*)}} x^{(*)}(i, s^t)$, and $M^{(*)p}(s^t) = \int_0^{N^{(*)}} m^{(*)}(i, s^t)$. The market clearing conditions for labor are $L(s^t) = \int_0^N l(i, s^t) + L_{fc} + N_e \tau_e$ and $L^*(s^t) = \int_0^{N^*} l^*(i, s^t) + L_{fc}^* + N_e^* \tau_e$. All profits from intermediate goods producers are given to the representative agent. The market clearing condition for international bonds is $B(s^t) + B^*(s^t) = 0$; bonds are in zero net supply. The number of firms in each country is $N^{(*)'} = n_s(N^{(*)} + N_e^{(*)})$ We normalize the price of consumption in Home to one $P_C(s^t) = 1$ for all s^t.

We center our attention on a stationary equilibrium so that all allocations and prices are functions of the state s^t. Exogenous state variables have been described. Endogenous states are bonds and the distribution of (η, k, n) across intermediate firms. With iid idiosyncratic firm productivity the distribution can be summarized by the mass of firms and exporters and the capital stock of exporters and non-exporters (N, N_x, K_0, K_1).

4 Calibration

Here we describe how we match the model to the data at the firm and aggregate levels. Our approach closely follows the international macro literature with and without firm heterogeneity (Engel and Wang (2011); Alessandria and Choi (2007)).

The utility function is non-separable between consumption and leisure

$$U(C(s^t), 1 - L(s^t)) = \frac{\left[C(s^t)^\gamma \left(1 - L(s^t)\right)^{1-\gamma} \right]^{1-\sigma}}{1 - \sigma},$$

where the intertemporal elasticity of substitution is $1/\sigma$ and γ determines the share of consumption in the composite good. These are traditional balanced growth preferences with an important role for wealth on labor supply. Recent work by Boppart and Krusell (2020) suggests a stronger wealth effect of labor supply than these preferences deliver.

The assigned parameters are reported in Table 2. Many of these parameters are standard and are taken from the literature. A period is one year. We set β=0.96 to match a steady state real interest rate of 4 percent. We choose the share of consumption γ in the utility function so that time devoted to labor is $1/4$ of the time endowment.[13] The intertemporal elasticity of substitution $1/\sigma$ is set to $1/2$. We set α=0.36, as is common in the literature, to match the share of revenue that goes to labor. We set $\delta = 0.1/n_s$. The firm survival rate n_s is set to 0.973 so that 2.7 percent of firms exit each year.

The elasticity of substitution between varieties within a country is determined by θ, which also determines markups of intermediate firms. Here we set $\theta = 5/6$ which implies a markup of 20 percent, within the estimates in the literature summarized by Schmitt-Grohé (1997). Given θ, we choose $\alpha_m = 0.4$, which implies that gross output in the economy is 1.5 times larger than value added. The elasticity of substitution between home and foreign goods is determined by ρ. Here we choose an elasticity of 4 (ρ=3/4). This value is higher than in most business cycle analyses (Backus et al. (1994)) but recent work suggests that when the

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[13]This parameter implies a Frisch elasticity of about 2, within the bounds of the estimates in the literature.

gap in trade barriers moves systematically with the business cycle, a model of this type can match aggregate fluctuations (Alessandria and Choi (2019b)). The model yields a long-run trade elasticity of close to 8, which is common in the trade literature (Caliendo and Parro (2014)) and matches the evidence of Khan and Khederlarian (2019) for the trade response to tariffs in NAFTA.

We calibrate the rest of the parameters to match aggregate and firm-level trade flows, which are determined by the taste parameters and the fixed and variable trade costs. The standard deviation of firm productivity σ_η is set to 0.3, which implies – in the final calibration – that exporter sales are 6.5 times higher than non-exporter sales on average. The steady state iceberg cost is normalized to $\bar{\xi} = 1.15$. The parameters that remain to be calibrated are home bias for investment, materials, and consumption ω_I, ω_M, and ω_C, and the fixed costs of exporting for incumbent and new exporters τ_1 and τ_0. We choose these parameters to match the following five features in steady state, which are loosely based on the current U.S. economy:

1. An aggregate import to GDP share of 15 percent,

2. 20 percent of trade in investment goods,

3. 60 percent of trade in intermediate inputs,

4. 21 percent of all firms export,

5. 5 percent of exporters stop exporting every period,

We assume variable trade costs are stationary but very persistent ($\rho_\xi = 0.9999$). The high persistence is necessary to capture the sustained rise in trade flows observed in the data. We set $\rho_\Delta = 0.75$ so that the model generates the same average trade barrier over 10 years as with a 10–year linear phase-in, which matches our empirical observations about FTAs.[14] We set $\omega_{ac} = 0.015$ so that the investment response to a Hicks-neutral productivity shock is

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[14]With our geometric trade costs this formulation leads to a slightly higher trade barrier over a ten year window.

about three times as large as the GDP response. Our adjustment cost on bonds ϕ_b is set to be very close to zero.

We consider several model variants to isolate the key channels of the model. The first two model variations help isolate how the nature of trade determines the aggregate effects of shocks to trade barriers. In the first variation, denoted *Unbiased*, we assume that trade in different goods is unbiased. In other words, we assume $\omega_C = \omega_I = \omega_M$ and give up on matching the share of trade in investment and input goods. In the second variation, denoted *Static*, we take *Unbiased* and constrain $\tau_1 = \tau_0$ so that the startup and continuation costs are identical and there is no dynamic aspect to the export decision. With a static exporting decision, we give up on matching exporter persistence. This model has a higher short-run trade elasticity and lower long-run trade elasticity than the benchmark or the unbiased trade model. We also consider various other assumptions that could affect our results including using Boppart and Krusell (2020) preferences that magnify the wealth effect, and allowing for the trade policy to be in tariffs rather than iceberg trade costs.

5   Model Results

We now discuss the response of the model economy to unanticipated and anticipated shocks to global trade costs. The aggregate effects of unanticipated shocks have been studied in the literature, and the aggregate response in our model to an unanticipated persistent trade cost shock is qualitatively similar to that of existing models, though the transitions for aggregate variables differ.[15] Anticipated shocks, by contrast, have novel aggregate effects, as the wealth effect and substitution effect occur at different times, particularly when trade results from a firm-level dynamic decision.

Figure 5 shows the aggregate response–in log changes from steady state–to an unanticipated and persistent decrease in the iceberg trade cost from 1.15 to 1.06, which doubles the

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[15]Recall the work by Crucini and Kahn (1996), Perri and Quadrini (2002), Alessandria et al. (2013), and Alessandria and Choi (2019b).

trade-to-output ratio after 10 years. The reduction in trade costs lowers the price of foreign relative to domestic intermediate goods, and trade grows 58 log points immediately. The short-run impact on trade relative to GDP is a little less than three fourths of the effect five years on as more firms from both countries start or continue exporting. These gradual effects on trade and exporting are unique to the benchmark dynamic exporting model.

Just as trade grows slowly, so do other aggregates. The aggregate gradualness arises because it takes time to accumulate export capacity and physical capital, and to change the mass of varieties. Because trade is intensive in investment goods, the decrease in the price of traded goods also lowers the relative price of capital to consumption, which leads to substantial capital deepening. On impact, investment grows 13 log points. Over time, more foreign firms begin to export, decreasing the cost of traded goods and investment by even more. Investment peaks two years after the agreement at more than 19 log points above steady state. Thereafter, investment falls and eventually reaches its long run value, which is about 8.5 log points above the initial steady state.

The overshooting of investment that we observe here occurs in many models with dynamic exporting and endogenous entry of firms. At the beginning of the liberalization, the economy has too many firms and too few exporters. The liberalization lowers the value of being a non-exporting firm, and because the probability of becoming an exporter is low, potential entrants stay out of the market. The labor that was used to create new varieties is shifted towards producing more goods, leading to elevated levels of investment and consumption. Over time, the number of firms reaches its new steady state, more than 8 log points below the initial steady state. The smaller number of firms means much less productive capacity at home and fewer goods can be produced, leading to the strong overshooting in investment.

On impact, consumption grows a little more than 3 log points and then gradually expands. The wealth effect makes consumers want to consume more goods. Furthermore, firms are delaying investment, freeing up resources to use for consumption. Consumption initially rises slowly as firms invest intensively in their capital stocks. After 10 years, the trade to

GDP ratio has doubled and yields a 5 log point increase in consumption. GDP, a weighted average of consumption and investment, increases slightly on impact and grows the first few years after the agreement before decreasing to its eventual long run outcome, reflecting the same overshooting that we see in investment.

Total labor supply drops on impact. Part of this fall is related to the wealth effect, which encourages consumers to take more leisure while the cost of goods is still high. However, labor is also lower because potential firms are not entering the market and are therefore not using labor to pay fixed costs. Indeed, labor devoted to production of goods increases on impact, though by much less than in the long run.

Figure 6 shows responses for the same aggregates to an anticipated shock that similarly doubles trade to output after 10 years. The shock is anticipated in two ways. First, it does not affect trade costs until tomorrow but enters agents' information set today. Second, the shock implies not only a decrease in trade costs tomorrow, but also a decreasing path of trade costs into the future. We can think about this shock as news of a future trade liberalization. Agents know that trade costs will drop when the agreement begins and that trade barriers will continue to fall in subsequent years.

As a result of discounting, this shock is substantially smaller than the unanticipated shock to trade costs even if the shocks would have the same long-run effects if they were permanent. Investment, trade, and GDP all fall sharply in the initial periods; an anticipated trade liberalization is recessionary in the short run. Consumption, by contrast, increases immediately but by only about half as much as with the unanticipated shock. Consumers understand that lower future trade costs will make them better off. Today, they would like to consume more, take more leisure, and save less. This wealth effect partly drives the decrease in investment, trade, and GDP. Eventually, traded goods become cheap enough that firms begin to replenish and then increase their capital stock. Cheaper goods also cause consumers to substitute away from leisure and toward consumption so that the labor response is positive in the long run. The increase in capital and labor translates to almost a 6 percent increase

in GDP after 10 years.

Although investment in physical capital is delayed until trade costs decrease and the price of investment falls, investment in export capacity increases immediately. Because firms expect trade costs to fall, the future value of exporting is high. Nevertheless, the probability of drawing a productivity shock high enough to begin exporting is still low. If firms get a good productivity shock before the agreement begins or before trade costs have fallen significantly, they will start exporting— even if they do so at a loss— because exporting today makes them more likely to be able to export tomorrow. In contrast, the liberalization leads to more entry of foreign exporters, which lowers the future value of being a non-exporter, and fewer potential firms enter the market.

To make clear the role of expectations and wealth effects, we now model a gradual liberalization in trade costs in three ways: (1) anticipated from the year before the trade cost declines, (2) as a series of unanticipated persistent trade cost shocks, or (3) as a series of unanticipated transitory trade cost shocks so that agents always expect a complete reversion of trade costs to steady state in the next period. As we move from the first to third case we are progressively reducing the wealth effect.

As we saw earlier, when the decreasing path of trade costs is anticipated, consumption increases on impact because the expected present value of the liberalization is larger than the current trade cost decline and thus induces a large wealth effect. Consumption stalls for the next few quarters as the capital stock depreciates; just as consumers expect to be richer a year from now, firms expect capital to be cheaper a year from now and wait to invest. Once the capital stock begins to grow again, consumption grows quickly throughout the rest of the transition. The consumption paths for the case with anticipated shocks and the two cases with unanticipated shocks cross, but we know that welfare is higher when agents anticipate the agreement because their information set is expanded. Indeed, the transition path for labor shows that agents enjoy more leisure early on because of the wealth effect.

When trade shock changes are unanticipated, there is no movement in the first period

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because trade costs have not yet actually changed. Thereafter, we see a small wealth effect in consumption for case (2), where shocks are perceived as almost permanent. A permanent trade cost decline makes agents richer today and even richer in the future as more foreign firms begin exporting, thereby reducing import prices. Consumption grows in transition as the trade costs continue to decline. Leisure also grows over time, partly because of the wealth effect, and partly because lower trade costs lower the value of being a non-exporter, leading to less entrants and less labor devoted to entry fixed costs. In case (3), when the trade costs are perceived to be purely transitory, agents see the low price of capital as temporary and invest a lot, crowding out consumption so that it grows very little at the beginning of the reform. As the shocks grow over time and capital accumulates, the demand for investment goods slows down allowing for more consumption. When shocks are perceived as transitory, agents work more to take advantage of the lower prices. Also, if the shock is expected to be temporary, it does not affect the future value of non-exporters, and firms continue to use labor to enter the market.

The previous experiment demonstrates the role of expectations of future trade reforms, as three identical trade cost paths yield very different outcomes for GDP, investment, consumption, and labor in the first few years of the transition. Any analysis of the impact of trade integration on the economy must therefore differentiate between expected and unexpected movements in trade costs.

5.1 Anticipation Horizons

We now explore how the timing of the future liberalization influences the transition path holding the size of the liberalization constant. In general, we find that the declines in consumption and employment on impact are quite similar. We also find that the longer the anticipatory period, the deeper the decline in economic activity until reforms begin.

To compare liberalizations expected at different time horizons, we define a discounted

average trade cost:[16]

$$\xi_{PV,t} = (1-\beta)\mathbb{E}_t \sum_{s=t}^{\infty} \beta^{s-t}\xi_s.$$

Consider three alternative trade liberalizations that are expected one, four, and eight years before implementation and have the same $\xi_{PV,t}$. Figure 8 shows the impulse response functions (IR) of macroeconomic variables for these three liberalizations.

Regardless of the expectation time horizon, the announcement of a trade liberalization is initially recessionary. In the case of four- and eight-year anticipation, the recession gets worse over time, with a trough in output the year before trade costs actually begin to fall. The recession is stronger at longer expectation horizons. Consumption increases on impact in all cases. After the initial boost, consumption declines with investment and labor until the liberalization actually begins.

Despite decreases in economic activity, the number of exporters does not fall in advance of the actual tariff cuts. Because firms are forward looking, they know that while exporting today might be unprofitable, the future value of being an exporter is high. If they receive a good productivity shock today, they use it to pay the sunk cost and begin exporting, recognizing that the likelihood of receiving another good shock after the liberalization is low. Once the liberalization begins, growth in the extensive margin of trade is even higher.

5.2   Violated Expectations

Our model can be used to study the effect of canceling or delaying an FTA that was expected by consumers and firms. FTAs are often canceled or delayed because of changes in a country's leadership, economic downturns, or other factors. For example, President Trump withdrew the United States from the TPP—a multilateral trade agreement that had already been signed—soon after his election. How does such a withdrawal affect U.S. consumers and firms?

Suppose that agents receive news today that a trade liberalization will begin in four

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[16]An ideal measure of the present value of trade costs would use the subject discount factor instead of β.

years. The year before it starts, however, they receive news that the liberalization is either delayed an additional four years or canceled.

Figure 9 compares the macroeconomic outcomes under these two situations. For the first three years, the IRs are the exact same, with consumption rising and investment, labor, trade and output falling. When the agreement is canceled, the consumers' expected future wealth decreases, causing them to consume less and work more. At the same time, firms now expect a higher future price of capital and lower future export value, which causes them to invest more in physical capital and pull out of the export market upon hearing the news. Canceling a trade agreement therefore yields a persistent increase in hours, output, investment, and trade *from the date of cancellation.* However, canceling an agreement also reduces the growth of GDP about 1/2 percentage point per year over the next 15 years when compared with the implied path when the liberalization occurs on time.

Delaying a trade agreement mitigates all of these effects compared with canceling the agreement. Labor, investment, output, and trade recover a little when the delay is announced, but decrease again before the new expected liberalization date. Consumption decreases as the delay lowers the present value of consumers' wealth. Prolonged low investment serves to exacerbate the dip in consumption in the medium run.

5.3   Sensitivity to Model Assumptions

In this section, we analyze how several key assumptions about the composition of trade, exporter dynamics, preferences, tariffs, and country size affect the aggregate response to changes in trade policy.[17] Discussions frequently refer to the IRs in Figures 5 and 6, which include dynamics for the benchmark model and all variations of the model described earlier. Table 2 also includes the calibrated parameters for each alternate model.

Trade composition. In our benchmark model, we have allowed for trade to be more intensive in investment and materials than in consumption. In this variation, we impose

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[17]In Appendix E, we also report sensitivity to the firm creation margin, the export decision, and the use of materials in production.

$\omega_C = \omega_I = \omega_M$ so that the composition of trade reflects the composition of the domestic economy. This variation is denoted as "Unbiased trade" in the figures. In our benchmark model, a liberalization in trade reduces the prices of investment (and materials) by more than the price of consumption, inducing a larger investment response. With an unanticipated and persistent trade cost decline, investment is more than 10 percent higher than in the inital steady state after 10 years with capital-intensive trade and only 5 percent without it. Long-run consumption and output are higher with capital-intensive trade, as higher investment means higher long run capital stocks. Consumers also take more leisure in the long run (not shown) when trade is intensive in capital as firms substitute toward capital and away from workers.

Dynamic exporting decision. We now show that the dynamic response of aggregates to a change in trade barriers depends on the firm-level trade frictions. The relative magnitude of the sunk and fixed costs of exporting is calibrated by matching the churning of firms in and out of the export market. This calibration resulted in a sunk cost that is about four times higher than the continuation cost so that becoming an exporter is much harder that continuing as an exporter. Now suppose that we assume there is no sunk cost of exporting $(\tau_0 = \tau_1)$ in addition to the unbiased trade composition. In that case, firms are no longer forward looking.[18]

With a persistent trade cost decline, the trade response is immediate in a model with static exporters. The immediate response is contrary to the slow adjustment of the extensive margin that we see in the data (Baier et al. (2014)). The static exporting decision also reduces long-run trade (and output), as a smaller share of exporters stay in the market each period.

When the cost of exporting is the same for both non-exporters and exporters, the probability of becoming an exporter is much higher (and is equal to export participation in steady state). As in the dynamic model, the liberalization raises the value of being an exporter and lowers the value of being a non-exporter, but non-exporters and potential firms no longer

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[18]An alternative approach to making trade static would be to eliminate fixed trade costs entirely. Results without the extensive margin are quite similar to the static exporting model and are shown in the Appendix.

see exporting as a rare event and the risks are more balanced. Hence, more firms enter than in the dynamic exporting model, and the number of firms falls by less. More labor is needed to pay entry costs in the early years of transition. As a result, fewer resources are available in transition to boost consumption and investment and they grow by less.

With an expected decrease in trade costs, the trade response in the static exporting model is gradual but only because trade costs change gradually. Nothing internal to the static exporting model slows down the trade response. As in the case with an unexpected decrease in trade costs, the dynamic exporting model delivers larger long-run changes in trade, output, investment, and consumption; the static model underestimates the effect of trade cost changes on aggregates.

Preferences. Wealth effects on labor supply primarily determine the response to changes in future trade policy. Recent cross-country evidence from Boppart and Krusell (2020) on employment with development is consistent with stronger wealth effects than in our benchmark preferences. Given that we are considering a global policy change, we revisit the effects with these alternative preferences. Figures 5 and 6 show that with these stronger wealth effects on labor supply, the initial contraction in labor is twice as large as our benchmark and the long-run expansion in labor supply is weaker. In fact, labor never returns to its initial steady state.

Tariffs. We now discuss how tariffs can amplify or mitigate the contractionary effects of future trade reforms. We show that cutting future tariffs will mitigate some of the contractionary effects on labor supply and magnify the long-run effects of a liberalization. For the model with a cut in tariffs, we introduce a 10 percent global tariff in steady state and then recalibrate the model.

Consider now a gradual phaseout of tariffs. We find such a cut is less contractionary in employment on impact and has a larger effect on long-run consumption. There are two key differences between tariffs and trade costs. First, with a change in trade costs, there is a direct resource gain from the change unlike with tariffs. Shifting to tariffs then tends to

make the effect of a reform less important for welfare. Second, the tariff is a tax on goods that reduces labor supply. This channel tends to magnify the effects of a reform. We can see that the long-run effect on labor supply is much larger with the tariff cut than with iceberg costs.

Asymmetric countries. The effects we identify from global reforms will be heterogeneous across countries. They will depend on the importance of trade and the size of the reform in each economy. We explore this heterogeneity by solving a version of the model with asymmetries in country size. Specifically, we introduce asymmetric TFP z: The big country has $z = 1.05$, and the small country has $z = 0.95$. Figure 10 shows the macroeconomic effects of a phased-in global iceberg cost liberalization for each country. The size of the liberalization in terms of the change in trade costs is the same for each country, but, by construction, the small country has a larger trade-to-output share and thus the reform is larger. The benchmark model in the figures is our model with symmetric countries (with $z = 1$ for each).

While the trade-to-GDP ratio evolves very similarly for both countries, the macroeconomic effects in transition are very different. Because the small country relies more on trade, the same future decrease in trade costs translates to a bigger decrease in prices and a larger increase in wealth than for the large country. Accordingly, the small country consumes more and works less once the path of future costs is known. Investment drops by more on impact in the small country, partly because it is crowded out by consumption, but also because firms in the small country are expecting a bigger capital price reduction in the coming years than are firms in the large country. Over time, investment in the small country grows quickly, far outpacing the growth of investment in the big country.

In the next section, we will discuss empirical evidence of the anticipation effects of FTAs. Our empirical method will exploit heterogeneity between the effects of global liberalizations (GATT rounds) for different countries. Our empirical results are consistent with this section on asymmetries: Countries for which the effect of an expected liberalization is larger have

lower investment and labor and higher consumption in anticipation.

6   Aggregate Evidence from GATT Rounds

We study the aggregate responses of OECD countries to future reductions in tariffs due to GATT round implementations. Because GATT rounds are negotiated for several years, we assume that participating countries have some prior knowledge about the timing and expected impact of the round on aggregate trade. We construct a proxy for expected future trade growth and implement a method similar to Arezki et al. (2017) to find the impact of expected future trade on current aggregate variables. The analysis confirms that labor and the investment rate fall and consumption rises in anticipation of a future trade liberalization as expected from aggregate behavior in the model.

Real GDP, investment, consumption, and trade data were obtained from the OECD, and total hours were obtained from the PWT.[19] We use only the 27 OECD countries that have continuous data since 1960 and end the analysis in 2008. This time frame covers three large GATT rounds: the Kennedy Round (implemented in 1968), the Tokyo Round (1980), and the Uruguay Round (1995). Each of these rounds was negotiated for at least five years, allowing member countries to anticipate the effects the agreements would have on the economy. To measure the anticipated size of the agreement, we assume that agents knew the effect the agreement would have on the trend growth of trade flows over the following 10 years. More specifically, we construct a variable with the following steps.

First, let $\lambda_t = \log(1 - \frac{EX_t + IM_t}{2GDP_t})$. That is, λ_t measures how closed an economy is to foreign trade, with an economy in autarky having $\lambda_t = \log(1)$. Let λ_t^T be the trend component of λ_t using a Hodrick-Prescott (HP) filter with smoothness parameter 6.25. The anticipated size of the agreement $\hat{\lambda}_t$ is

$$\hat{\lambda}_t = \frac{\sum_{s=t}^{t+10} \beta^{s-t} \Delta \lambda_s^T}{\sum_{s=t}^{t+10} \beta^{s-t}}.$$

---

[19]Consumption is assumed to include private consumption, government spending and net exports. Investments is the gross capital flows.

$\hat{\lambda}_t$ is the discounted 10-year growth rate of λ^T starting at year t. Figure 11 shows λ_t^T for the U.S. over the sample and $-\hat{\lambda}_t$ at all GATT round implementations. As the figure illustrates, $\hat{\lambda}_t$ is increasing (further from zero) in future trade growth and initial openness.

We assume agents know this measure of future trade growth in advance and estimate the following equation:

$$y_{it} = \gamma y_{i,t-1} - \sum_{s=-5}^{10} \beta_s \hat{\lambda}_{i,t-s} GATT_{i,t-s} + \alpha Z_{i,t} + \alpha_i + \varepsilon_{it}$$

where y_{it} is a macroeconomic variable of interest; $GATT_{i,t}$ is an indicator variable equal to one if a GATT round is implemented at time t and country i is a GATT or World Trade Organization member at the time; α_i is a country-specific fixed effect; and $Z_{i,t}$ is a vector of control variables, including the real effective exchange rate, oil prices, the cyclical component of HP-filtered Group of Seven (G-7) total GDP, and a quadratic country-specific trend as appropriate. The cyclical component of G-7 GDP is intended to control for the state of the world business cycle at time t.

We estimate the regression for logged hours, logged GDP, and the consumption and investment rates. Figure 12 shows the IRs and 90 percent confidence intervals–calculated using Driscoll-Kraay standard errors (Driscoll and Kraay (1998))– assuming $\hat{\lambda}_t = 1$ percent, which is roughly the mean value across countries in the first year of GATT rounds.

For the average country, hours dropped more than 1 percent in the years preceding the agreement and consumption as a share of GDP rose about 0.5 percent. The model rationalizes these movements as a wealth effect with no offsetting substitution effect. Because workers knew that the tariff cuts would increase wealth and wages, they reduced labor supply and increased consumption in anticipation. GDP fell more than 1 percent. Mirroring the consumption rate, the investment rate fell about 0.4 percent in anticipation of GATT tariff cuts and then began to rise after the cuts began.

The results confirm that investment and hours worked fall and consumption rises when

agents expect future tariff cuts, as predicted by the model. Importantly, the effect is not the same for all countries. Rather, countries that had (and, we assume, expected) higher trade growth after the tariff cuts had larger decreases in investment and hours and a larger increase in consumption. The results are qualitatively robust to alternative measures of future trade growth, excluding outliers, and to other ways of controlling for the global business cycle.

Though adopted from Arezki et al. (2017), our empirical method differs in key ways. In Appendix D, we validate this method for our purposes by using it to estimate IRs in model-simulated data. The resulting IRs exhibit very similar paths as in the data, especially for the consumption rate, the investment rate, and GDP. Because the method picks up the anticipatory effects in the model–where we know they exist–and yields results very similar to the data, we conclude that the empirical method is indeed picking up anticipatory effects of future trade agreements in the data.

7   Conclusion

We study the aggregate effects of changes in past, present, and future trade barriers in a quantitative general equilibrium model with a dynamic exporting decision. Similar to previous work on news on productivity, we find that expected decreases in future trade costs lower employment, investment, and GDP on impact because of a wealth effect that is not offset by a substitution effect until trade costs actually change. Future decreases in trade costs also induce entry of firms into export markets as firms recognize that the future value of exporting is high. This result, as well as the slow response of trade to changes in trade costs, depends crucially on the firm export decision being dynamic. A first look at aggregate movements before and after GATT liberalization suggests that hours and investment decline and consumption increases before an anticipated liberalization, as predicted in the model.

Because past and future trade costs can affect current trade, measures of trade costs that rely on static gravity models and data on trade flows are prone to error. A model

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Because past and future trade costs can affect current trade, measures of trade costs that rely on static gravity models and data on trade flows are prone to error. A model

that incorporates the importance of trade cost timing and time-varying trade elasticity is crucial to obtain accurate measures of trade costs over time and a better understanding of the aggregate effects of global integration. An open question is then how to measure the expected path of trade barriers at various points in time. Were each of the GATT rounds expected at the formation of GATT? Or did the path of expected trade policy change dynamically with past negotiation successes and business cycles? Our analysis suggests we can use aggregate series to extract information on the outlook of trade policy.

Our theory also suggests that variations in trade policy could be an important driver of movements in GDP. Most trade models have a limited role for trade to affect the level of activity as they abstract from issues of labor supply, capital accumulation, trade dynamics, or trade barrier dynamics. Our model, extended to include usual business cycle shocks, is well suited to estimate these effects. We expect that there are periods when these changes are relatively important for both business cycle fluctuations and fluctuations in trend growth. Importantly, these shocks to future trade policy may help to understand how changes to other policies or technologies affect the aggregate economy. While we have not addressed these questions here, our framework can easily be brought to bear on these issues. Indeed, in a follow-up paper, Alessandria and Mix (2018), we study the contributions of changes in trade barriers to U.S. aggregate fluctuations and extract an expected path of inward and outward U.S. trade policies.

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A   Tables

Name	Negotiation Period	Phaseout
Kennedy Round	1964-1967	1968-1972
Tokyo Round	1973-1979	1980-1986
Uruguay Round	1986-1993	1995-1999
ATC	-	1995-2005
NAFTA	1988-1993	1994-2004
US Korea FTA	2006-2012	-

Table 1: Tariff Phaseouts and Negotiations

	Parameter	Benchmark	Unbiased	+Static	Boppart-Krussell	Tariff
	β	0.96	0.96	0.96	0.96	0.96
Preferences	γ	0.31	0.31	0.31	120.93	0.32
	σ	2	2	2	2	2
	θ	5/6	5/6	5/6	5/6	5/6
	ρ	3/4	3/4	3/4	3/4	3/4
	ω_C	0.28	0.87	0.66	0.28	0.41
	ω_I	1.61	0.87	0.66	1.61	2.59
	ω_M	1.97	0.87	0.66	1.97	3.23
Production	δ	0.103	0.103	0.103	0.103	0.103
	α	0.36	0.36	0.36	0.36	0.36
	α_m	0.4	0.4	0.4	0.4	0.4
	n_s	0.973	0.973	0.973	0.973	0.973
	σ_η	0.3	0.3	0.3	0.3	0.3
	ω_{ac}	0.015	0.015	0.015	0.015	0.015
	$\bar{\xi}$	1.15	1.15	1.15	1.15	1.15
	ρ_ξ	0.9999	0.9999	0.9999	0.9999	0.9999
Trade Costs	ρ_Δ	0.75	0.75	0.75	0.75	0.75
	τ_1	0.076	0.039	0.067	0.076	0.079
	τ_0	0.29	0.25	0.067	0.29	0.298

Table 2: Calibrated Parameters

B Figures

Real US Trade Share
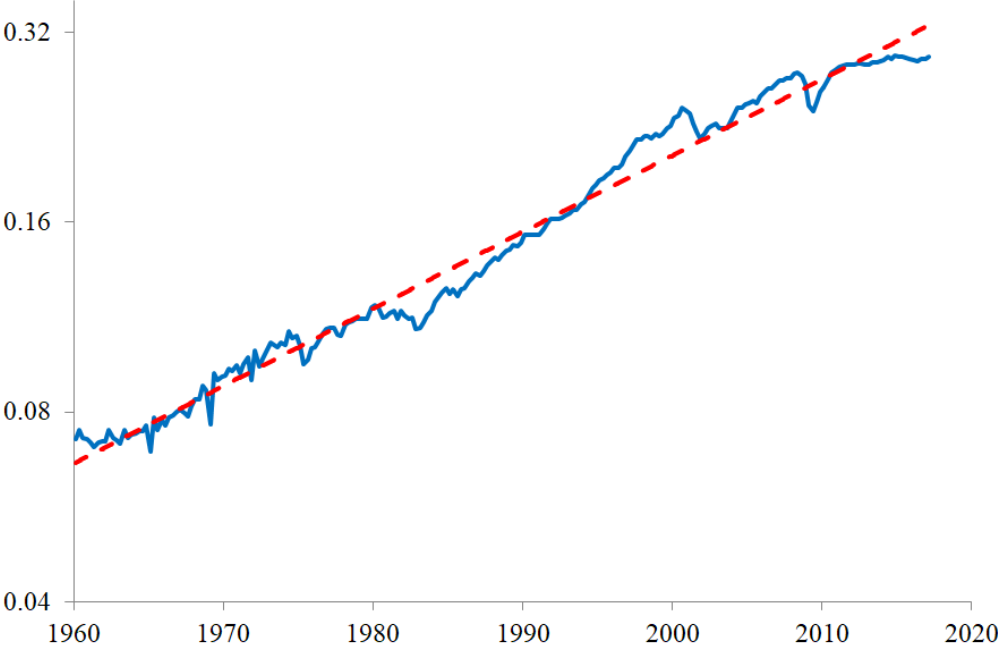
Figure 1: US Trade to GDP (EX+M)/Y
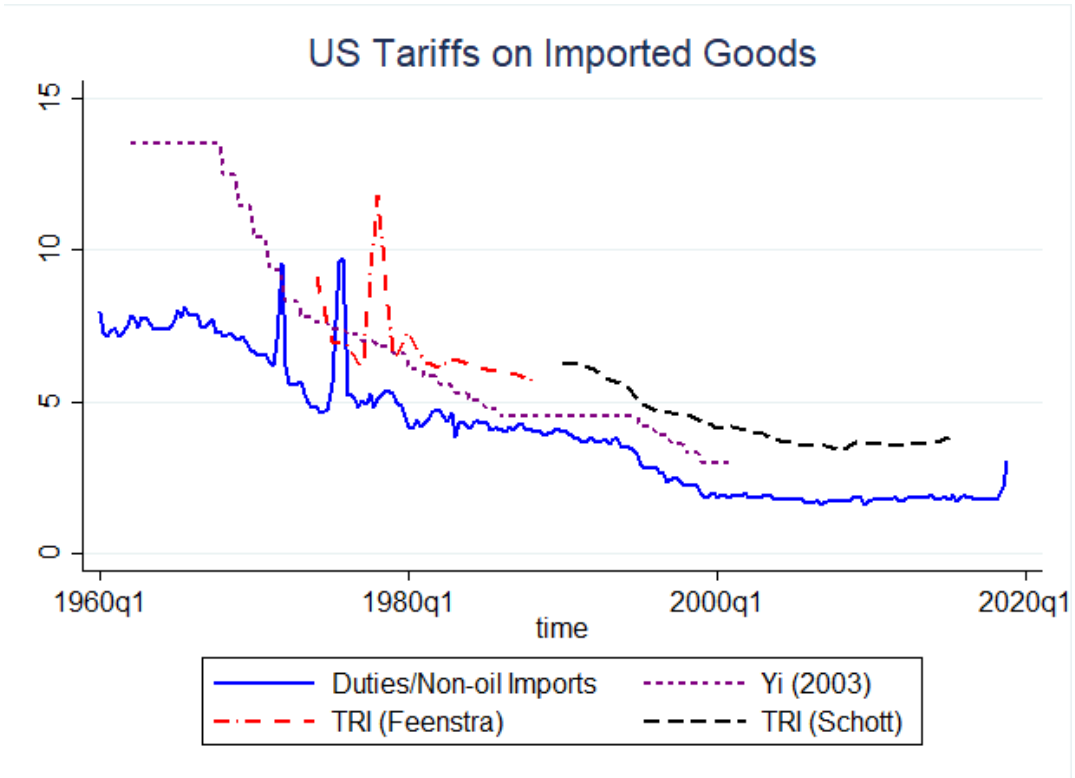
Figure 2: US Tariffs
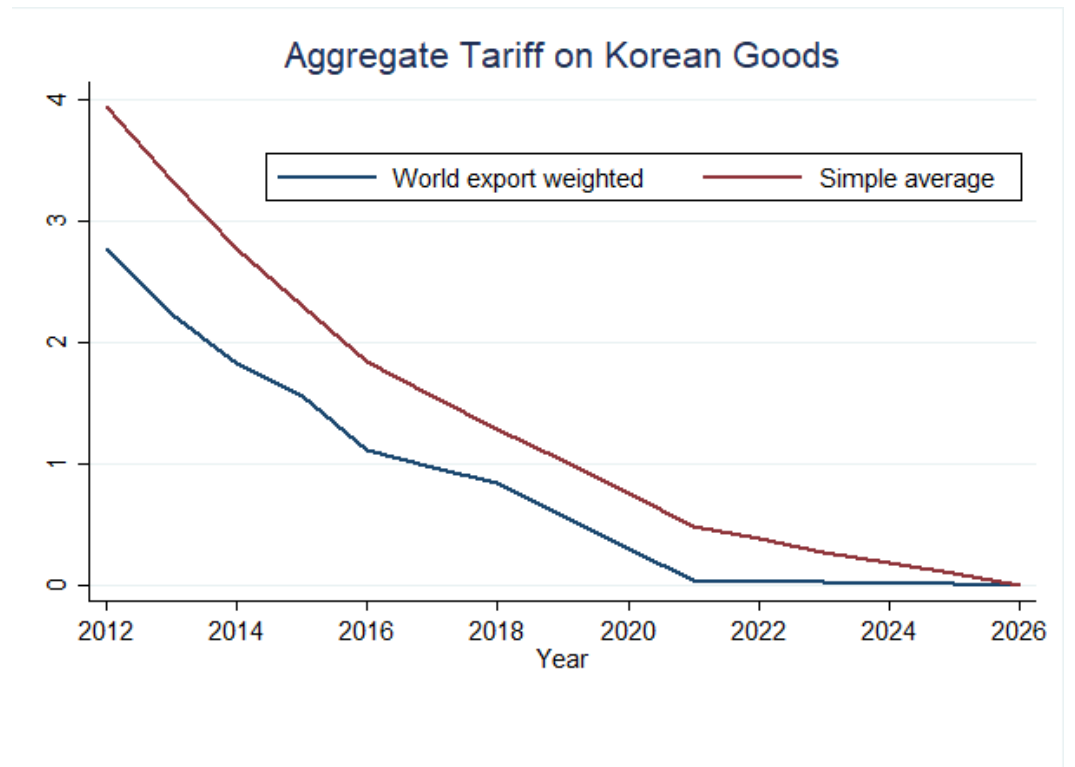
Figure 3: US Korea Bilateral Tariff Schedule
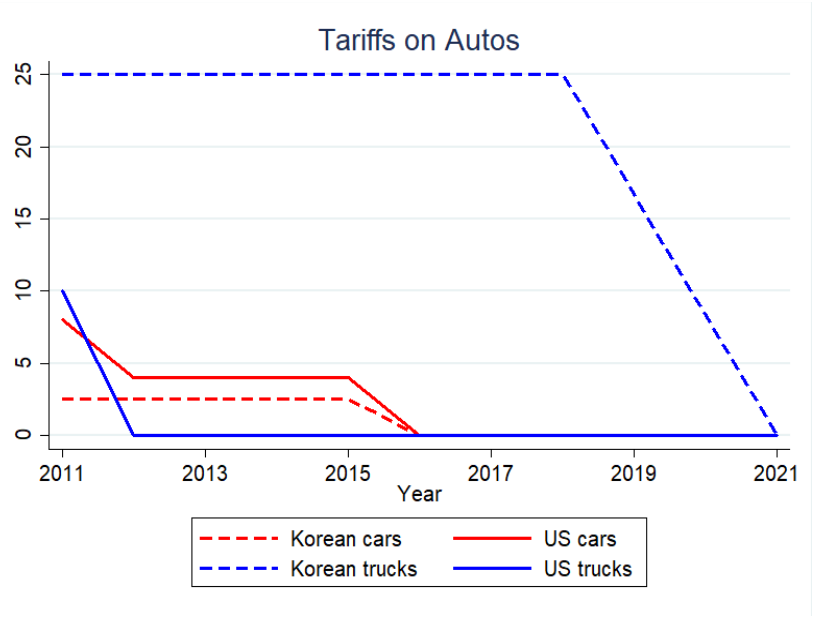
Figure 4: US Korea Auto Tariff Schedule
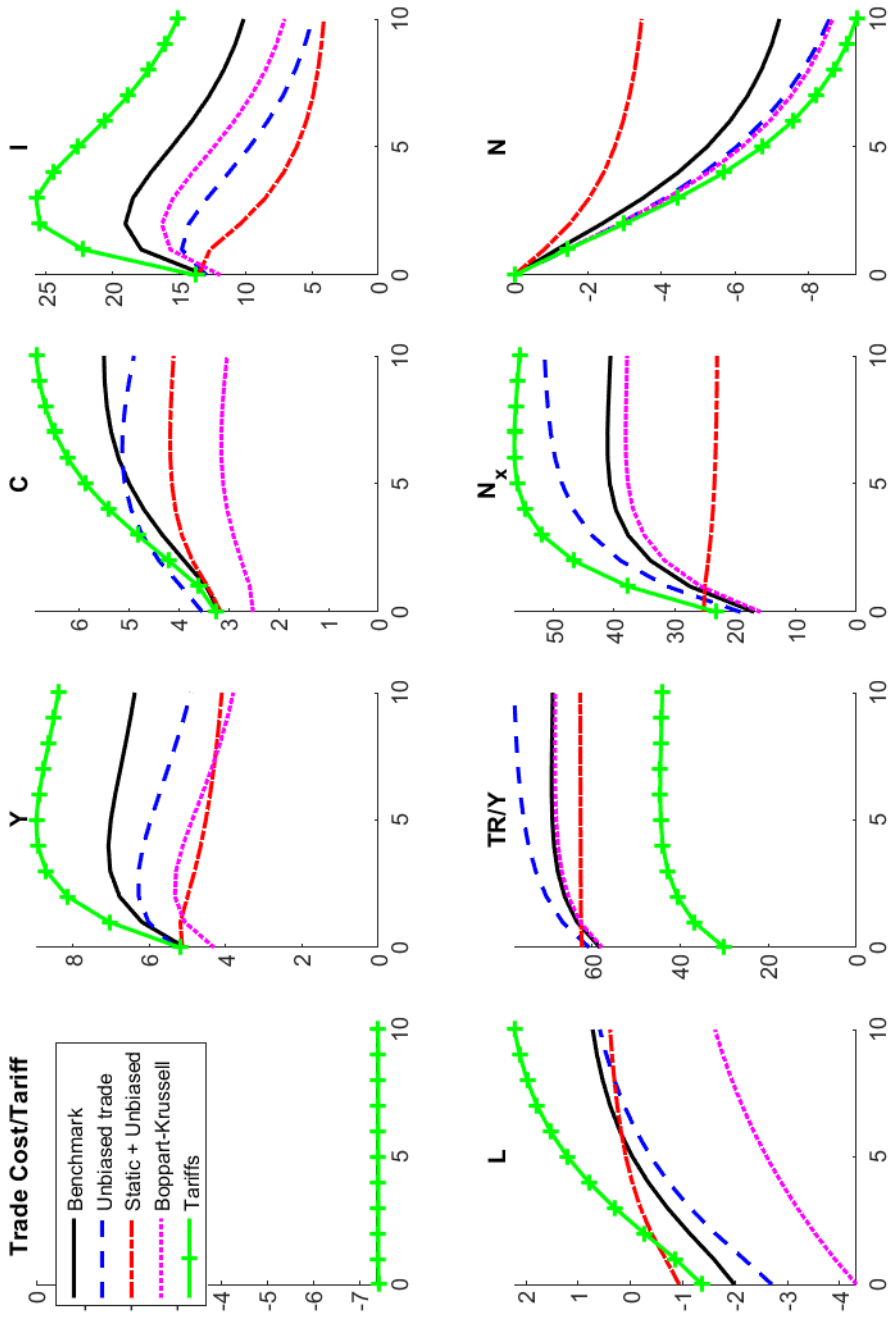
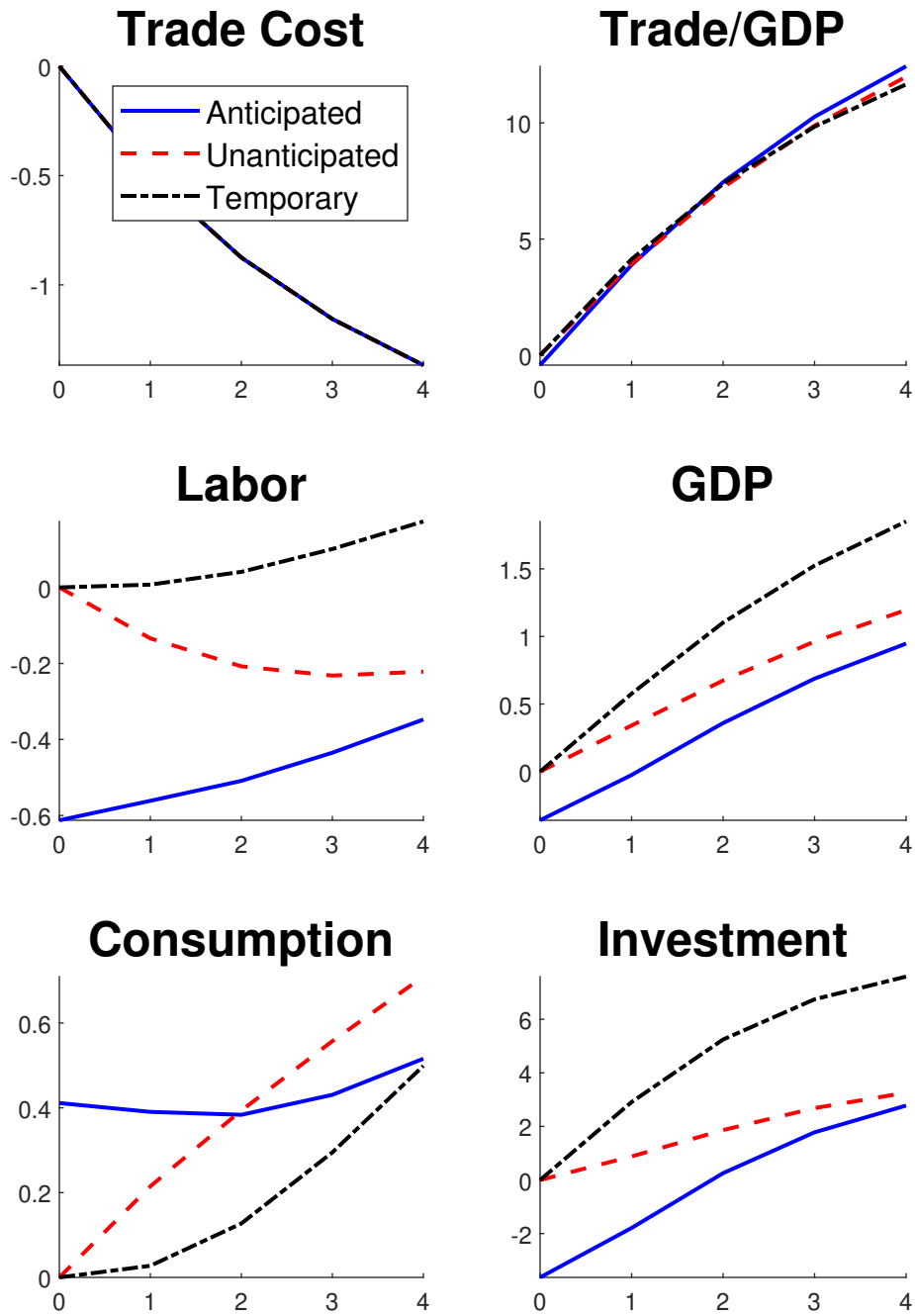Figure 5: IRF Trade Cost
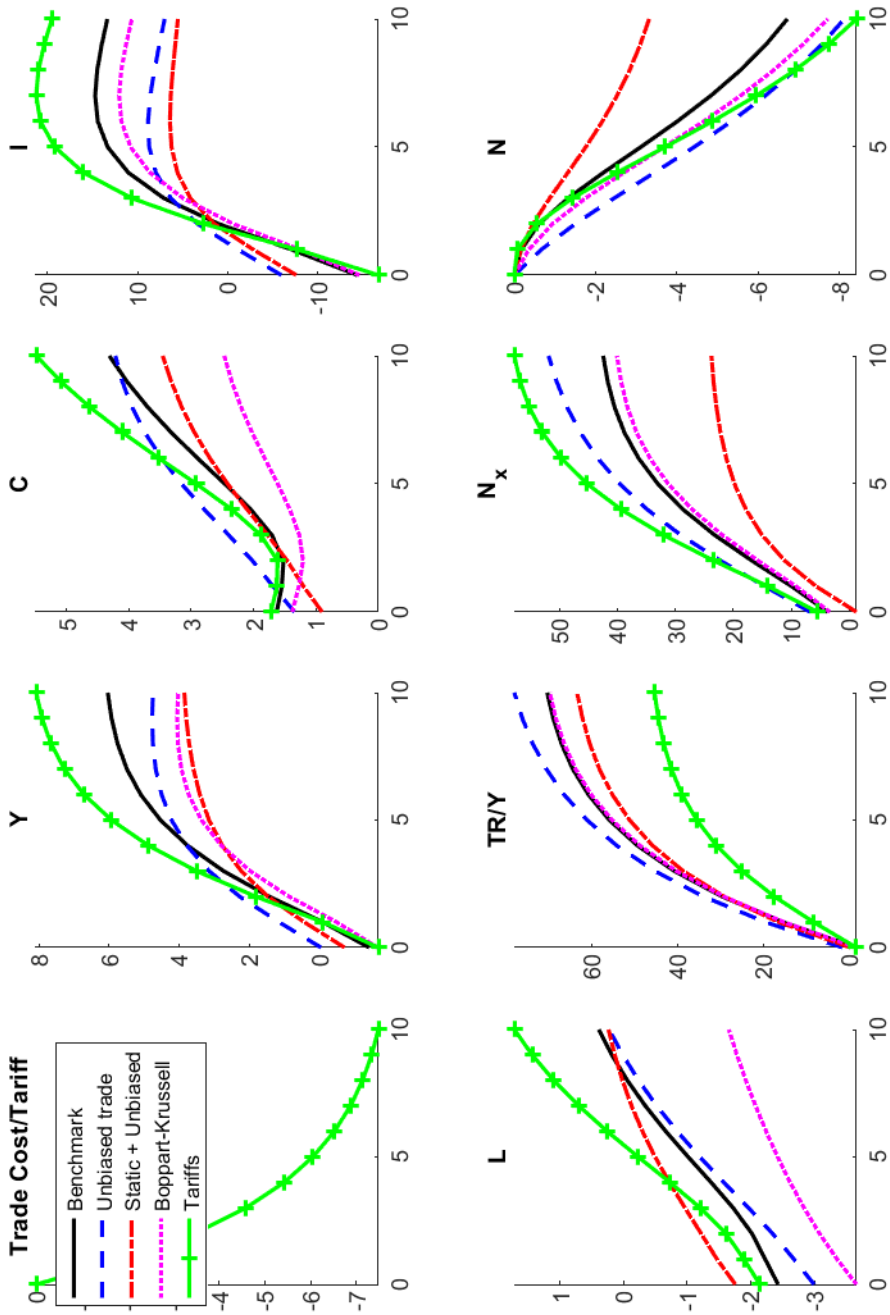
Figure 6: IRF Trend Trade Cost

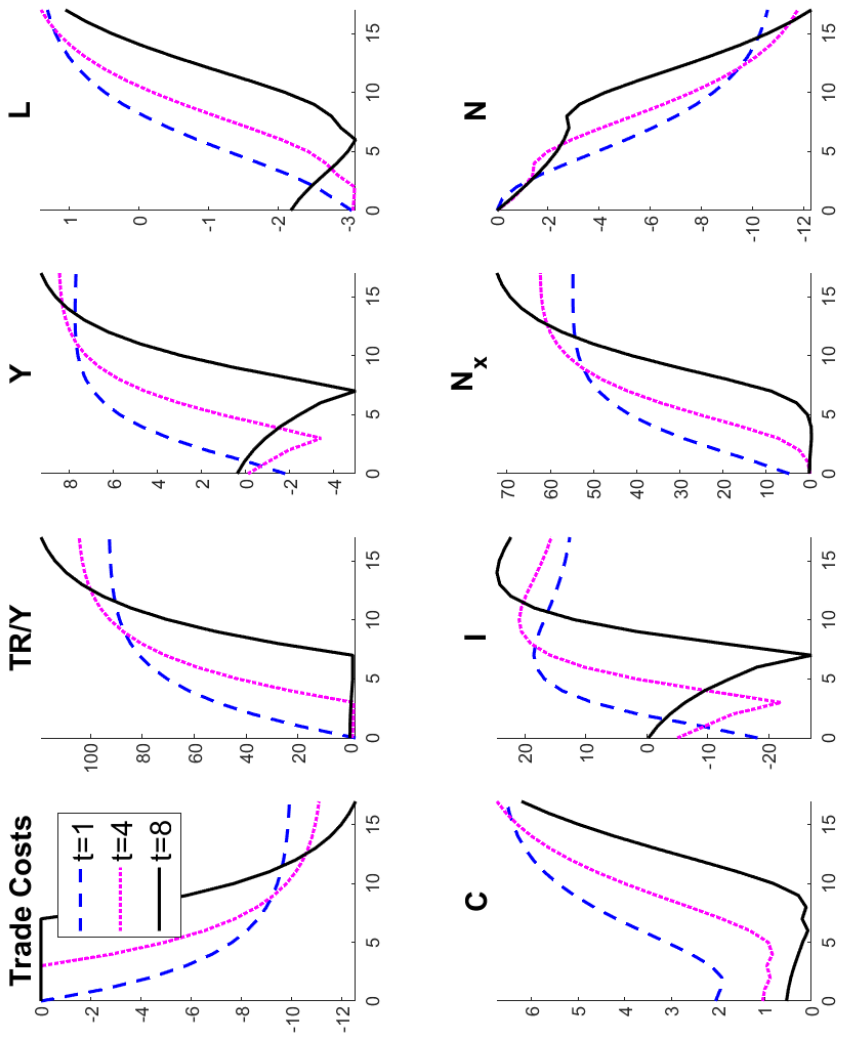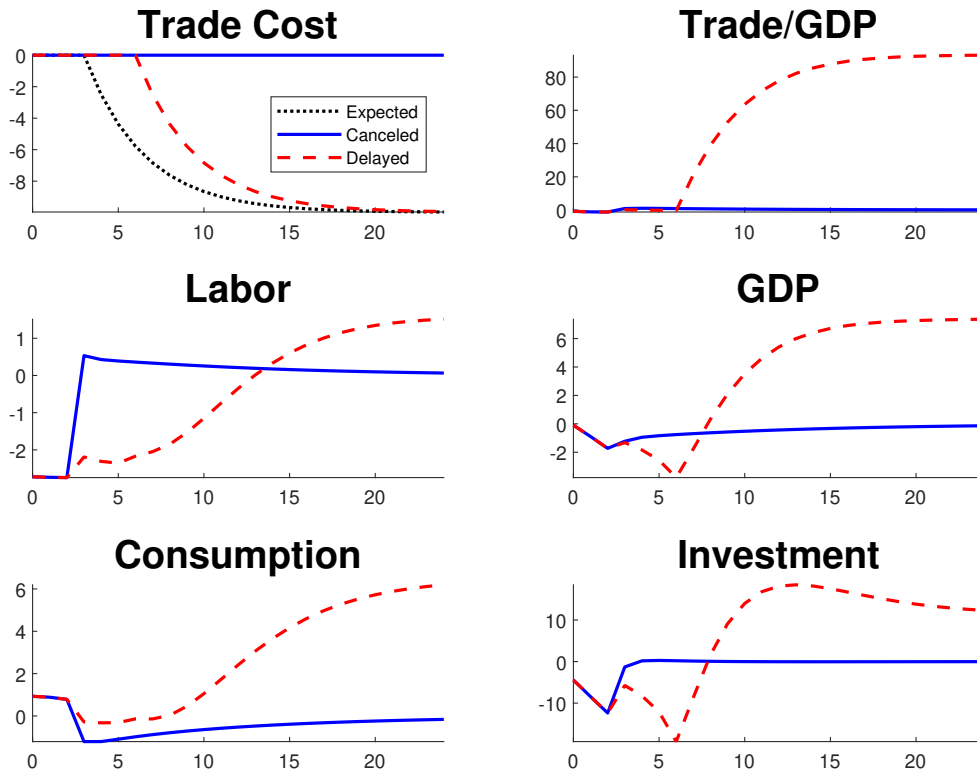Figure 7: Anticipated vs Unanticipated Liberalization

Figure 8: Trend Trade Cost - Lagged
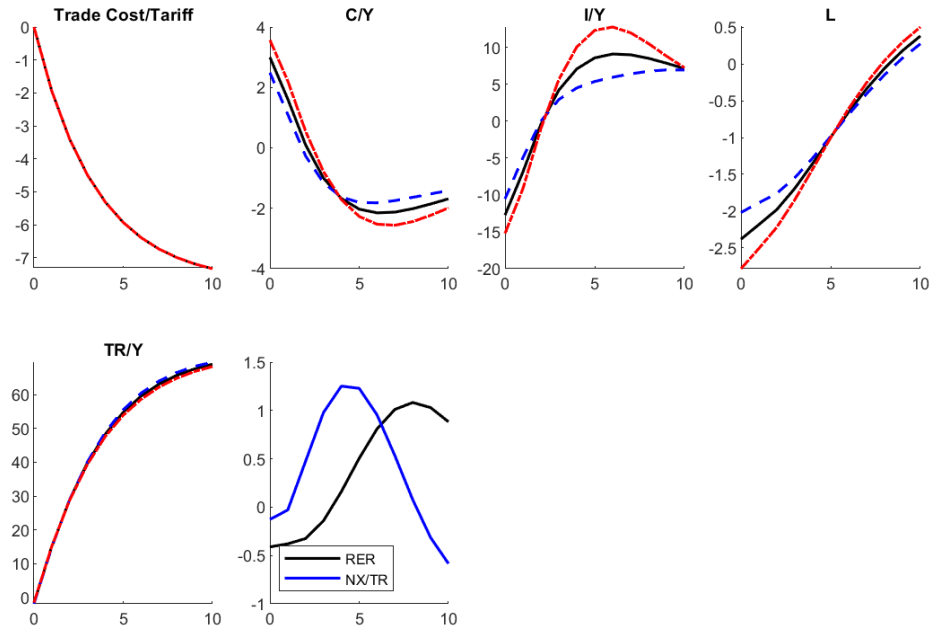
Figure 9: Canceled and Delayed Free Trade Agreements
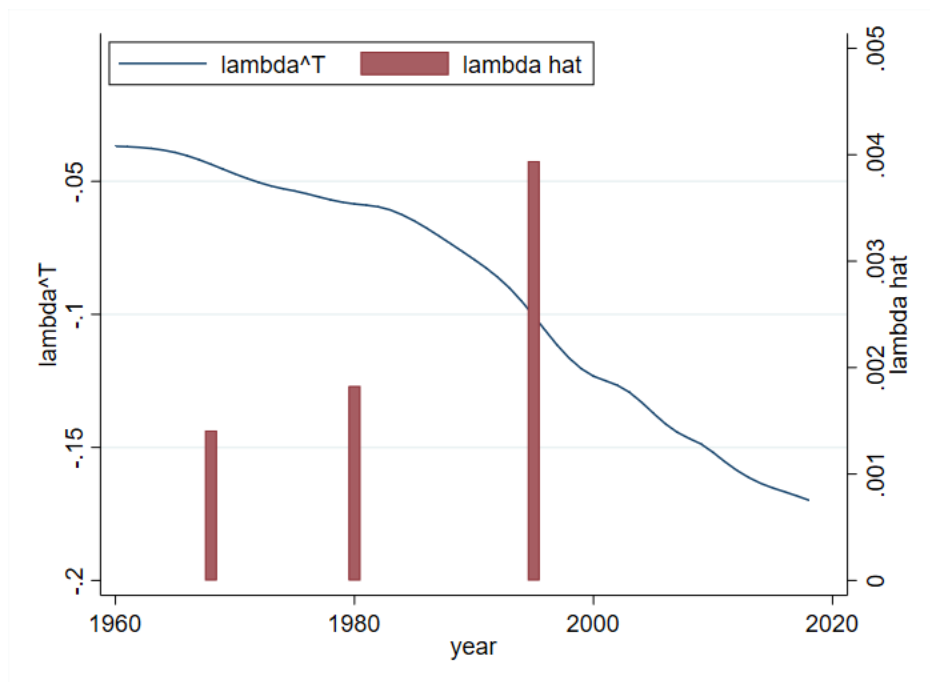
Figure 10: A Liberalization with Asymmetric Countries

Figure 11: Aggregate Responses Before and After GATT Liberalizations

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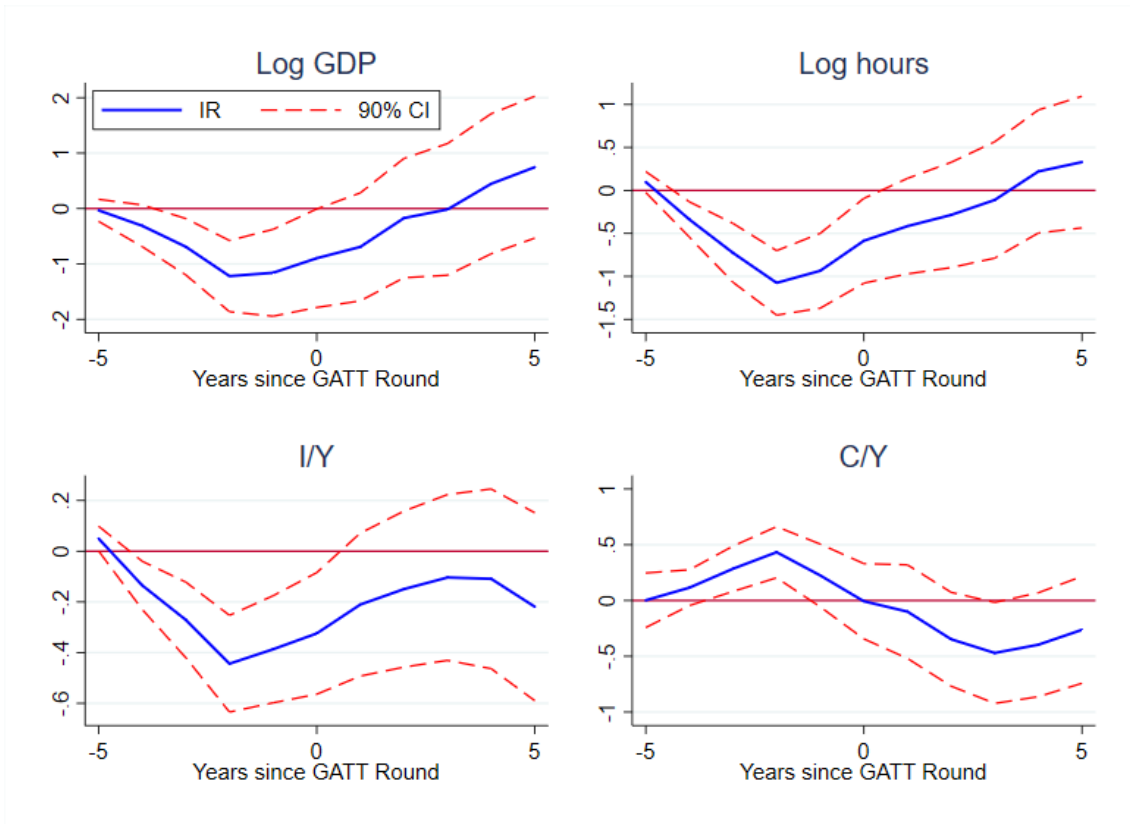
Figure 12: Aggregate Responses Before and After GATT Liberalizations

C Data Description

Our final data set includes data for the following 27 OECD countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Portugal, South Africa, Spain, Sweden, Switzerland, Turkey, United Kingdom, and the United States. We get data for real consumption, investment, GDP, and trade from the OECD and data on hours from the Penn World Tables version 9 (Feenstra et al. (2015)). We use the West Texas Intermediate spot price of crude oil as the measure of global oil prices, obtained from the U.S. Energy Information Administration.

Among countries, there is substantial variation in the growth of trade following GATT rounds. Our measure of the size of a liberalization for each country, $\hat{\lambda}$, reflects this variation in trade growth, and it is the cross-sectional variation in the size of the liberalization across countries that we are exploiting for our key result. Figure 13 shows the distribution of our measure across all countries and all GATT rounds.
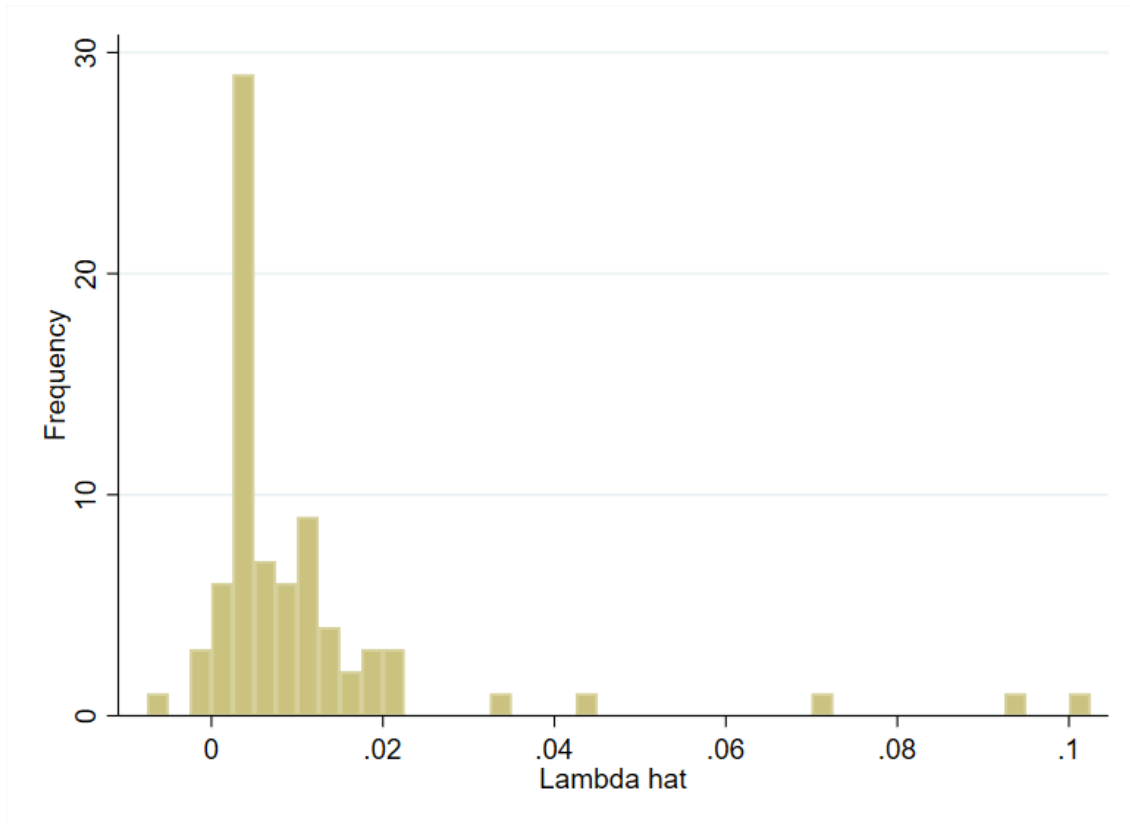
Figure 13: $\hat{\lambda}$ for all countries in the year of a GATT round.

On average, $\hat{\lambda} = 0.011$, and the standard deviation among all countries and rounds is 0.018. The outlying observations belong to Belgium, Ireland, Luxembourg, and the Netherlands, and our results still hold even when excluding these countries from analysis.

D Validity of Empirical Method

Our empirical method differs from that of Arezki et al. (2017) in three key ways. First, the timing of oil discoveries, and thus the timing of changes in expectations about future wealth, are well-documented. While we know when negotiations began for GATT rounds, we do not know at what point economic agents change their expectations about future tariffs. Second, the change in expected wealth is much easier to measure with oil discoveries, as the quantity of oil discovered and current price of oil is known. For GATT rounds, however, agents may change their expectations about how large the agreement will be often during the negotiating period, and it is unclear at what point expectations are clearly set. Furthermore, measuring the expected size of the agreement for each country is difficult because we do not really know how it affects the likelihood of future agreements or was already expected from past agreements. In our analysis, we have assumed that post-GATT round trade growth was known by agents and use variation in trade growth across countries to account for variation in expectations. Finally, oil discoveries are a country-specific event while GATT rounds are essentially global (though some of the countries in our analysis are not part of the GATT for the Kennedy or Tokyo Rounds). We try to control for possible global cyclicality surrounding trade agreements by including cyclical fluctuations in G-7 GDP in the regression.

In this section, we validate our empirical method by performing the same exercise on model-simulated data. In the model, we know the timing of changes in expectations because it coincides with the period of announcement. We also know the expected size of the agreement as the change in trade costs is announced beforehand. We find that the estimated IRs are qualitatively similar to the data, albeit stronger quantitatively. We take this finding as evidence that our empirical method is indeed capturing anticipatory effects of future trade agreements.

We use a stochastic version of the six-country model of Mix (2020), which predicts similar anticipatory effects as in our model, to simulate data for use in our empirical exercise. Countries are subject to contemporaneous TFP shocks and trend trade cost shocks that

are announced three years before implementation. The TFP shocks have both a global component z_c and an idiosyncratic component z_i. We choose the same standard deviation of the TFP shocks for all countries. The variance and persistence of the total TFP shock imply that the HP-filtered cyclical GDP of each country has a standard deviation of roughly 3 percent. We simulate the model for 300 periods with a global liberalization announced at period 200 that takes all tariffs to zero in the long run. Initial tariffs are chosen to match the initial tariffs in Mix (2020) for a global liberalization.

After each simulation, we take the periods between 190 and 250 and estimate the implied IRs for a country with $\hat{\lambda} = 0.01$ using the same method we applied in the data. Our expected trade cost shocks are calculated using discounted future growth after the liberalization, just as in the data. The lag structure on the expected trade cost shock begins the year before the announcement (four years before implementation) and extends to four years after implementation. We control for the global cycle using the cyclical component of U.S. and European Union total GDP.

We perform 100 simulations and take the mean over all IRs. Because TFP shocks are quantitatively larger and have a more direct effect on macro aggregates in the model than the trade cost shock, the standard deviation of these IRs is large, but the qualitative implications of the IRs are consistently supportive of our analysis in the data: The investment rate, GDP, and hours fall while the consumption rate rises in anticipation of the agreement more for countries that expect a larger impact on trade. To show that these simulations do indeed tell a consistent story, we perform the same 100–simulation exercise 100 times and calculate the mean IR over all the individual mean IRs from each exercise. In Figure 14, we report this "mean of means" and the 90 percent confidence interval.

As in the data, the estimation on the model implies that the investment rate, GDP, and hours fall in anticipation of the agreement. The contractionary effects on the investment rate, GDP, and hours are significant, and the paths of the investment rate and GDP before the liberalization look like a scaled-up version of the path in the data. The consumption

rate also follows the same anticipatory path in both model and data IRs (scaled similarly to the investment rate). All in all, our empirical method applied to the model produced IRs that mirror those of the data. We know that the anticipatory effects exist in the model, so these results strengthen our conviction that the same anticipatory movements occur in the data, albeit on a smaller scale.
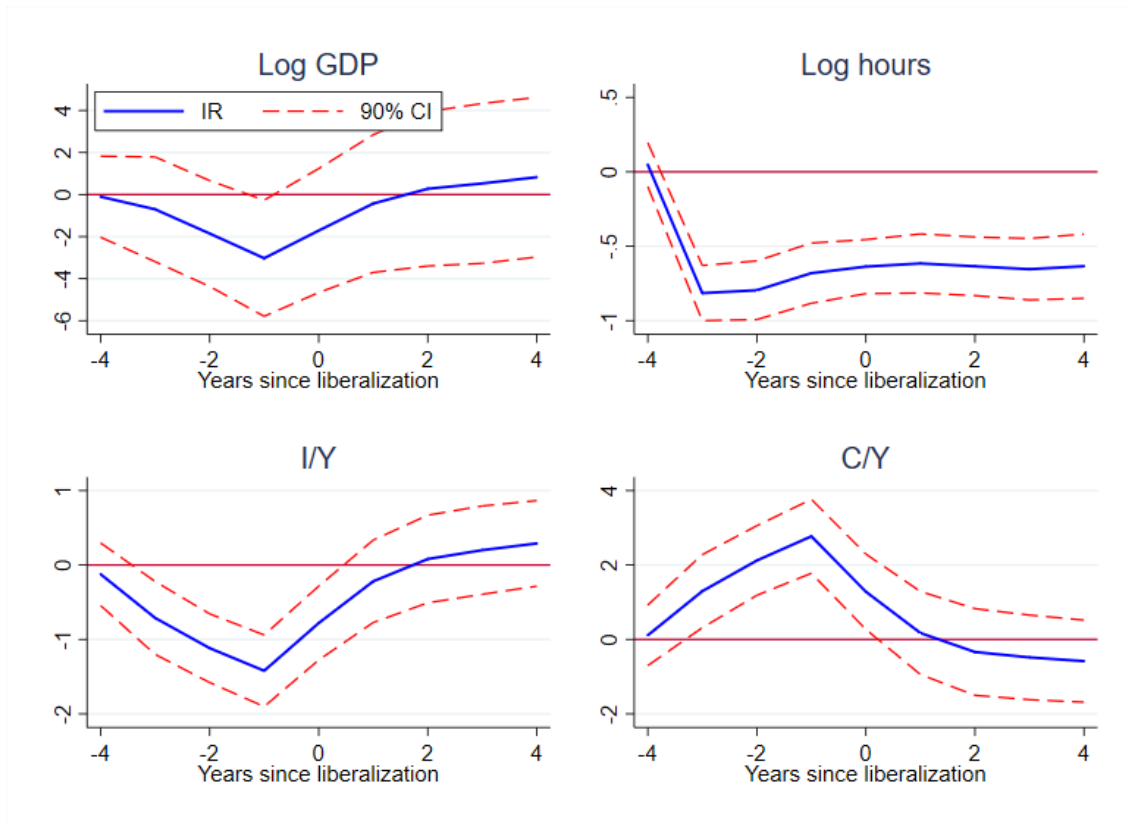

Figure 14: Impulse responses in the model with 90 percent confidence intervals.

E   Additional Model Sensitivity - Not for Publication

In this section, we report the sensitivity of the model to three modeling features: firm creation, an extensive margin of trade, and an input–output structure. Many analyses of the effects of trade policy abstract from these three margins and thus this offers a glimpse into the quantitative importance of these abstractions. We also discuss how the level and variation in the interest rates influence our results.

Fixed Entry. Abstracting from endogenous firm creation substantially mitigates the contractionary short-run effects and amplifies the long-run effects on labor supply. Specifically, we assume that a fixed mass of firms replaces exiting firms every period. Without a firm entry decision, we find that trade grows about 25 percent less in the long run and the short-run contractionary effect on labor with trend trade costs shocks is about 1/2 as large. Unanticipated shocks are now expansionary.

Krugman. We calibrate the model so that virtually all firms export (99.8 percent) so the exporter margin is very inelastic. The response of trade to changes in trade costs closely mimics the response in the static exporter model in that there are no endogenous trade dynamics. With all firms exporting, we substantially mitigate the contractionary effects of unanticipated and anticipated trade reforms.

The model with all firms exporting is similar to other dynamic trade models in the literature, such as Eaton et al. (2016). This analysis shows that a change in trade costs in these models yields a smaller aggregate response in output and consumption than when the export decision is endogenous and dynamic.

Input–Output Structure. We remove the input–output structure from the model by getting rid of the material final goods. Previous work has found that this input–output structure can magnify the aggregate effect of trade. Our work is consistent with the previous work, as in the long run, the model without materials exhibits lower consumption and output despite a similar transition in the trade share.

Discounting and IES. There are two additional ways in which preferences will affect the

size of the wealth effects related to the level and variation in interest rates, which are governed by the discount factor, β, and the intertemporal elasticity of substitution, $1/\sigma$. When we make agents more patient, we substantially raise the present value of a phased-in reform and increase the contractionary effects. Likewise, when we lower $1/\sigma$, the interest rate rises less early in the reform thereby increasing the wealth effect and leading to a more contractionary effect on employment. This type of experiment is what one might get in a partial equilibrium model with a fixed interest rate.
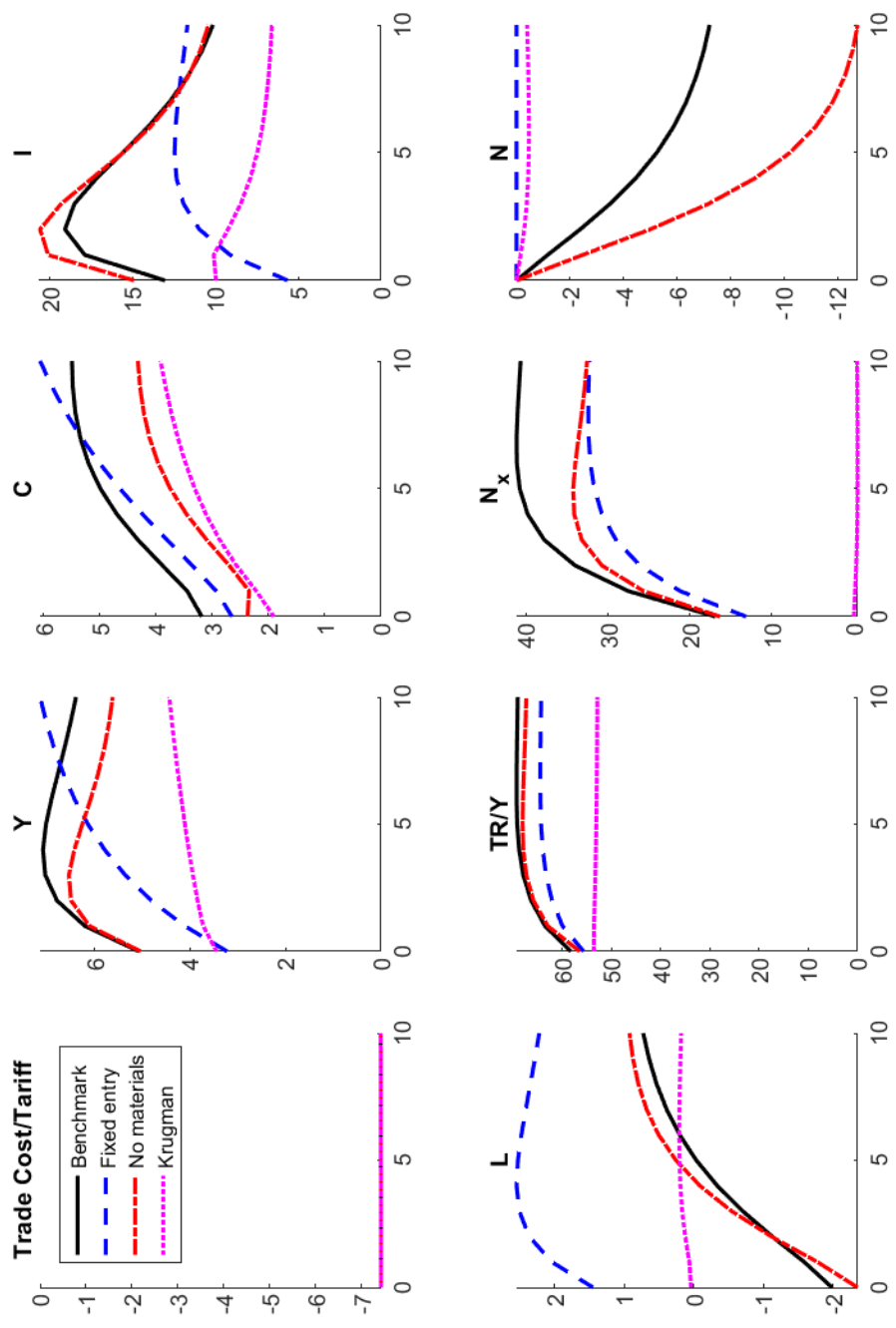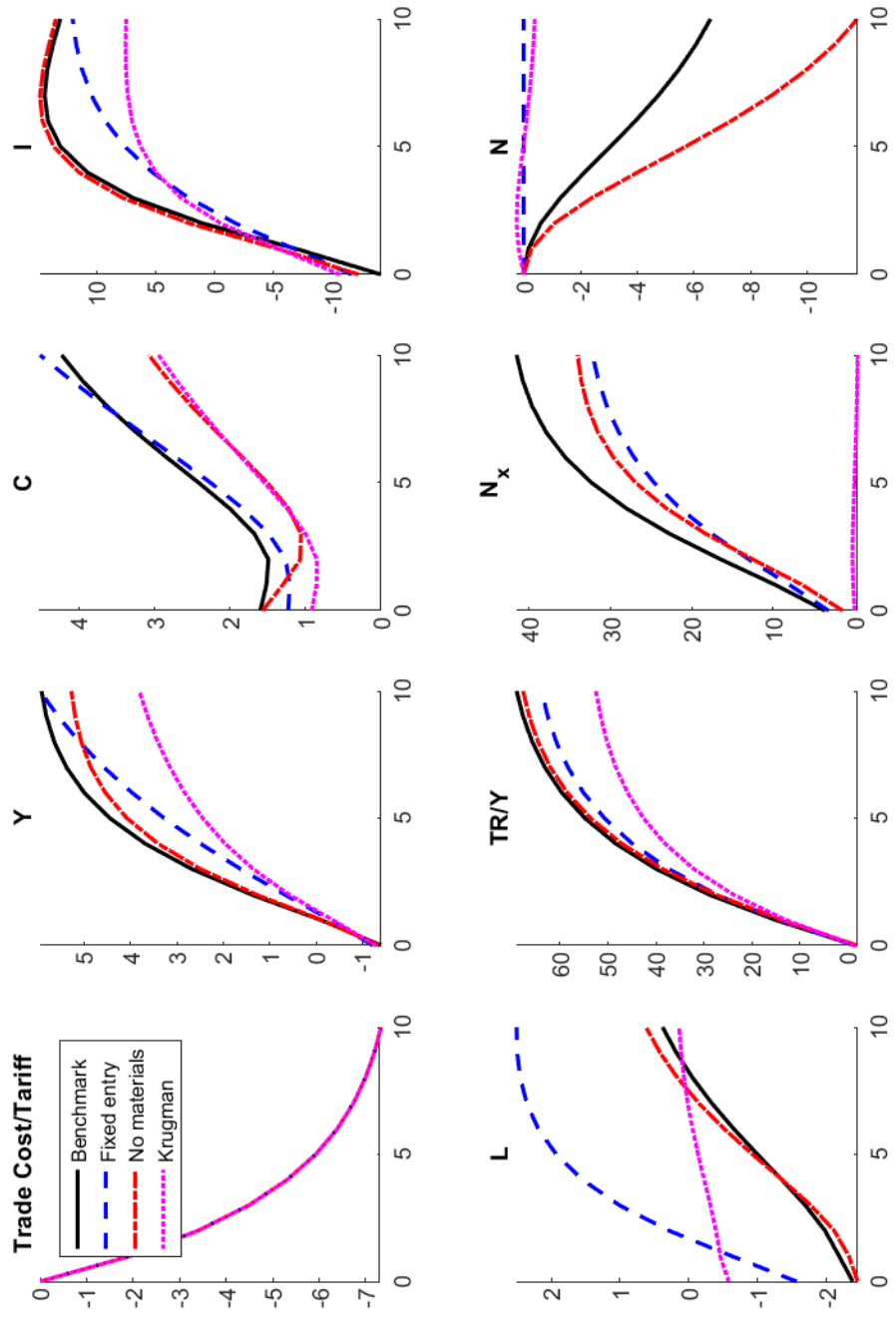
Figure 15: IRF Trade Cost

Figure 16: IRF Trend Trade Cost