Adjusting to Economic Sanctions*

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Abstract

We investigate how firms adjust to the introduction of sudden, unanticipated and eventually long-lasting economic sanctions. We explore a unique event when, due to political reasons, unrelated to the underlying economic conditions, the exporters completely lost access to a major foreign market. In particular, in 2014 Russia introduced sanctions on imports from Europe and this caused an abrupt negative shock to the food production sector in Lithuania. We find that part-time employment is used as the first shock absorber, followed by investment and full-time employment. At the same time, firms dampen shock effects by expanding to other export markets. To rationalize this firm behavior, we provide a theoretical mechanism where forward-looking firms face nonconvexities in the labor market along with heterogeneous variable costs of entering new export markets.

JEL classification: D22, D25, F14, F16, F51

Keywords: economic sanctions, firm adjustment margins, part-time employment, new export markets

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1 Introduction

In the current times of deglobalization and trade wars, governments are increasingly using economic sanctions and company boycotts to influence each others' actions. Some of these sanctions directly target particular foreign firms or economic sectors, which consequently experience unanticipated drops in demand for their products and thus have to adjust how they organize their activities.

When faced with economic sanctions, firms are likely to adjust on a number of dimensions. Such adjustments might interact with each other and involve a substantial degree of heterogeneity as firms are subject to non-uniform adjustment costs and expectations of demand shock permanence. Understanding how firms adjust to economic sanctions and boycotts helps to determine the external validity of the findings of trade liberalization, i.e. by shedding light on whether the trade liberalization-driven adjustments are symmetrically undone when the trade stops.

We look at a unique event in which a major sector of a small open economy lost its main export market for political reasons unrelated to trade or other economic conditions. Following the political tensions in 2014, Russia banned agricultural and food product imports from a number of countries, including those from the European Union (EU). As a consequence, Lithuania's food sector which was highly exposed to the Russian market suffered an unexpected loss in demand. We use a rich firm-level dataset that covers all firms in Lithuania and enables us to comprehensively quantify the adjustment margins.

Our empirical analysis is based on the reduced-form triple-differences estimates for the food manufacturing sector in the Lithuanian economy over 2011-2017. We consider affected firms to be those that had exports of banned products to Russia in 2013. We then compare firm-level responses for the firms affected by Russia's export ban and the control firms in the period after the ban (2014-2017) as compared to the period before the ban (2011-2013). We pick control firms to be from the same sector, of a similar size, and also engaging in exports of their products to countries outside of Russia, thus unaffected directly by Russia's export ban. In this way, the procedure not only takes into account non-time-varying differences between firms but also controls for the general food sector-trends that might have varied across the firms of similar size. Our third difference compares whether the change in change was more pronounced for the affected firms that had a higher share of banned products to Russia as a fraction of their sales and thus were *more* exposed to Russia's export ban, as compared to the change in change in affected firms that were *less* exposed to the export ban.

We find that following the Russian trade ban, affected food manufacturers experienced an immediate drop in part-time employment, a delayed drop in full-time employment, and a downward adjustment of capital investment. An average exposed firm with 6.69% pre-ban share of banned export products in its sales reduced part-time employees by 67% compared to the pre-period sample mean and full-time employees by 6.6% over the pre-shock period average. The affected firms also experienced a drop in investment and a rise in the exports to the rest of the world, destinations which can be seen as a proxy for revenue-increasing strategies exploited by manufacturers affected by the sanctions.

Motivated by these empirical findings, we set up a stylized theoretical framework on optimal firm adjustment that delivers further predictions. We adopt a production function, similar to the one proposed by Krusell et al. (2000), in which we combine capital with full-time labor into a composite input. We then suggest a cost minimization problem when firms face no adjustment costs for part-time labor, non-convex adjustment costs for full-time labor, and time rigidity when adjusting for capital.

Following a simplified version of Helpman et al. (2010), our firms export their products in addition to selling on a domestic market. We extend Helpman et al. (2010) by allowing firm-specific variable trade costs that reflect varying exporting efficiency, such as efficiency in transporting goods, accessing customs, and managing a distribution network.[1] Furthermore, we consider two foreign markets, i.e., Russia and the rest of the world.

[1]However, we abstract from the demand and fixed costs heterogeneity, unlike Roberts et al. (2018), who, in addition to prices and destination patterns, also exploit data on quantity, which we do not observe. Roberts et al. (2018) find that demand shifters and marginal costs are key drivers of observed variation in the revenue share and the intensive margin of trade, which also constitute our focus.

We show that firm choices are determined by their production technology, input adjustment frictions, and heterogenous trade costs with foreign markets outside of Russia. Our stylized mechanism captures smooth capital decline and jumpy reaction in labor when absorbing the unexpected sanctions. While part-time employment is generally the first shock absorber, depending on the magnitude of the shock, firms may start adjusting full-time employment and capital, and also engage in more exports to the rest of the world.

We find that the other adjustments can be expressed in terms of the part-time employment margin, which serves as a proxy for the severity of the shock. In particular, capital investment is predicted to drop more, the larger the part-time employment adjustment. Similarly, the layoffs of full-time labor and the increase in the share of exports to the rest of the world are more likely if the shock is large and persistent and the part-time employment adjustment is sizeable.

Our empirical findings are in line with the interpretation provided in our theory that part-time employment, as the most flexible margin, is adjusted first, and may precede further, costlier changes. More importantly, we empirically observe that food manufacturers that in the short term reduced part-time employment relatively more, later reduced capital investment and laid off full-time employees. Also, firms that were able to increase exports to other foreign markets were able to keep full-time employees on their payroll.

Taken together, these findings suggest that at times of global uncertainty, open economies need even more flexible labor regulations allowing for an array of different work contracts. Policymakers should also increase efforts to ensure access to wide trade markets as a way to reduce reliance on one particular trade partner.

Our paper contributes to several streams of literature. In broad terms, our paper belongs to the literature analysing negative trade shocks and their economic consequences on different firms. With our empirical setting, we are able to overcome the identification challenge that many international trade barriers, which lead to substantial negative demand shocks, are likely to be correlated with the other more direct macroeconomic adjustments. For instance, they could be linked to changes in domestic worker wage expectations and labor supply. Technological shocks can also trigger alterations to trade agreements but are also likely to lead to demand changes directly or through the production function recompositions. In our case, rather than observing a trade shock stemming from a trade-agreement, tariff change or currency depreciation, we study a complete trade ban, i.e., limiting the exports of a range of products to a particular destination country, which is unlikely to be related to Lithuanian domestic economy or its other potential export markets. As we have detailed micro-level data on the affected firms, we can identify the magnitude of firm-level responses based on the variation of shock size across the firms.

We exploit the trade shock to provide the evidence on which adjustments firms adopt when they are faced with the drop in demand for their production. Contrary to a one-dimensional focus as in Hogan and Ragan (1995), Mouelhi (2007), Fabiani et al. (2015), Asquith et al. (2019), Tanaka et al. (2019), Egger et al. (2020), who analyze labor margin adjustments, or Kee and Krishna (2008), Bernard et al. (2009), Morales et al. (2019), Eaton et al. (2022) who are interested in trade adjustments, we study multiple (competing) adjustment margins, somewhat similar to Bernard et al. (2006), Eslava et al. (2010), Bertola et al. (2012), and Casacuberta and Gandelman (2012). While Bernard et al. (2006) track manufacturing activity reallocation and product-mix changes, Eslava et al. (2010) and Casacuberta and Gandelman (2012) are looking at employment and capital adjustments, and Bertola et al. (2012) analyze price versus cost and wage versus employment adjustments, we analyze how firms change their full-time and part-time labour, investment, and new market selection choices after the shock.

Our paper is also related to a recent strand of literature discussing trade liberalization effects on the labor market (Dix-Carneiro and Kovak 2019, Dix-Carneiro 2014, Caliendo et al. 2019, Dix-Carneiro et al. 2018). Yet while these papers mostly look into general equilibrium effects and cross-industry or inter-regional adjustments of the labor market, we take a look at the adjustments within a firm and uncover part-time vs. full-time relationship, providing more granular evidence on the scope and the extent of the adjustments. With this, we abstract from general equilibrium implications in our model and only look into intra-firm adjustments. We also allow for other margins, in addition to labor, to play a role. Finally, a stark difference of our paper from the above-mentioned literature is the nature of the shock: trade liberalization is typically considered as a negative cost-push shock, provided that reduced tariffs result in higher international competition in the domestic market. In our case, the sanctions of international trade ban is a demand shock to the producers.

In contrast to most studies mentioned above, we also go a step further by trying to provide the mechanism responsible for these adjustments. Our approach is thus similar to Levchenko et al. (2010), who find compositional effects and the use of intermediate inputs being responsible for the largest trade drops, Toshiyuki et al. (2011) who find adjustments being dependent on firm's revenue volatility, Bricongne et al. (2012) who show the role of financial frictions and firm size, and Iacovone et al. (2013) who find that plant size affects its performance after shock. In our case, firm-specific labor and capital intensities, the nature of labor and capital adjustment costs, and the production function (technological) differences are the key drivers in firm responses to the trade shock.

Finally, we make a contribution to the literature on the topic of trade bans, or, more generally, severe trade restrictions. This literature has exploded recently, reflecting the new era of geopolitical tensions across countries, and includes the meta-analysis of the sanction effects (Siddiquee and van Bergeijk 2012), the estimates of macroeconomic and political effects of trade restrictions with Iran (Dizaji and van Bergeijk 2013), and effects on Danish firms in the aftermath of the Danish cartoon crisis (Hiller et al. 2014, Friedrich and Zator 2019). More recent research discusses the effects of Russia's sanctions on firms in Western European countries (Crozet and Hinz 2016, 2020, Klomp 2020, Crozet et al. 2021) and China - US trade war effects (Selmi et al. 2020, Fusacchia 2020, Hanson 2020, Fajgelbaum et al. 2022), mostly concerned with macro effects for the countries engaged in the trade war rather than micro-level adjustments as in our work.

2 Motivation

2.1 Trade Shock and Data

The negative trade shock that we analyze is Russia's import ban of agricultural and food products as well as certain raw materials from the EU, the United States (US) and some other countries in 2014.[2] The ban came as a result of the political tensions between Russia and the EU and was not related to economic reasons. In particular, in response to the Russia-Ukraine conflict, in February 2014, the EU, the US, and a few other Western countries introduced non-trade (primarily, financial) sanctions against certain Russian individuals. In August 2014, Russia responded by imposing import restrictions on a number of agricultural and food products from these countries. The range of products subject to Russian import restrictions mainly included meats, dairy products, fruits, and vegetables. These import restrictions were initially introduced for one year but they have been extended annually since their adoption, and thus it is likely that at some point they started to be perceived as near-permanent.

This shock was particularly important to Lithuania, a small open economy, and a member of the EU, as Russia has been one of the most important trade partners for Lithuanian agricultural and food product exports. In 2013, 20% of Lithuanian exports were directed to Russia. Around 18% of them contained banned product exports. Since Lithuania is a small open economy and exports make 80% of its GDP, a shock to the exports to Russia was a significant event, especially for industries exporting a considerable amount of banned products. As shown in Table 1, in 2014, the year of the ban, exports of banned products to Russia shrunk by 38% (the ban was imposed in August) and by another 89% in 2015. Exports of all products to Russia decreased by 7% in 2014 and by another 27% in 2015, thus

[2] The full list includes the countries of the EU, US, Switzerland, Canada, Australia, Norway, Ukraine, Albania, Montenegro, Iceland, and Lichtenstein. More information about this decree is available at: https://ec.europa.eu/food/horizontal-topics/international-affairs/eu-russia-sps-issues/russian-import-ban-eu-products_en.

the ban affected a considerable proportion of country's exports.[3]

Table 1: Firm exports and the exposure to the trade ban from Russia

	Total Economy	**Food Manufacturing**
Value added, m EUR, 2013	28,727	1,276
Total exports, m EUR, 2013	23,470	1,429
Total exports, % of GDP	81%	5%
Banned exports, m EUR, 2013	887	136
Banned exports, % of Total exports	4%	9%
Banned exports, m EUR, 2014	547	79
Banned exports, y-o-y % change	−38%	−41%
Banned exports, m EUR, 2015	61	5
Banned exports, y-o-y % change	−89%	−94%
Banned exports, m EUR, 2016	13	0
Banned exports, y-o-y % change	−79%	−99%

Source: National Accounts Statistics, main statistics are averages over 2000-2017.

We use a detailed firm-level dataset that consists of the whole population of food manufacturing firms in Lithuania[4] over 2011 to 2017. This time window provides us with enough power to study the adjustment margins and their dynamics over time for up to four years after the event while controlling for the trends prior to the event. The dataset covers firm balance sheet and income statement variables at a rather disaggregated level, as well as firm-level employment characteristics. Crucially, it also includes detailed data on firm-level trade, such as international trade values by 8-digit HS products and destination (source) country exports (imports), allowing us to track which specific firms have been affected by the trade ban.

[3]Across Lithuanian firms, the ten most affected products (based on 8-digit HS codes) were: Cheese and curd; Milk and cream, not concentrated, not containing added sugar; Milk and cream, concentrated or containing added sugar Meat of bovine animals, fresh or chilled; Prepared or preserved fish, caviar; Whey and products consisting of natural milk constituents; Apples, pears, and quinces; Citrus fruit; Fruit; Vegetables.

[4]Based on Eurostat data, Lithuanian firms compare similarly to the rest of the EU in terms of the margins we study in this paper. Average part-time and full-time employment is right at the median of EU-28 sample in 2013. In fact, an average Lithuanian food manufacturing firm (that includes exporters and non-exporters) in the food manufacturing sector has slightly more employees than the average firm in the EU.

2.2 Direct Outcomes for Affected Firms

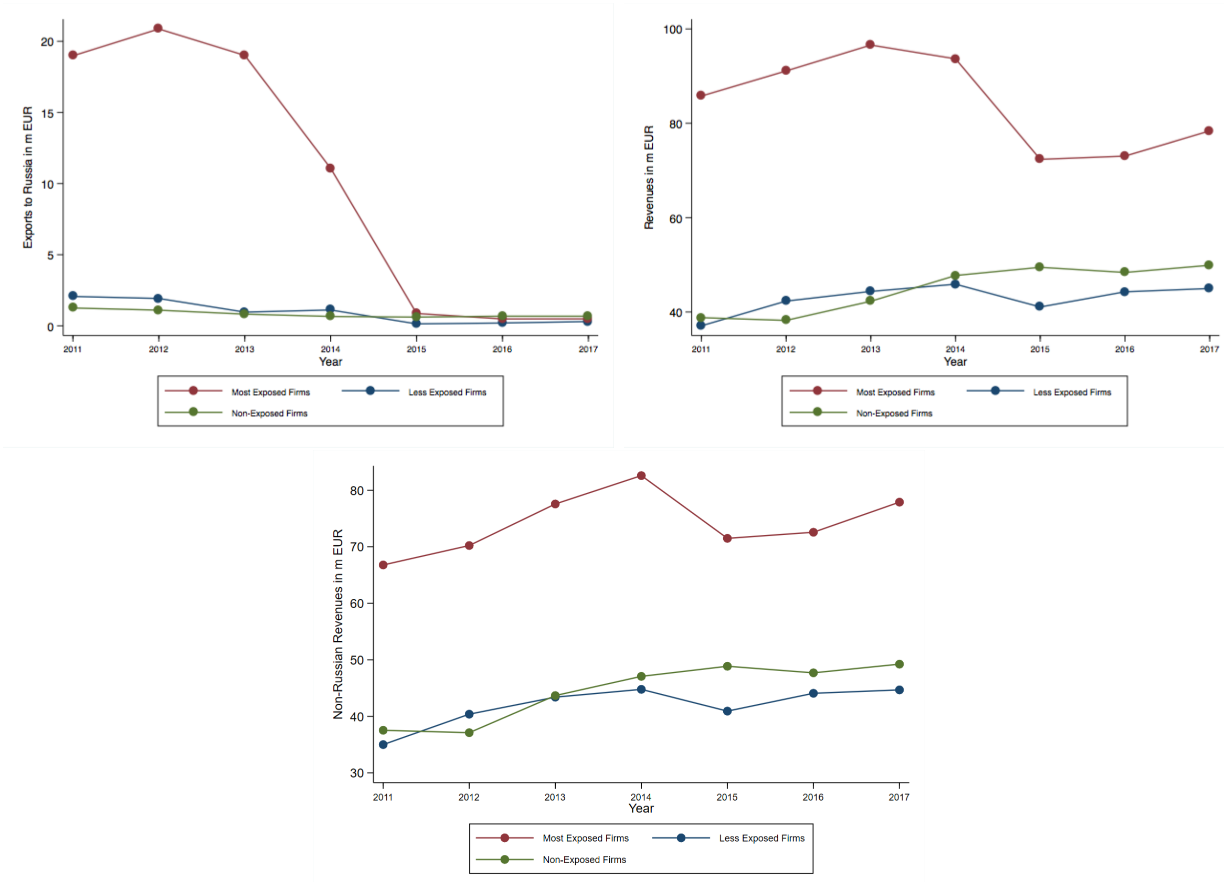
In estimating each firm's direct exposure to this abrupt trade shock, for each Lithuanian firm we look at the pre-ban exports of the banned 8-digit level HS products to Russia. In particular, firm-level exposure to the trade shock is measured by the fraction of firm's sales that were composed of the banned product exports to Russia in 2013, the year before the ban was imposed. Figure 1 shows the dynamics of exports to Russia for the most exposed firms (with exports to Russia constituting over 10% of revenues), less exposed firms (with exports to Russia constituting between 2-10% of revenues), and non-exposed firms (with exports to Russia constituting less than 2% of revenues).[5] The top left panel of Figure 1 depicts total exports of all products (that include banned and non-banned products) to Russia for these firms. We see a significant drop of exports for the firms exposed to the shock.

Moreover, these drops in exports are reflected in the overall decrease in the affected firms' sales, suggesting that the demand shock for these firms was indeed considerable. As shown in the top right panel of Figure 1, affected food manufacturers experienced a sharp drop in the overall revenues but later also showed some recovery. The drop in overall sales also suggests that the venting-in effect was limited, i.e., the drop in exports was not replaced by a respective increase in the domestic sales. We also confirm that in the bottom panel of Figure 1, which plots the dynamics of revenues from outside of Russia.

This observation of different exposure to the shock will be our key identifying variable in the empirical analysis and also one of the guiding inputs in building our theoretical framework.

[5] In our further empirical estimations, we consider the continuous treatment with both *more* and *less* exposed firms considered as treated firms and non-exposed firms considered as the control firms.

Figure 1: Exports to Russia, Total Revenues, and Revenues from Outside of Russia



Notes: The top left figure plots the dynamics of all exports to Russia by food manufacturing firms. The top right figure plots the dynamics of overall revenues by food manufacturing firms. The bottom figure plots the dynamics of revenues from outside of Russia by food manufacturing firms. The red lines represent the firms with high pre-2013 exposure of exports to Russia (with exports to Russia constituting over 10% of revenues), the blue lines represent the firms with low pre-2013 exposure of exports to Russia (with exports to Russia constituting between 2-10% of revenues), the green lines represent the average for all food manufacturing firms in the economy (with exports to Russia constituting less than 2% of revenues).

3 Empirical Analysis

3.1 Reduced-form Identification

We start with the reduced-form analysis that provides causal evidence on the Russian ban's impact on Lithuanian food exporters. In particular, we match the export-level data to the balance sheet data and employ a reduced-form difference-in-differences identification strategy to identify the effect of how these firms have adjusted to the negative trade shock.

We define the period of 2011-2013, which precedes the export ban, to be *pre-period*, and the period of 2014-2017, which follows the export ban, to be *post-period*. Our treatment group consists of firms that had banned-product exports to Russia in 2013. For each of the treated firms we choose a control firm (with replacement) that satisfies the following criteria: (a) the control firm is also in the food manufacturing sector; (b) it is an exporter; and (c) of all the candidate firms satisfying (a) and (b), it is the closest one in terms of size to the focal treated firm, as measured by total sales in 2013. Given likely heterogeneity across firms, we impose these criteria to make sure that before the event, the treated and control firms are as similar as possible. As reported in Table 2, in the pre-period the treated and control observations are not significantly different in terms of our main outcome variables.

Table 2: Balance checks

	Treated	**Control**	**Difference**
Sales, m EUR, 2013	55.5	60.8	−5.3
Full-time employees, 2013	393.2	286.6	106.6
Part-time employees, 2013	14.5	3.8	10.7
Fixed assets, m EUR, 2013	9.6	15.1	−5.5
Total exports, m EUR, 2013	25.9	29.8	3.9
Exports to Russia, m EUR, 2013	6.4	0.9	5.5***

This table shows the mean values of firm characteristics for the two groups of firms in 2013. ***, **, and * refer to the statistical significance at 1%, 5%, and 10%, respectively.

As firms are likely to vary in terms of the exposure to the sanctions, we rely on *Banned export share* to identify the exposure to Russia's ban. *Banned export share* is defined as the fraction of the firm's revenue from exports of the banned products to Russia in 2013 as a proportion of the total revenues of the firm in 2013. We then study whether the food production firms that had a larger fraction of their sales exported to Russia in 2013 experienced changes across different adjustment margins in 2014-2017 as compared to 2011-2013, and whether such changes had larger magnitudes than those experienced by the corresponding firms with a smaller fraction of their sales exported to Russia in 2013.

We investigate the following adjustment margins: the number of part-time employees, the number of full-time employees, the dollar value of investment, measured as a change in fixed assets, and the change in exports to the rest of the world. We then estimate a reduced form triple-differences specification:

$$\Delta Y_{i,t} = \beta_1 \times Banned\,export\,share_i \times Post2014_t + \gamma_i + \tau_t + \epsilon_{i,t}. \tag{1}$$

In this specification, $\Delta Y_{i,t}$ refers to the difference in the adjustment margin $Y_{i,t}$, where the difference is taken between the values of a treated firm i and its matched control firm in a particular year t. $Banned\,export\,share_i$ refers to the fraction of firm i's sales of the banned products that it exported to Russia in 2013 over the total sales of firm i in 2013. $Post2014_t$ refers to the dummy equal to 1 in the years 2014-2017 and equal to 0 in years 2011-2013. γ_i and τ_t denote the firm- and year-fixed effects. The identification thus relies on the variation in $Banned\,export\,share_i$ across treated firms in 2013.

In other words, we study whether the food producers that had a larger $Banned\,export\,share_i$ experienced changes in adjustment margins $Y_{i,t}$ in 2014-2017 (a) as compared to their average $Y_{i,t}$ over 2011-2013, (b) as compared to the respective changes in $Y_{i,t}$ in control firms, and (c) as compared to the respective changes in changes in corresponding firms with a smaller $Banned\,export\,share_i$. This estimation thus not only controls for non-time-varying differences between firms but also controls for general sectoral-trends that might have varied across the firms of similar size.

In our analysis we also estimate a specification that studies dynamic adjustments to the trade shock:

$$\begin{aligned} \Delta Y_{i,t} =& \beta_1 \times Banned\,export\,share_i \times Post2014_t + \\ & \beta_2 \times Banned\,export\,share_i \times Post2016_t + \gamma_i + \tau_t + \epsilon_{i,t}. \end{aligned} \tag{2}$$

Compared to the specification (1), here we separately estimate the additional adjustment that happened in years 2016-2017, over the general adjustment in 2014-2017. That is, $Post2016_t$

refers to the dummy equal to 1 in the years 2016-2017 and equal to 0 in years 2011-2015, while as before, $Post2014_t$ refers to the dummy equal to 1 in the years 2014-2017 and equal to 0 in years 2011-2013. All other variables are defined as in specification (1).

3.2 Findings

In this section we report the results from the empirical analysis. We separately discuss the results on labor market, investment, and revenue-increasing strategies.

3.2.1 Labor Market

We start with the number of employees and report results in Table 3. We report the results separately for part-time and full-time employees, and also split our treatment effect into the overall effect after year 2014 and the additional effect after 2016.

Table 3: Number of employees

	(1)	(2)	(3)	(4)
	Part-time employees		Full-time employees	
Banned export share x Post 2014	-146.909***	-125.123**	-384.578**	-128.022
	(50.223)	(48.105)	(177.502)	(159.867)
Banned export share x Post 2016		-56.133		-661.058**
		(52.725)		(314.478)
Constant	24.411***	24.378***	141.696***	141.306***
	(4.478)	(4.474)	(16.923)	(17.150)
R^2	0.755	0.757	0.953	0.956
N	151	151	151	151

Notes: This table shows the effect of the Russian ban on the number of employees in Lithuanian food manufacturing firms over 2011-2017. For each *treated* firm that exported any banned products to Russia in 2013, we assign one *control* firm that is a food exporter, and is closest in size (as measured by total sales). The dependent variable is then the difference in the number of either part-time employees (Columns 1-2) or full-time employees (Columns 3-4) between the treated and control firms. ***, **, and * refer to the statistical significance at 1%, 5%, and 10%, respectively.

We see the statistically significant adjustment for both part-time and full-time employees. We see that for the part-time employees, the effect is immediate, i.e., there is no statistically significant effect after 2016. For an average exposed food manufacturing firm with 6.69% of revenues coming from the banned product exports to Russia in 2013, the number of part-time employees dropped by an average of 9.76 (compared to the change in control firms), which constituted a 67% drop over the sample mean of 14.48 part-time employees in treated food manufacturing firms in 2013. Such an economically large depletion in the number of employees suggests that the shock perceived by the firms was substantial as they had significantly depleted their most flexible margin.

When we look at the full-time employees, we see that the adjustment is delayed. That is, the effect is not immediate but rather appears in years 2016-2017. In terms of the economic effect for an average exposed firm with 6.69% of revenues coming from the banned product exports to Russia in 2013, the number of employees dropped by an average of 25.9, constituting a 6.6% drop over the sample mean of 393.2 employees in treated firms in 2013. Taken together with our findings on the adjustment of part-time employees, these results suggest that firms lay off part-time employees first and then when they realize the actual magnitude of the shock, its permanence, or the lack of adjustment in terms of revenue-increasing strategies, they consequently reduce the number of full-time employees.

3.2.2 Investment

While part-time and full-time employees represent the adjustments of the labor input, we also look at the adjustment of capital. We proxy the adjustment of capital by the change in investment, which we define as the annual change in the fixed assets, adjusted for depreciation. As shown in Table 4, we see a drop in investment; the effect is immediate and does not reverse in the longer term.

3.2.3 Revenue-Increasing Strategies

Finally, we study revenue-increasing strategies. In particular, we look at whether the affected firms increased their sales from exports to countries outside of Russia. We report results in Table 5, where we see a rise in the dollar value of exports. While we document an immediate

Table 4: Investment

	(1)	(2)
Banned export share x Post 2014	-24.459**	-26.798*
	(11.235)	(13.657)
Banned export share x Post 2016		6.103
		(14.727)
Constant	-0.926	-1.274
	(1.609)	(1.772)
R^2	0.596	0.597
N	126	126

Notes: This table shows the effect of the Russian ban on the investment in fixed assets in Lithuanian food manufacturing firms over 2011-2017. For each *treated* firm that has exported any banned products to Russia in 2013, we assign one *control* firm that is a food exporter, and is closest in size (as measured by total sales). The dependent variable is the difference in the investment between the treated and control firms (in 1 million euros). ***, **, and * refer to the statistical significance at 1%, 5%, and 10%, respectively.

positive effect, the effect is only statistically significant with a longer lag, suggesting that when we split the effect into two periods, the later effect dominates. These results could be interpreted as suggesting that reaching new export markets requires a longer time and larger trade costs.

Table 5: Exports outside of Russia

	(1)	(2)
Banned export share x Post 2014	46.042**	19.626
	(20.687)	(24.308)
Banned export share x Post 2016		54.657*
		(30.436)
Constant	-9.581***	-9.566***
	(1.799)	(1.807)
R^2	0.889	0.892
N	165	165

Notes: This table shows the effect of the Russian ban on dollar value of exports outside Russia in Lithuanian food manufacturing firms over 2011-2017. For each *treated* firm that has exported any banned products to Russia in 2013, we assign one *control* firm that is a food exporter, and is closest in size (as measured by total sales). The dependent variable is then the difference in the dollar value of exports, excluding Russia. ***, **, and * refer to the statistical significance at 1%, 5%, and 10%, respectively.

4 Conceptual Mechanisms

In developing the theoretical mechanisms to rationalize our empirical findings, we conceptualize Russia's trade ban as an exogenous shock to the variable trade costs and analyze its effects on various adjustment margins. We use a stylized framework with a firm as the ultimate decision maker.[6] We show that even without delving into a fully-fledged general equilibrium – due to very targeted sanctions — we can rationalize the empirical findings by highlighting the main role played by the part-time employment, a flexible shock absorption tier. We set out by describing preferences, technology, and sketching key open economy relationships before discussing the implications.

4.1 Preferences and Technology

The real consumption index (Q_t) is defined as follows:

$$Q_t = \left[\int_{j\in J} q_t\left(j\right)^{\frac{\sigma-1}{\sigma}} dj\right]^{\frac{\sigma}{\sigma-1}}, \qquad \sigma > 1, \tag{3}$$

where j indexes varieties; J is the set of all varieties; $q_t\left(j\right)$ denotes consumption of variety j; and σ governs the elasticity of substitution between varieties. The dual price index for the differentiated sector (P_t) is given by:

$$P_t = \left[\int_{j\in J} p_t\left(j\right)^{1-\sigma} dj\right]^{\frac{1}{1-\sigma}}. \tag{4}$$

Then it follows that the domestic demand for variety j is:

$$q_t\left(j\right) = \left(\frac{p_t(j)}{P_t}\right)^{-\sigma} Q_t = \left(\frac{A_t}{p_t\left(j\right)}\right)^{\sigma}, \tag{5}$$

where $A_t \equiv Q_t^{\frac{1}{\sigma}} P_t$ is a demand-shifter, similarly to Helpman et al. (2010). See Appendix A.1 for the derivation.

[6] As in our dataset we do not observe the agents in other markets (e.g., employees, job searchers, suppliers), we limit the analysis to the firms' choices. Also, we do not aim to explain the salient features of technologies, and take them as given.

A firm takes consumers' choices as given. Given the specification of the demand, the equilibrium revenues of a firm are:

$$r_t(j) \equiv p_t(j)\, q_t(j) = A_t q_t(j)^{\frac{\sigma-1}{\sigma}} = p_t(j)^{1-\sigma} A_t^{\sigma}. \tag{6}$$

The production function is given by:

$$q_t(j) = \left(K_t^{\psi}(j)\left(L_t^F(j)\right)^{1-\psi}\right)^{\phi} \left(L_t^P(j)\right)^{1-\phi}, \tag{7}$$

where the functional form is assumed to be identical across all firms producing varieties $j \in J$; ϕ, ψ denote distribution (share) parameters. As is standard, $q_t(j)$ denotes quantity, $K_t(j)$ capital, $L_t^F(j)$ full-time employment and $L_t^P(j)$ part-time employment. A simplifying assumption of the unitary elasticity of substitution across inputs helps us clarify key channels and arrive at the closed-form solutions.[7] Before turning to key mechanisms, we first clarify how trade impacts firm production.

4.2 Trade

In addition to selling to the domestic market, a firm exports a fraction of its good after covering a fixed cost of exporting $f_x(j) > 0$. Note that fixed exporting costs entail firm-specific variation, capturing firm efficiency in setting up a distribution network. Additionally, in order for one unit to arrive in the foreign market, a firm faces an iceberg variable trade cost, $\tau(j) > 1$, denominated in units of a variety. Again, variable trade costs are firm-specific, showing, for example, efficiency in transporting goods, accessing customs, or managing a distribution network. The total production is then split between the domestic market: $q_t^d(j)$ and the export market $q_t^x(j)$, so that the firm's marginal revenues are equated in the two

[7]Please see Appendix A.3 for a more general case with the two-part production function, $q_t(j) = \left(\psi K_t^{\gamma}(j) + (1-\psi)\left(L_t^F(j)\right)^{\gamma}\right)^{\frac{\phi}{\gamma}} \left(L_t^P(j)\right)^{1-\phi}$, $0 < \phi < 1$, $0 < \psi < 1$, $\gamma \leq 1$ (see, for instance, Goldin and Katz (1998), Krusell et al. (2000)). In such a case, the elasticity of substitution between full-time employment and capital is $\epsilon_{K,L^F} = \frac{1}{1-\gamma}$ but it is unitary between the part-time employment and the other two inputs, i.e., $\epsilon_{K,L^P} = \epsilon_{L^F,L^P} = 1$. Since the additional parameter, γ, capturing imperfect substitutability between part-time labor and the mix of full-time labor and capital, cannot be reliably inferred from our data and also some solutions would require approximations, we stick to the Cobb-Douglas specification to demonstrate the key mechanism for our baseline analysis.

markets. Based on equation (5), the domestic quantity satisfies $q_t(j) = \left(\frac{A_t}{p_t(j)}\right)^{\sigma}$ and it follows that a foreign consumer faces a price $\tau(j)\, p_t(j)$, whereas a domestic producer has to produce $\tau(j) > 1$ units for $\left(\frac{A_t^{\star}}{\tau(j)p_t(j)}\right)^{\sigma}$ quantity to arrive to the foreign market:

$$q_t^x(j) = \tau(j)\left(\frac{A_t^{\star}}{\tau(j)\, p_t(j)}\right)^{\sigma},$$

where $A_t^{\star}$ is the foreign demand shifter, $A_t^{\star} \equiv Q_t^{\star\frac{1}{\sigma}} P_t^{\star}$.

This expression yields $\left(\frac{q_t^x(j)}{q_t^d(j)}\right)^{\frac{1}{\sigma}} = \tau_t^{\frac{1-\sigma}{\sigma}}(j)\left(\frac{A_t^{\star}}{A_t}\right)$. Note that unlike Helpman et al. (2010), where production shares for export and domestic markets within firms are identical, in our setting trade cost heterogeneity generates varying (firm-specific) proportions of export production. Last, we can express total quantity as:

$$\begin{aligned} q_t(j) &\equiv q_t^d(j) + \mathbb{I}_t^x(j)\, q_t^x(j) = q_t^d(j) + \mathbb{I}_t^x(j)\left[\tau_t^{\frac{1-\sigma}{\sigma}}(j)\left(\frac{A_t^{\star}}{A_t}\right)\right]^{\sigma} q_t^d(j) \\ &= \left[1 + \mathbb{I}_t^x(j)\left(\tau_t^{\frac{1-\sigma}{\sigma}}(j)\left(\frac{A_t^{\star}}{A_t}\right)\right)^{\sigma}\right]\left(\frac{A_t}{p_t(j)}\right)^{\sigma} = \Upsilon_t(j)\left(\frac{A_t}{p_t(j)}\right)^{\sigma}, \end{aligned}$$

and the total revenues of a firm as follows:

$$\begin{aligned} r_t(j) &\equiv p_t(j)\, q_t(j) \\ &= \left[1 + \mathbb{I}_t^x(j)\, \tau_t^{1-\sigma}(j)\left(\frac{A_t^{\star}}{A_t}\right)^{\sigma}\right]^{\frac{1}{\sigma}} A_t q_t^{\frac{\sigma-1}{\sigma}}(j) = \Upsilon_t^{\frac{1}{\sigma}}(j)\, A_t q_t^{\frac{\sigma-1}{\sigma}}(j). \end{aligned} \tag{8}$$

The variable $\Upsilon_t(j) - 1$ denotes the market access by a firm, and captures the share of exports over domestic revenue:

$$\Upsilon_t(j) \equiv 1 + \mathbb{I}_t^x(j)\, \tau_t^{1-\sigma}(j)\left(\frac{A_t^{\star}}{A_t}\right)^{\sigma} \geq 1, \tag{9}$$

where $\mathbb{I}_t^x(j)$ is an indicator variable equal to one (zero) if firm j chooses to serve a foreign market. It is straightforward to extend this setting to more than two foreign countries[8] but it suffices to consider two trade partners. In our case, we refer to them as Russia (RU) and the rest of the world (RW):

$$\Upsilon_t(j) \equiv 1 + \tau_{RU,t}^{1-\sigma}(j)\left(\frac{A_{RU,t}^{\star}}{A_t}\right)^{\sigma} + s_{RW,t}^x(j)\, \tau_{RW,t}^{1-\sigma}(j)\left(\frac{A_{RW,t}^{\star}}{A_t}\right)^{\sigma} \geq 1. \tag{10}$$

[8] If each firm reaches a set of foreign markets, we can generalize: $\Upsilon_t(j) \equiv 1 + \sum_{\ell} \mathbb{I}_{\ell t}^x(j)\, \tau_{\ell t}^{1-\sigma}(j)\left(\frac{A_{\ell t}^{\star}}{A_t}\right)^{\sigma} \geq 1$, where $\ell = 1, \ldots, \mathcal{L}$.

We consider only those firms that are exporters to Russia, so there is no indicator function (in other words, we consider firms *conditional* on exporting to Russia). The rest of the world is captured by the share function, $s^{x}_{RW,t}(j)$, an extensive margin of trade. Unlike a binary choice ($\mathbb{I}^{x}_{t}(j)$), and to provide as close and transparent connection as possible to the data, $s^{x}_{RW,t}(j)$ captures the coverage of all remaining world markets under a trade costs symmetry assumption.[9] We denote a share of export revenues (an intensive margin) as:

$$\mathcal{S}^{RU}_{t}(j) = \frac{\Upsilon_t(j)-1}{\Upsilon_t(j)} - \frac{s^{x}_{RW,t}(j)\tau^{1-\sigma}_{RW,t}(j)\left(\frac{A^{\star}_{RW,t}}{A_t}\right)^{\sigma}}{\Upsilon_t(j)}$$

and

$$\mathcal{S}^{RW}_{t}(j) = \frac{r^{RW}_{t}(j)}{r^{d}_{t}(j)+r^{RU}_{t}(j)+r^{RW}_{t}(j)} = \frac{\Upsilon_t(j)-1}{\Upsilon_t(j)} - \frac{\tau^{1-\sigma}_{RU,t}(j)\left(\frac{A^{\star}_{RU,t}}{A_t}\right)^{\sigma}}{\Upsilon_t(j)}. \tag{11}$$

In a standard two-country setting, export revenue share collapses to $\mathcal{S}_t(j) = \frac{\Upsilon_t(j)-1}{\Upsilon_t(j)}$.[10]

4.3 Optimal Choices

Since the focus of our empirical analysis is on the exporters to Russia, we only consider those firms that have been trading with Russia. As in the data, these firms have a choice to increase exporting to the rest of the world. The per-period profit of a firm is then:

$$\begin{aligned}\pi_t(j) = \Bigg\{ &\left[1+\tau^{1-\sigma}_{RU,t}(j)\left(\frac{A^{\star}_{RU,t}}{A_t}\right)^{\sigma} + s^{x}_{RW,t}(j)\,\tau^{1-\sigma}_{RW,t}(j)\left(\frac{A^{\star}_{RW,t}}{A_t}\right)^{\sigma}\right]^{\frac{1}{\sigma}} \times \\ &A_t\left(\left(\psi K^{\gamma}_{t}(j) + (1-\psi)\left(L^{F}_{t}(j)\right)^{\gamma}\right)^{\frac{\phi}{\gamma}}\left(L^{P}_{t}(j)\right)^{1-\phi}\right)^{\frac{\sigma-1}{\sigma}} \\ &- w^{F}_{t}L^{F}_{t}(j) - w^{P}_{t}L^{P}_{t}(j) - I_t(j) - \Phi^{L}\left(L^{F}_{t}(j), H^{F}_{t}(j)\right) - s^{x}_{RW,t}(j)\,f_x\Bigg\},\end{aligned} \tag{12}$$

[9] One can think of the (normalized) sum as: $\sum_{\ell=1}^{\mathcal{L}}\mathbb{I}^{x}_{\ell,t}(j)\,\tau^{1-\sigma}_{RW,t}(j)\left(\frac{A^{\star}_{RW,t}}{A_t}\right)^{\sigma} = \tau^{1-\sigma}_{RW,t}(j)\left(\frac{A^{\star}_{RW,t}}{A_t}\right)^{\sigma}\sum_{\ell}\mathbb{I}^{x}_{\ell,t}(j)$, where symmetry across foreign markets was assumed. In such a case, $\mathcal{L}\times s^{x}_{RW,t}(j) = \sum_{\ell}\mathbb{I}^{x}_{\ell,t}(j)$, and we can thus normalize $\mathcal{L}=1$.

[10] For full details regarding the derivation of quantity, prices and revenues in this three-country setting, please refer to Appendix A.2.

where Φ^L stands for a full-time labor adjustment costs function. The other notation is standard: $I_t(j)$ stands for the firm j investment, $H_t^F(j)$ denotes a change in full-time labor stock, and $\Phi^L\left(L_t^F(j), H_t^F(j)\right)$ takes full-time labor adjustment costs into account. We will assume that hiring and firing costs per each full-time employee, h and f, respectively, are constant across all firms.

Since factor instalment, legal environment, and contractual obligations entail time rigidities, a firm engages in a dynamic planning and optimizes by taking into account a constant discount rate ρ:

$$\max_{\substack{L_{t+1}^F(j), H_t^F(j), L_t^P(j), \\ K_{t+1}(j), I_t(j), s_{RW,t}^x(j)}} \mathbb{E}_t \sum_{s=t}^{+\infty} \rho^s \pi_s(j) =$$

$$\begin{aligned} \max_{\substack{L_{t+1}^F, H_t^F, L_t^P, \\ K_{t+1}, I_t, s_{RW,t}^x(j)}} \quad & \mathbb{E}_t \sum_{s=t}^{+\infty} \rho^s \Bigg\{ \left[1 + \tau_{RU,s}^{1-\sigma}(j) \left(\frac{A_{RU,s}^\star}{A_s}\right)^\sigma + s_{RW,s}^x(j)\, \tau_{RW,s}^{1-\sigma}(j) \left(\frac{A_{RW,s}^\star}{A_s}\right)^\sigma\right]^{\frac{1}{\sigma}} \\ & \times A_s \left(\left(\psi K_s^\gamma(j) + (1-\psi)\left(L_s^F(j)\right)^\gamma\right)^{\frac{\phi}{\gamma}} \left(L_s^P(j)\right)^{1-\phi}\right)^{\frac{\sigma-1}{\sigma}} \\ & - w_s^F L_s^F(j) - w_s^P L_s^P(j) - I_s(j) \\ & - \Phi^L\left(L_s^F(j), H_s^F(j)\right) - s_{RW,s}^x(j)\, f_x \Bigg\}, \end{aligned} \tag{13}$$

subject to the following constraints:

$$I_t(j) = K_{t+1}(j) - (1-\delta)\, K_t(j), \tag{14}$$

$$L_{t+1}^F(j) = L_t^F(j) + H_t^F(j), \tag{15}$$

$$\Phi^L\left(L_t^F(j), H_t^F(j)\right) = h H_t^F(j)\, \mathbb{I}_{\triangle L_t^F(j)>0} - f H_t^F(j)\, \mathbb{I}_{\triangle L_t^F(j)<0}. \tag{16}$$

The firm's optimal choices can be summarized as follows:

$$
\begin{aligned}
\mu_t = &\quad \rho\left(\Upsilon_{t+1}^{\frac{1}{\sigma}} A_{t+1}\left(\tfrac{\sigma-1}{\sigma}\right) q_{t+1}^{\frac{\sigma-1}{\sigma}}\left(1-\psi\right)\phi\left(L_{t+1}^{F}\right)^{\gamma-1}\left(\Phi_{t+1}^{\gamma}\right)^{-1} - w_{t+1}^{F} + \mu_{t+1}\right),\\
\mu_t = &\quad h\mathbb{I}_{H_t^F>0} - f\mathbb{I}_{H_t^F<0},\\
w_t^P = &\quad \Upsilon_t^{\frac{1}{\sigma}} A_t\left(\tfrac{\sigma-1}{\sigma}\right) q_t^{-\frac{1}{\sigma}}\frac{\partial q_t}{\partial L_t^P},\\
\tfrac{1-\rho+\delta\rho}{\rho} = &\quad \Upsilon_{t+1}^{\frac{1}{\sigma}} A_{t+1}\left(\tfrac{\sigma-1}{\sigma}\right) q_{t+1}^{-\frac{1}{\sigma}}\frac{\partial q_{t+1}}{\partial K_{t+1}},\\
q_t^{\frac{1}{\sigma}} = &\quad \frac{\tau_{RW,t} A_t\left(A_{RW,t}^{\star}\right)^{\frac{\sigma}{1-\sigma}}}{\sigma^{\frac{1}{1-\sigma}} f_x^{\frac{1}{1-\sigma}}}\Upsilon_t^{\frac{1}{\sigma}}\left(s_{RW,t}^{x};\tau_{RU,t},\tau_{RW,t}\right).
\end{aligned}
$$

As usual, capital takes time to be installed and become productive and depreciates at a rate δ (see equation (14)). Otherwise, we abstract from the adjustment costs of investment, thus marginal (revenue) product of capital refers to marginal product of capital and additional revenue, both evaluated next period and discounted, as well as depreciation rate.

The shadow value of full-time labor, μ_t, embodies an inter-temporal optimization where a current value of full-time employment needs is equal to the discounted value of the marginal value of full-time employment,[11] discounted wage, and future value of full-time employment. Since a decision today realizes only next period due to the lengthy search for employees, discounting affects the current value (and thus the optimal action). As full-time labor can be hired or fired with a lag due to search and other frictions, the net variation in full-time employment, H_t^F, can be positive, negative or zero, and result in the new labor stock L_{t+1}^F next period. Employment protection ($\Phi^L\left(L_t^F, H_t^F\right) = hH_t^F\Im_{\triangle L_t^F>0} - fH_t^F\Im_{\triangle L_t^F<0}$), as captured by hiring costs h and firing costs f, is common across firms within an economy, and makes firm's employment change costly. This adjustment mechanism introduces non-convexities and thus intervals of optimal inaction, as covered in Bentolila and Bertola (1990). The part-time employment can be adjusted more quickly and costlessly, equating wage w_t^P with the marginal (revenue) product of part-time labor.

Lastly, since we analyze only those firms that exported to Russia before the shock, we obtain the optimal intensive margin of trade with the rest of the world, $s_{RW,t}^x$, which also

[11] Marginal product tells how much output gets reduced by marginally reducing employment and then multiplying it by the price of (the last unit of) production.

links the firm's openness and quantity. We can therefore get an expression for the share of the rest of the world's market through the openness variable, Υ_t:

$$
\begin{aligned}
s^x_{RW,t}(j) = & \frac{q_t}{\tau^{1-\sigma}_{RW,t}(j)\left(\frac{A^\star_{RW,t}}{A_t}\right)^\sigma \frac{\tau^\sigma_{RW,t} A^\sigma_t \left(A^\star_{RW,t}\right)^{\frac{\sigma}{1-\sigma}\sigma}}{\sigma^{\frac{\sigma}{1-\sigma}} f_x^{\frac{\sigma}{1-\sigma}}}} \\
& -\tau^{\sigma-1}_{RW,t}(j)\left(\frac{A^\star_{RW,t}}{A_t}\right)^{-\sigma} - \left(\frac{\tau_{RU,t}(j)}{\tau_{RW,t}(j)}\right)^{1-\sigma}\left(\frac{A^\star_{RU,t}}{A^\star_{RW,t}}\right)^\sigma .
\end{aligned}
$$

Based on the first-order condition for the flexible adjustment margin, namely part-time employment, we can express output as:

$$
q_t = \left[(1-\phi)\left(\tfrac{\sigma-1}{\sigma}\right)\right]^{\frac{\sigma}{1-\sigma}} \Upsilon_t^{\frac{1}{1-\sigma}} A_t^{\frac{\sigma}{1-\sigma}} \left(w^P_t L^P_t\right)^{\frac{\sigma}{\sigma-1}} .
$$

Finally, the trade share can be expressed in an explicit form as:

$$
\begin{aligned}
s^x_{RW,t}(j) = & (\sigma-1)^{\frac{\sigma}{1-\sigma}} \left(\frac{w^P L^P_t}{1-\phi}\right)^{\frac{\sigma}{\sigma-1}} f_x^{\frac{\sigma}{1-\sigma}} \tau^{-1}_{RW,t}(j)\left(\frac{A_t}{A^\star_{RW,t}}\right)^{\frac{\sigma}{1-\sigma}} \Upsilon_t^{\frac{1}{1-\sigma}} \\
& -\tau^{\sigma-1}_{RW,t}(j)\left(\frac{A^\star_{RW,t}}{A_t}\right)^{-\sigma} - \left(\frac{\tau_{RU,t}(j)}{\tau_{RW,t}(j)}\right)^{1-\sigma}\left(\frac{A^\star_{RU,t}}{A^\star_{RW,t}}\right)^\sigma .
\end{aligned}
\tag{17}
$$

5 Testable Implications

We first discuss what happens with the intensive margin of trade and then turn to implications for the firms experiencing a large trade shock.

5.1 Flexible Adjustment Margin

We can express the intensive margin of trade as:

$$
\Upsilon_t = \left(\frac{w^P L^P_t}{1-\phi}\right)(\sigma-1)^{-1} \tau^{1-\sigma}_{RW,t} \left(\frac{A^\star_{RW,t}}{A_t}\right)^\sigma f_x^{-1}.
$$

As derived in Appendix A.4.1, Υ_t is determined by the part-time labor, which acts as a choice variable in the face of an exogenous shock to trade with Russia. In other words, a change in an intensive margin of trade acts through a direct effect of trade costs and an indirect channel through the flexible adjustment margin, part-time labor. We can therefore conclude that:

$$\frac{\frac{\partial \Upsilon_t}{\partial \tau_{RU,t}(j)}}{\frac{\partial \Upsilon_t}{\partial L_t^P}} = \frac{\partial L_t^P}{\partial \tau_{RU,t}(j)} = \frac{(\sigma-1)(1-\sigma)\,\tau_{RU,t}^{-\sigma}(j)\, f_x}{\left(\frac{w^P}{1-\phi}\right)\tau_{RW,t}^{1-\sigma}} \left(\frac{A_{RU,t}^{\star}}{A_{RW,t}^{\star}}\right)^{\sigma} < 0, \tag{18}$$

leading to the following result:

Proposition 1. *An exogenous increase in trade costs with Russia induces layoffs of part-time employees. Conditional on exporting to Russia prior to the ban, this effect is larger for larger fixed exporting costs*[12] *and for lower variable exporting costs to Russia before a shock (in other words, the larger f_x and thus the larger export basket and/or the lower $\tau_{RU,t}(j)$ or the larger the revenue share of exports to Russia, $\mathcal{S}_t^{RU}(j) \equiv \frac{(\tau_{RU,t}(j))^{1-\sigma}\left(\frac{A_{RU,t}^{\star}}{A_t}\right)^{\sigma}}{\Upsilon_t(j)}$, for a given level of intensive margin $\Upsilon_t(j)$).*

Proof. Follows from the equation (18), which is derived in Appendix A.4.1. □

Our empirical strategy is thus be based on the approximation:

$$\triangle L_t^P \approx \frac{(\sigma-1)(1-\sigma)\, f_x}{\left(\frac{w^P}{1-\phi}\right)} \left(\frac{A_{RU,t}^{\star}}{A_{RW,t}^{\star}}\right)^{\sigma} \underbrace{\left(\frac{\tau_{RU,t}(j)}{\tau_{RW,t}(j)}\right)^{1-\sigma}}_{\text{Rel.trade costs: RU/RW;}} \underbrace{\frac{\triangle \tau_{RU,t}(j)}{\tau_{RU,t}(j)}}_{\text{Rel.change in trade costs w RU}} \tag{19}$$

A change in part-time labor is solely driven by a change in trade costs, adjusted by exogenous forces (from the firm's perspective). What matters is not only the relative magnitude of a trade costs shock ($\triangle \tau_{RU,t}(j) / \tau_{RU,t}(j)$), but also how large trading costs with Russia are vis-a-vis the rest of the world ($\tau_{RU,t}(j) / \tau_{RW,t}(j)$). As a result, we should look not only at the change in trade costs but also how it affects the entire firm's portfolio, i.e., how small or large exports to Russia have been compared to all other countries. This observation justifies the use of the banned share defined as a ratio of sales of banned products to Russia, compared to the total sales to other destinations.

[12] We are conditioning on the firms that are exporters to Russia, therefore higher fixed exporting costs must be associated with larger pre-shock export share to Russia.

5.2 Trade Adjustment

Since the openness measure Υ_t in equation (10) may be less intuitive than the immediately observable revenue share of openness, $\mathcal{S}_t^{RW}$, we move on to analyze the key drivers in its adjustment to the Russian trade shock. As per equation (4.2), the response in the revenue share is given by:

$$\frac{\partial \mathcal{S}_t^{RW}(j)}{\partial \tau_{RU,t}(j)} = \frac{1}{(\Upsilon_t(j))^2}\frac{\partial \Upsilon_t(j)}{\partial \tau_{RU,t}(j)}$$
$$\times\left[1-(1-\sigma)\,\tau_{RU,t}^{-\sigma}(j)\,\Upsilon_t(j)\left(\frac{A_{RU,t}^{\star}}{A_t}\right)^{\sigma}\left(\frac{\partial \Upsilon_t(j)}{\partial \tau_{RU,t}(j)}\right)^{-1}+\tau_{RU,t}^{1-\sigma}(j)\left(\frac{A_{RU,t}^{\star}}{A_t}\right)^{\sigma}\right] \tag{20}$$
$$= -\frac{\tau_{RU,t}(j)}{\Upsilon_t(j)}\frac{\partial \Upsilon_t(j)}{\partial \tau_{RU,t}(j)}\frac{\mathcal{S}_t^{RW}(j)}{\tau_{RU,t}(j)} > 0,$$

where the last inequality follows since $\frac{\partial \Upsilon_t(j)}{\partial \tau_{RU,t}(j)} < 0$.

Note that a two-country case only has a direct effect, which is negative, $\frac{1}{(\Upsilon_t(j))^2}\frac{\partial \Upsilon_t(j)}{\partial \tau_{RU,t}(j)} < 0$. As shown in equation (20), in a multi-country case, however, the sign switches to a positive one. All else equal, trade reallocation to the rest of the world is larger if a firm's openness sensitivity to trade costs was larger (i.e., a relative trade shock, $\triangle \tau_{RU,t}(j)/\tau_{RU,t}(j)$, induced a larger adjustment in relative openness, $\triangle \Upsilon_t/\Upsilon_t$,[13] trade costs to export to Russia were smaller (lower $\tau_{RU,t}(j)$), and the firm had a larger revenue share of the rest of the world, $\mathcal{S}_t^{RW}$, to start with.

Proposition 2. *Elasticity of the revenue share of the rest of the world, after an increase in variable trade costs with Russia, is given by:*

$$\frac{\partial \mathcal{S}_t^{RW}(j)}{\partial \tau_{RU,t}(j)}\frac{\tau_{RU,t}(j)}{\mathcal{S}_t^{RW}(j)} = -\frac{\partial \Upsilon_t(j)\Upsilon_t(j)}{\partial \tau_{RU,t}(j)\tau_{RU,t}(j)} > 0.$$

For each level of openness, the larger the relative trade shock, the larger the adjustment in the revenue share of the rest of the world.

Proof. Follows from the equation (20), which is derived in Appendix A.4.2. □

As summarized in Table 5, the dollar value of exports in fact increases after a shock to

[13]Recall that $\frac{\triangle \Upsilon_t}{\triangle \tau_{RU,t}(j)} \approx (1-\sigma)\,\tau_{RU,t}^{-\sigma}(j)\left(\frac{A_{RU,t}^{\star}}{A_t}\right)^{\sigma}$.

trade costs with Russia, suggesting a rise in revenue share of the rest of the world. Note that the full effect is a combination of a mechanical effect of lower or no trade with Russia and also export reorientation towards other markets. Table 5 reports only the latter effect as it looks at the pre-shock export revenue to non-Russian destinations.

5.3 Large Shock

We are now equipped with the required tools to analyze costly adjustment margins. Since a small and temporary shock could have been fully absorbed by the flexible adjustment margin and shifting exports to other destinations but Russia, we introduce a concept of a large shock, which necessitates costly adjustment margins by a firm. We start with clarifying the concept of a large shock.

According to equation (16), the full-time labor shadow value varies in the interval $h \geq \mu_{it} \geq -f$, with the equality constraint binding when hiring or firing occurs. To illustrate the mechanism and find a closed-form solution, we consider a state space reduction into two discrete states – good and bad. In the former case, a firm hires new full-time staff whereas in the latter – it lays off current full-time employees. Our definition of a large shock considers only those shocks that surpass the thresholds of hiring and firing. That is, due to non-convexities, if a shock is small and does not surpass a required threshold of hiring and firing, the optimal strategy in terms of full-time labor is inaction.

Let the transition probability of moving between good and bad states be p, whereas with probability $1 - p$ that the state remains the same in the next period. For instance, a degenerate probability of no change implies $1 - p = 1$, and thus a firm is permanently stuck in the current state. Note that we do not explicitly model the probability parameter as a stochastic process or endogenize it, which can reflect firm's capabilities in forecasting future events, past experience or severity of a shock.[14]

[14]The persistence of the state can be explicitly modeled by an autoregressive process and richer state space but we merely treat it as one of the reasons behind an increase in the probability of a bad state remaining bad in the next period.

Using the first-order conditions for the full-time labor, summarized by the first two equations of the shadow value μ_t in Section A.3, we get:

$$-f = \rho \left(\Upsilon_{t+1}^{\frac{1}{\sigma}} A_{t+1} \left(\frac{\sigma - 1}{\sigma} \right) \underline{q}_{t+1}^{-\frac{1}{\sigma}} \frac{\partial \underline{q}_{t+1}}{\partial L_{t+1}^{F}} - w_{t+1}^{F} - (1-p) f + ph \right), \tag{21}$$

where $\underline{q}_{t+1} \equiv q \left(L_{t+1}^{F-}, L_{t+1}^{P} \right)$ denotes *reduced* employment levels (thereby implying a negative H_t^F). This means that firing is optimal rather than waiting. That coincides with our definition of a large shock, i.e., a situation when the trade disruption is so large that paying firing costs is preferred.[15] In a good state:

$$h = \rho \left(\Upsilon_{t+1}^{\frac{1}{\sigma}} A_{t+1} \left(\frac{\sigma - 1}{\sigma} \right) \bar{q}_{t+1}^{-\frac{1}{\sigma}} \frac{\partial \bar{q}_{t+1}}{\partial L_{t+1}^{F}} - w_{t+1}^{F} - pf + (1-p) h \right), \tag{22}$$

where $\bar{q}_{t+1} \equiv q \left(L_{t+1}^{F+}, L_{t+1}^{P} \right)$ denotes *increased* employment levels (implying positive H_t^F). Manipulating these two expressions and simplifying by the normalization of hiring costs to $h = 0$, we end up with:

$$\left(L_{t+1}^{F-}(j) \right)^{(1-\psi)\phi \frac{\sigma-1}{\sigma} - 1} = \Psi_{t+1} \tau_{RW,t+1}^{\frac{\sigma-1}{\sigma}} K_{t+1}(j)^{-\psi\phi \frac{\sigma-1}{\sigma}} \left(L_{t+1}^{P}(j) \right)^{-(1-\phi)\frac{\sigma-1}{\sigma} - \frac{1}{\sigma}}, \tag{23}$$

where Ψ_{t+1} is a time-varying term, exogenous from the perspective of a firm.[16]

Before learning how full-time employment adjusts, we first solve for the capital choice. From the first-order conditions,[17] we get:

$$K_{t+1} = \left(\frac{w^P}{1-\phi} \right) (\sigma - 1)^{-1} f_x^{-1} \frac{\rho f_x \phi \psi (\sigma - 1)}{1 - \rho + \delta \rho} L_{t+1}^{P}, \tag{24}$$

yielding

$$I_t = \left(\frac{w^P}{1-\phi} \right) \frac{\rho}{1-\rho} \phi \psi \triangle L_{t+1}^{P} \tag{25}$$

where, for exposition purposes, we assume depreciation to be equal to zero, $\delta = 0$.

[15] Technically, when μ_t drops below $-f$, an optimizing firm must fire full-time workers and do so until $\mu_t \geq -f$ is restored. That is why we only consider marginal values with equality.

[16] The term is given by $\Psi_{t+1} \equiv \frac{\left(-\frac{1}{\rho} f + (1-p(j)) f + w_{t+1}^{F}\right)(\sigma-1)^{\frac{1}{\sigma}} f_x^{\frac{1}{\sigma}}}{A_{RW,t+1}^{\star} \left(\frac{\sigma-1}{\sigma}\right) \left(\frac{w^P}{1-\phi}\right)^{\frac{1}{\sigma}} (1-\psi)\phi}$. See Appendix A.4.3 for derivation.

[17] See equation (43) in the Appendix.

Proposition 3. *A forward-looking firm reduces investment proportionally to a forthcoming drop in part-time employment.*

Proof. Follows from the capital equation (48), which is derived in Appendix A.4.4. See also equation (18) where the relationship between trade costs and part-time employment is established. □

Table 4 provides empirical support for the Proposition 3: firms cut investment early on with no significant effect in later periods. A change in the part-time employment acts a measure of the shock severity. Since expansion to the new export markets is lengthy and costly, whereas full time labor and capital are costlier adjustment margins, a change in part-time labor becomes an indicator of investment plans.

Finally, taking into account capital adjustment in equation (24), we can re-express labor adjustment equation (23) in terms of the flexible adjustment margin, part-time employment, and exogenous (from the perspective of a firm) variables:

$$\left(L_{t+1}^{F-}(j)\right)^{(1-\psi)\phi\left(\frac{\sigma-1}{\sigma}\right)-1} = \widetilde{\Psi}_t \tau_{RW,t+1}^{\frac{\sigma-1}{\sigma}} \left(L_{t+1}^{P}(j)\right)^{-\frac{1}{\sigma}([1-\phi+\psi\phi](\sigma-1)+1)}, \tag{26}$$

where $\widetilde{\Psi}_t$ is a mix of aggregate and exogenous terms.[18] A new (lower) level of full-time employees is driven by variable trade costs with all other countries except for Russia and part-time employees present with a firm at the time of full-time employment adjustment. As in Bertola (2004), under a strictly diminishing marginal productivity of inputs, an interior solution would require $L_{it}^{F+} > L_{it}^{F-} > 0$. It is clear that the larger the firing and hiring costs, the larger the opportunity costs, and thus the wedge between marginal values, making a strategy of hoarding labor more likely. We summarize this finding as follows:

Proposition 4. *Contingent on the decision to fire full-time employees, the layoffs are more likely to be larger (i.e., there is a decrease in $L_{t+1}^{F-}(j)$ or an increase in $\left(L_{t+1}^{F-}(j)\right)^{(1-\psi)\phi\frac{\sigma-1}{\sigma}-1}$*

[18] It is equal to $\widetilde{\Psi}_t \equiv \Psi_t \left(\left(\frac{w^P}{1-\phi}\right)(\sigma-1)^{-1} f_x^{-1} \frac{\rho f_x \phi \psi(\sigma-1)}{1-\rho+\delta\rho}\right)^{-\psi\phi\frac{\sigma-1}{\sigma}}$, as elaborated in Appendix A.4.5.

since $(1-\psi)\,\phi\frac{\sigma-1}{\sigma} < 1$*), the higher the firm's variable costs to trade with the rest of the world, the smaller the stock of part-time employment, and a bad state is more likely to persist (higher* $1-p$*).*

Proof. Follows from the equation (26), which is derived in Appendix A.4.3. As for the first claim, higher $\tau_{RW,t+1}$ leads to a larger full-time labor adjustment. To establish the second claim, notice that $(1-\psi)\,\phi\frac{\sigma-1}{\sigma} < 1$ as all terms are strictly between zero and one. The power of part-time employment is negative, i.e., $-\frac{1}{\sigma}\left([1-\phi+\psi\phi]\,(\sigma-1)+1\right) < 0$ since $[1-\phi+\psi\phi]\,(\sigma-1)+1 > 0$ or $(1-\psi)\,\phi < \frac{\sigma}{\sigma-1}$, which is always the case since ψ, ϕ are between zero and one, whereas $\sigma > 1$, hence, $\frac{\sigma}{\sigma-1} > 1$. As for the last claim, Ψ_{t+1} is an increasing function of $1-p$. □

Recall that, even though a level of part-time employment is an endogenous firm's choice, a change, for a given level of part-time workers, is driven by exogenous factors (e.g. an unexpected change in trade costs due to political reasons), as summarized in equation (19). This insight underlies our ensuing empirical strategy.

6 Discussion and Additional Empirical Results

6.1 Discussion of Mechanism's Implications

Before moving to the additional empirical evidence, we take stock of the main theoretical implications. First, as Proposition 1 indicates, an exogenous increase in trade costs with Russia induces layoffs of part-time employees. This effect is larger, the larger the revenue share of exports to Russia had been before a shock. An implication is that if a shock is large relative to the flexible labor margin (part-time employment) and/or considered to be persistent (i.e., lost access to the Russian market in the future periods), it triggers other adjustments: further inputs reductions and export re-direction to other markets (rest of the world).

Regarding the latter, we saw that export re-orientation to the rest of the world, i.e., an increase in the trade share with the rest of the world, is larger for a larger trade shock. In other words, a larger exposure to the Russian market makes producers search for alternative routes, other factors being held constant (see Proposition 2).

When it comes to timely and costly adjustment margins, Propositions 3 and 4 claim that investment drops more, the larger the part-time employment adjustment, whereas the layoffs of full-time labor are more likely the larger and more persistent the shock and the larger the part-time employment adjustment. A larger shock makes firms reduce temporary workers more quickly, thereby making future prospects gloomier. Due to forward-looking behavior, firms start reducing investment straight-away (front-loading future costs), whereas non-convexity in full-time labor requires a sufficiently large shock; otherwise, we observe a delayed reaction after the ban turns out to be persistent, making firing optimal rather than waiting. Put differently, an optimizing firm front-loads costs if it guesses severity and persistence of the shock correctly. However, if the firm lays off full-time employees later, it could have still been part of an optimal strategy, resulting from the unforeseen persistence of the bad shocks.

Starting by adjusting on the margin with no adjustment costs, i.e., part-time labor, larger shocks trigger forward-looking firms to pursue other adjustments, i.e., investment. When the shocks turns out to be large and persistent, firms also adjust the margin with non-convex adjustment costs, i.e., full-time labor. There are two types of firms that engage in costly adjustments. First, conditional on other actions such as new markets search, firms hit by a large shock engage in front-loading of future adjustments costs. Second, some firms engage in costly adjustments later since the original shock turns out be more persistent than expected, thereby necessitating changes in capital and full-time labor. The non-action in the first period following the shock can be optimal from the perspective of a temporary original shock, sufficiently small to be absorbed by a flexible input in the first period, but forcing a firm to recalculate its response if the pre-ban status actually does not come back. In fact, a firm faces more depleted temporary staff and is thus more likely to change its full-time labor and capital.

6.2 Additional Empirical Evidence

The model shows that the adjustment on other margins depend on such parameters as heterogeneity in the variable exporting costs to Russia and to the rest of the world, time preference, expected probability of the shock persistence, and various adjustment costs. Thus, while our theoretical framework demonstrates that the firm's response to the unanticipated shocks is likely to be heterogeneous depending on these parameters, such heterogeneity might be challenging to capture empirically for the econometrician with limited data.

At the same time, as the model implies, such heterogeneity can be expressed by how strongly the firm adjusts on its most flexible adjustment margin, the part-time labor. Thus, one way to test the theory is to track a change in part-time employment caused by an exogenous change in trade costs with Russia and see whether it is a relevant statistic of subsequent adjustments within a firm. Hence, we now present empirical results on whether the same firms that adjust part-time labor also follow other adjustments.

In particular, we add additional interaction of the change in part-time employees over 2014-2015 to our dynamic specification (2):

$$\begin{aligned} \Delta Y_{i,t} = & \beta_1 \times Banned\, export\, share_i \times Post2014_t + \\ & \beta_2 \times Banned\, export\, share_i \times Post2016_t + \\ & \beta_2 \times Banned\, export\, share_i \times \Delta Part\, time\, change_i \times Post2016_t + \gamma_i + \tau_t + \epsilon_{i,t} \end{aligned} \tag{27}$$

In this specification, $\Delta Part\, time\, change_i$ refers to the difference in the change of part-time employees between 2013 and 2014, where the difference is taken between the values of a treated firm i and its matched control firm. All other variables are defined as in specifications (1) and (2).

We report the results in Table 6, where we show that the adjustment in full-time employees and investment over 2016-2017 was larger for firms that had a larger decrease in part-time employees between 2013 and 2014, as compared to the respective change in the control firms.

Table 6: Interaction with the change in part-time employees

	(1) Full-time employees	(2) Investment
Banned export share x Post 2014	-128.022	-26.798*
	(154.568)	(13.679)
Banned export share x Post 2016	-484.914*	7.230
	(271.284)	(15.670)
Delta Part Time (2014-2015) x Post 2016	-0.896	-0.097
	(1.379)	(0.077)
Banned export share x Delta Part Time (2014-2015) x Post 2016	22.104***	0.744*
	(7.738)	(0.408)
Constant	142.967***	-1.056
	(15.420)	(1.839)
R^2	0.963	0.603
N	149	125

Notes: This table shows the effect of the Russian ban on the number of employees in Lithuanian food manufacturing firms over 2011-2017. For each *treated* firm that has exported any banned products to Russia in 2013, we assign one *control* firm that is a food exporter, and is closest in size (as measured by total sales). The dependent variables are the difference in the number of full-time employees (Column 1) and investment (Column 2) between the treated and control firms. ***, **, and * refer to the statistical significance at 1%, 5%, and 10%, respectively.

These findings suggest the heterogeneity of the adjustment margins that the firms were facing but also bring a broader takeaway from our paper: that when the expected permanence of the cost and the adjustment margins are not fully observable, one proxy that could capture the full extent of the shock exposure of the firm with perfect foresight is its adjustment on the most flexible margin.

As suggested by the mechanism we set out in Section 4, part-time employment features informational contents even beyond the banned export share, proxying for the size of the shock. Firms that experienced larger bans and fired more part-time employees, as captured by the triple interaction term, also engaged in larger layoffs of full-time labor and reductions in investment.

This insight brings us to the policy implications. To prevent costly layoffs of full-time labor, firms could face lower shadow costs of keeping employees on the payroll if a government subsidized wage costs. Part-time labor acts as an important shock absorber but that requires smooth and fast reallocation across fired labor, effective and accessible training policies, and labor market regulation admitting different types of work contracts.

In addition, another policy-relevant dimension is firms' ability to adjust towards finding new export markets. In the spirit of the specification (27), we add an additional interaction of the change in dollar value of exports outside of Russia between 2013 and 2014 to our dynamic specification:

$$\begin{aligned}\Delta Y_{i,t} =& \beta_1 \times Banned\, export\, share_i \times Post2014_t + \\ & \beta_2 \times Banned\, export\, share_i \times Post2016_t + \\ & \beta_2 \times Banned\, export\, share_i \times \Delta NonRu\, export\, change_i \times Post2016_t + \gamma_i + \tau_t + \epsilon_{i,t}\end{aligned} \tag{28}$$

In this specification, $\Delta NonRu\, export\, change_i$ refers to the difference in the change of exports outside of Russia between 2013 and 2014, where the difference is taken between the values of a treated firm i and its matched control firm. All other variables are defined as in specifications (1) and (2).

We report the results in Table 7, where we show that the adjustment in full-time employees over 2016-2017 was smaller for firms that had a larger increase in exports outside of Russia between 2013 and 2014, as compared to the respective change in the control firms.

These results are well aligned with the mechanisms in Section 4. When the shock turns out to be severe in terms of its persistence and expected cumulative effect, firms lay off full-time labor. However, those firms that managed to increase the reach of export markets outside of Russia reduced full-time employment less. This suggests another policy implication: trade deregulation and the infrastructure to direct more products to existing and new foreign markets can help absorb trade shocks.

Table 7: Interaction with the change in exports outside of Russia

	(1) Full-time employees
Banned export share x Post 2014	-128.022
	(163.557)
Banned export share x Post 2016	-546.798**
	(261.905)
Banned export share x Delta Non-Ru Exports (2013-2014) x Post 2016	25.454*
	(13.311)
Delta Non-Ru Exports (2013-2014) x Post 2016	-0.951
	(1.053)
Constant	142.975***
	(16.655)
R^2	0.958
N	149

Notes: This table shows the effect of the Russian ban on the number of employees in Lithuanian food manufacturing firms over 2011-2017. For each *treated* firm that has exported any banned products to Russia in 2013, we assign one *control* firm that is a food exporter, and is closest in size (as measured by total sales). The dependent variable is the difference in the number of full-time employees between the treated and control firms. ***, **, and * refer to the statistical significance at 1%, 5%, and 10%, respectively.

7 Conclusions

We investigate how firms in a small open economy adjust to a sudden, unanticipated, and permanent negative demand shock coming from the economic sanctions. We explore a unique event when, due to political reasons, unrelated to trade, the exporters lost access to a major export market. In particular, we look at an abrupt negative trade shock to the food production sector in Lithuania in 2014 after the Russian sanctions on imports from Europe, the US, and some other countries. We use a rich firm-level dataset, which covers all exporters in the country and which allows us to comprehensively quantify the adjustment margins.

We look at the sample of all Lithuanian firms over 2011-2017, and first show that indeed the exports to Russia and consequently the total revenues dropped after 2013 for those food manufacturers that had substantial exports to Russia prior to the trade ban. We then estimate reduced form difference-in-differences estimation, comparing the adjustments of the affected versus unaffected food exporters. We find that part-time employment drops first and we see further adjustments in full-time employment, capital investment, and the expansion to markets outside of Russia. This suggests that if flexible adjustment margins are limited, food manufacturers might embark on finding new markets.

Based on these observations, we sketch a theoretical framework which explicitly considers an important adjustment margin, the employment of part-time workers. We show that part-time employment, as the most flexible margin, adjusts first. The further adjustments depend on the size of the shock and the expectations of persistence. In case of a larger shock, the full-time employment and capital also adjust. Moreover, if the shock is large enough that flexible adjustment margins are exhausted, the firms might revert to revenue-increasing strategies.

This conceptual set-up suggests additional theoretical predictions that we confirm in the data. Indeed, we see that food manufacturing firms which were quick to reduce part-time employees first, also reduced their full-time employees later on and dropped investment.

Understanding the full scale of adjustments that are implemented in response to cleanly identified exposure to the economic sanctions can guide economic policy makers in deciding what alterations to policy making should be done on their behalf. This is particularly important because any adjustment is likely to result in aggregate economic effects and might even generate feedback loops with further uncertainty.

Our results thus contribute to the literature on the most efficient ways to react to such shocks, which may have implications for labor and trade market reforms. For instance, at times of global uncertainty, more flexible work contracts could help absorb unexpected demand shocks. Such contracts could also allow firms to be more confident in their ex ante hiring decisions. Ensuring access to wide exports markets could also mitigate the risks that result from the unexpected loss of a large trade partner.

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A Appendix: Derivations

A.1 Demand Derivation

$$\max\left[\int_{j\in J} q_t(j)^{\frac{\sigma-1}{\sigma}}\,dj\right]^{\frac{\sigma}{\sigma-1}}, s.t. \int_{j\in J} p_t(j)\,q_t(j) = E_t = P_t Q_t.$$

The first order conditions (FOCs), after setting a Lagrangian, are

$$\frac{\sigma}{\sigma-1}\left[\int_{j\in J} q_t(j)^{\frac{\sigma-1}{\sigma}}\,dj\right]^{\frac{\sigma}{\sigma-1}-1}\frac{\sigma-1}{\sigma}q_t(j)^{\frac{\sigma-1}{\sigma}-1} - \lambda p_t(j) = 0$$
$$Q_t^{\frac{1}{\sigma}} q_t(j)^{-\frac{1}{\sigma}} - \lambda p_t(j) = 0$$
$$Q_t^{\frac{1}{\sigma}} q_t(j')^{-\frac{1}{\sigma}} - \lambda p_t(j') = 0$$

So, $\begin{array}{c} Q_t^{\frac{1}{\sigma}} q_t(j)^{-\frac{1}{\sigma}} = \lambda p_t(j) \\ Q_t^{\frac{1}{\sigma}} q_t(j')^{-\frac{1}{\sigma}} = \lambda p_t(j') \end{array}$ or $q_t(j)^{-\frac{1}{\sigma}} = \frac{p_t(j)}{p_t(j')} q_t(j')^{-\frac{1}{\sigma}}$. It follows that

$$\int_{j\in J} q_t(j)^{-\frac{1}{\sigma}} p_t(j')\,q_t(j')^{\frac{1}{\sigma}} q_t(j)\,dj = p_t(j')\,q_t(j')^{\frac{1}{\sigma}} \int_{j\in J} q_t(j)^{\frac{\sigma-1}{\sigma}}\,dj$$
$$= p_t(j')\,q_t(j')^{\frac{1}{\sigma}} Q_t^{\frac{\sigma-1}{\sigma}} = P_t Q_t$$

and $q_t(j)^{\frac{1}{\sigma}} = p_t(j)^{-1} P_t Q_t^{\frac{1}{\sigma}}$ or $q_t(j) = p_t(j)^{-\sigma} P_t^{\sigma} Q_t$. An inverse demand function follows immediately:

$$p_t(j) = A_t\,(q_t(j))^{-\frac{1}{\sigma}}.$$

A.2 Extension to Multiple Countries

For the two foreign countries, the additivity is useful when it comes to expressing a total quantity for an exporter as:

$$q_t(j) \equiv q_t^{d}(j) + q_t^{RU}(j) + q_t^{RW}(j)$$
$$= (p_t(j))^{-\sigma} A_t^{\sigma}\left[1 + \left(\frac{A^{\star}_{RU,t}}{A_t}\right)^{\sigma} \tau_{RU,t}^{1-\sigma}(j) + s^{x}_{RW,t}(j)\left(\frac{A^{\star}_{RW,t}}{A_t}\right)^{\sigma} \tau_{RW,t}^{1-\sigma}(j)\right]$$

and inverse demand

$$p_t(j) = (q_t(j))^{-\frac{1}{\sigma}} A_t \left(1 + \left(\frac{A^{\star}_{RU,t}}{A_t}\right)^{\sigma} \tau^{1-\sigma}_{RU,t}(j) + s^{x}_{RW,t}(j) \left(\frac{A^{\star}_{RW,t}}{A_t}\right)^{\sigma} \tau^{1-\sigma}_{RW,t}(j)\right)^{\frac{1}{\sigma}}$$
$$= (q_t(j))^{-\frac{1}{\sigma}} A_t \Upsilon_t(j)^{\frac{1}{\sigma}},$$

thereby yielding

$$r_t(j) \equiv p_t(j)\, q^{d}_t(j) + p_t(j)\, q^{RU}_t(j) + p_t(j)\, q^{RW}_t(j) = p_t(j)\, q^{d}_t(j) \left[1 + \frac{q^{RU}_t(j)}{q^{d}_t(j)} + \frac{q^{RW}_t(j)}{q^{d}_t(j)}\right]$$
$$= (p_t(j))^{1-\sigma} A^{\sigma}_t \left[1 + \left(\frac{A^{\star}_{RU,t}}{A_t}\right)^{\sigma} \tau^{1-\sigma}_{RU,t}(j) + s^{x}_{RW,t}(j) \left(\frac{A^{\star}_{RW,t}}{A_t}\right)^{\sigma} \tau^{1-\sigma}_{RW,t}(j)\right]$$
$$= (q_t(j))^{\frac{\sigma-1}{\sigma}} A_t \left[1 + \left(\frac{A^{\star}_{RU,t}}{A_t}\right)^{\sigma} \tau^{1-\sigma}_{RU,t}(j) + s^{x}_{RW,t}(j) \left(\frac{A^{\star}_{RW,t}}{A_t}\right)^{\sigma} \tau^{1-\sigma}_{RW,t}(j)\right]^{\frac{1}{\sigma}}.$$

We will denote a share of export revenues (an intensive margin) as

$$\mathcal{S}^{RU}_t(j) = \frac{r^{RU}_t(j)}{r^{d}_t(j)+r^{RU}_t(j)+r^{RW}_t(j)} = \frac{\tau_{RU,t}(j)\left(\frac{A^{\star}_{RU,t}}{\tau_{RU,t}(j)}\right)^{\sigma} p^{1-\sigma}_t(j)}{(q_t(j))^{\frac{\sigma-1}{\sigma}} A_t \left[1+\left(\frac{A^{\star}_{RU,t}}{A_t}\right)^{\sigma} \tau^{1-\sigma}_{RU,t}(j)+s^{x}_{RW,t}(j)\left(\frac{A^{\star}_{RW,t}}{A_t}\right)^{\sigma} \tau^{1-\sigma}_{RW,t}(j)\right]^{\frac{1}{\sigma}}}$$
$$= \frac{\tau_{RU,t}(j)\left(\frac{A^{\star}_{RU,t}}{\tau_{RU,t}(j)}\right)^{\sigma} (q_t(j))^{-\frac{1-\sigma}{\sigma}} A^{1-\sigma}_t \Upsilon_t(j)^{\frac{1-\sigma}{\sigma}}}{(q_t(j))^{\frac{\sigma-1}{\sigma}} A_t \Upsilon_t(j)^{\frac{1}{\sigma}}} = \frac{\tau_{RU,t}(j)\left(\frac{A^{\star}_{RU,t}}{\tau_{RU,t}(j)}\right)^{\sigma} A^{-\sigma}_t}{\Upsilon_t(j)}$$
$$= \frac{\Upsilon_t(j)-1-s^{x}_{RW,t}(j)\tau^{1-\sigma}_{RW,t}(j)\left(\frac{A^{\star}_{RW,t}}{A_t}\right)^{\sigma}}{\Upsilon_t(j)} = \frac{\Upsilon_t(j)-1}{\Upsilon_t(j)} - \frac{s^{x}_{RW,t}(j)\tau^{1-\sigma}_{RW,t}(j)\left(\frac{A^{\star}_{RW,t}}{A_t}\right)^{\sigma}}{\Upsilon_t(j)}$$

and

$$\mathcal{S}^{RW}_t(j) = \frac{r^{RW}_t(j)}{r^{d}_t(j)+r^{RU}_t(j)+r^{RW}_t(j)} = \frac{s^{x}_{RW,t}(j)\tau_{RW,t}(j)\left(\frac{A^{\star}_{RW,t}}{\tau_{RW,t}(j)}\right)^{\sigma} p^{1-\sigma}_t(j)}{(q_t(j))^{\frac{\sigma-1}{\sigma}} A_t \left[1+\left(\frac{A^{\star}_{RU,t}}{A_t}\right)^{\sigma} \tau^{1-\sigma}_{RU,t}(j)+s^{x}_{RW,t}(j)\left(\frac{A^{\star}_{RW,t}}{A_t}\right)^{\sigma} \tau^{1-\sigma}_{RW,t}(j)\right]^{\frac{1}{\sigma}}}$$
$$= \frac{s^{x}_{RW,t}(j)\tau_{RW,t}(j)\left(\frac{A^{\star}_{RW,t}}{\tau_{RW,t}(j)}\right)^{\sigma} (q_t(j))^{-\frac{1-\sigma}{\sigma}} A^{1-\sigma}_t \Upsilon_t(j)^{\frac{1-\sigma}{\sigma}}}{(q_t(j))^{\frac{\sigma-1}{\sigma}} A_t \Upsilon_t(j)^{\frac{1}{\sigma}}} = \frac{s^{x}_{RW,t}(j)\tau_{RW,t}(j)\left(\frac{A^{\star}_{RW,t}}{\tau_{RW,t}(j)}\right)^{\sigma} A^{-\sigma}_t}{\Upsilon_t(j)}$$
$$= \frac{\Upsilon_t(j)-1-\tau^{1-\sigma}_{RU,t}(j)\left(\frac{A^{\star}_{RU,t}}{A_t}\right)^{\sigma}}{\Upsilon_t(j)} = \frac{\Upsilon_t(j)-1}{\Upsilon_t(j)} - \frac{\tau^{1-\sigma}_{RU,t}(j)\left(\frac{A^{\star}_{RU,t}}{A_t}\right)^{\sigma}}{\Upsilon_t(j)}.$$

It is clear that when $\tau_{RU,t}(j) \to \infty$, $\mathcal{S}^{RU}_t(j) \to 0$ and $\mathcal{S}^{RW}_t(j) \to \frac{\Upsilon_t(j)-1}{\Upsilon_t(j)}$, thereby replicating a two-country world, as in Helpman et al. (2010) (see their footnote 15).

A.3 Optimal Choices

Setting up a Lagrangian in a perfect foresight environment with firm symmetry (to save on notation for each firm j) yields:

$$
\begin{aligned}
\mathcal{L} = \textstyle\sum_{s=t}^{+\infty} \rho^{s} \Bigg\{ & \left[1 + \tau_{RU,s}^{1-\sigma} \left(\tfrac{A_{RU,s}^{\star}}{A_s}\right)^{\sigma} + s_{RW,s}^{x} \tau_{RW,s}^{1-\sigma} \left(\tfrac{A_{RW,s}^{\star}}{A_s}\right)^{\sigma}\right]^{\frac{1}{\sigma}} \times \\
& A_s \left(\left(\psi K_s^{\gamma} + (1-\psi)\left(L_s^F\right)^{\gamma}\right)^{\frac{\phi}{\gamma}} \left(L_s^P\right)^{1-\phi} \right)^{\frac{\sigma-1}{\sigma}} \\
& - w_s^F L_s^F - w_s^P L_s^P - I_s - h H_s^F \mathbb{I}_{\triangle L_s^F > 0} \\
& + f H_s^F \mathbb{I}_{\triangle L_s^F < 0} - s_{RW,s}^{x} f_x \\
& + \mathsf{q}_s \left(I_s + (1-\delta) K_s - K_{s+1}\right) \\
& + \mu_s \left(H_s^F + L_s^F - L_{s+1}^F\right) \Bigg\}.
\end{aligned}
$$

The optimality conditions read as follows:

$$
\frac{\partial \mathcal{L}}{\partial L_{t+1}^F} = 0 \Rightarrow -\rho^{t+1} w_{t+1}^F - \rho^t \mu_t + \rho^{t+1}\mu_{t+1} + \rho^{t+1} \Upsilon_{t+1}^{\frac{1}{\sigma}} A_{t+1} \left(\frac{\sigma-1}{\sigma}\right) q_{t+1}^{-\frac{1}{\sigma}} \frac{\partial q_{t+1}}{\partial L_{t+1}^F}
$$

$$
\mu_t = \rho \left(\Upsilon_{t+1}^{\frac{1}{\sigma}} A_{t+1} \left(\frac{\sigma-1}{\sigma}\right) q_{t+1}^{-\frac{1}{\sigma}} \frac{\partial q_{t+1}}{\partial L_{t+1}^F} - w_{t+1}^F + \mu_{t+1} \right) \tag{29}
$$

$$
\mu_t = \rho \left(\Upsilon_{t+1}^{\frac{1}{\sigma}} A_{t+1} \left(\frac{\sigma-1}{\sigma}\right) q_{t+1}^{\frac{\sigma-1}{\sigma}} (1-\psi)\phi \left(L_{t+1}^F\right)^{\gamma-1} \left(\psi K_{t+1}^{\gamma} + (1-\psi)\left(L_{t+1}^F\right)^{\gamma}\right)^{-1} \right. \tag{30}
$$

$$
\left. - w_{t+1}^F + \mu_{t+1} \right) \tag{31}
$$

$$
\mu_t = \rho \left(\Upsilon_{t+1}^{\frac{1}{\sigma}} A_{t+1} \left(\frac{\sigma-1}{\sigma}\right) q_{t+1}^{\frac{\sigma-1}{\sigma}} (1-\psi)\phi \left(L_{t+1}^F\right)^{\gamma-1} \left(\Phi_{t+1}^{\gamma}\right)^{-1} - w_{t+1}^F + \mu_{t+1} \right) \tag{32}
$$

$$
\frac{\partial \mathcal{L}}{\partial H_t^F} = 0 \Rightarrow h \mathbb{I}_{H_t^F > 0} - f \mathbb{I}_{H_t^F < 0} = \mu_t, \tag{33}
$$

$$
\frac{\partial \mathcal{L}}{\partial L_{it}^P} = 0 \Rightarrow w_t^P = \Upsilon_t^{\frac{1}{\sigma}} A_t \left(\frac{\sigma-1}{\sigma}\right) q_t^{-\frac{1}{\sigma}} \frac{\partial q_t}{\partial L_t^P}, \tag{34}
$$

$$\frac{\partial \mathcal{L}}{\partial K_{t+1}} = 0 \Rightarrow \mathsf{q}_{t+1}(1-\delta)\rho^{t+1} - \rho^t \mathsf{q}_t \tag{35}$$

$$+ \rho^{t+1}\Upsilon_{t+1}^{\frac{1}{\sigma}} A_{t+1}\left(\frac{\sigma-1}{\sigma}\right) q_{t+1}^{-\frac{1}{\sigma}} \frac{\partial q_{t+1}}{\partial K_{t+1}} = 0,$$

$$\frac{1}{\rho}\mathsf{q}_t = \Upsilon_{t+1}^{\frac{1}{\sigma}} A_{t+1}\left(\frac{\sigma-1}{\sigma}\right) q_{t+1}^{-\frac{1}{\sigma}} \frac{\partial q_{t+1}}{\partial K_{t+1}} + \mathsf{q}_{t+1}(1-\delta), \tag{36}$$

$$\frac{\partial \mathcal{L}}{\partial s^x_{RW,t}} = 0 \Rightarrow \frac{1}{\sigma}\left[1 + \tau_{RU,t}^{1-\sigma}\left(\frac{A^\star_{RU,t}}{A_t}\right)^{\sigma} + s^x_{RW,t}\tau_{RW,t}^{1-\sigma}\left(\frac{A^\star_{RW,t}}{A_t}\right)^{\sigma}\right]^{\frac{1-\sigma}{\sigma}} \tau_{RW,t}^{1-\sigma}\left(\frac{A^\star_{RW,t}}{A_t}\right)^{\sigma} A_t q_t^{\frac{\sigma-1}{\sigma}} = f_x, \tag{37}$$

$$\sigma^{-\frac{1}{\sigma-1}}\Upsilon_t^{-\frac{1}{\sigma}}\left(s^x_{RW,t};\tau_{RU,t},\tau_{RW,t}\right)\tau_{RW,t}^{-1}\left(\frac{A^\star_{RW,t}}{A_t}\right)^{\frac{\sigma}{\sigma-1}} A_t^{\frac{1}{\sigma-1}} q_t^{\frac{1}{\sigma}} = f_x^{\frac{1}{\sigma-1}} \tag{38}$$

$$q_t^{\frac{1}{\sigma}} = \frac{\tau_{RW,t}A_t\left(A^\star_{RW,t}\right)^{\frac{\sigma}{1-\sigma}}}{\sigma^{\frac{1}{1-\sigma}} f_x^{\frac{1}{1-\sigma}}}\Upsilon_t^{\frac{1}{\sigma}}\left(s^x_{RW,t};\tau_{RU,t},\tau_{RW,t}\right), \tag{39}$$

$$\frac{\partial \mathcal{L}}{\partial I_t} = 0 \Rightarrow \mathsf{q}_t = 1, \tag{40}$$

$$\frac{1-\rho+\delta\rho}{\rho} = \Upsilon_{t+1}^{\frac{1}{\sigma}} A_{t+1}\left(\frac{\sigma-1}{\sigma}\right) q_{t+1}^{-\frac{1}{\sigma}} \frac{\partial q_{t+1}}{\partial K_{t+1}} \tag{41}$$

$$= \Upsilon_{t+1}^{\frac{1}{\sigma}} A_{t+1}\left(\frac{\sigma-1}{\sigma}\right) q_{t+1}^{\frac{\sigma-1}{\sigma}} \phi\psi K_{t+1}^{\gamma-1}\left(\psi K_{t+1}^{\gamma} + (1-\psi)\left(L^F_{t+1}\right)^{\gamma}\right)^{-1} \tag{42}$$

$$= \Upsilon_{t+1}(\sigma-1)\tau_{RW,t+1}^{\sigma-1}\left(\frac{A_{t+1}}{A^\star_{RW,t+1}}\right)^{\sigma} f_x\phi\psi K_{t+1}^{\gamma-1}\left(\Phi_{t+1}^{\gamma}\right)^{-1} = \frac{1-\rho+\delta\rho}{\rho}. \tag{43}$$

Notice that output can be split into flexible and non-flexible parts, $q_t = \Phi_t^{\phi}\left(L_t^P\right)^{1-\phi}$, where the non-flexible part of production is summarized by $\Phi_t^{\gamma} \equiv \left(\psi K_t^{\gamma} + (1-\psi)\left(L_t^F\right)^{\gamma}\right)$. In the main text, we consider a special case when γ approaches zero, the elasticity of substitution becomes unitary, and the production function becomes (7).

Not that next period's capital requires adjusting investment in the current period, whereas full-time labor entails hiring and firing costs on top of temporal rigidities (a firm cannot hire or fire full-time employees contemporaneously).

A.4 Implications

A.4.1 Intensive Margin of Trade

We can use the trade share choice (39) in combination with the part-time employment expression (34) to pin down the relationship between openness and firm adjustment in the face of a shock. From (39) , we have:

$$q_t = \frac{\tau_{RW,t}^{\sigma} A_t^{\sigma} \left(A_{RW,t}^{\star}\right)^{\frac{\sigma}{1-\sigma}\sigma}}{\sigma^{\frac{\sigma}{1-\sigma}} f_x^{\frac{\sigma}{1-\sigma}}} \Upsilon_t,$$

and equating to (34), we obtain

$$\Upsilon_t^{\frac{1}{1-\sigma}\frac{\sigma-1}{\sigma}} A_t^{\frac{\sigma}{1-\sigma}\frac{\sigma-1}{\sigma}} \left(\frac{\sigma-1}{\sigma}\right)^{\frac{\sigma}{1-\sigma}\frac{\sigma-1}{\sigma}} \left(\frac{w^P L_t^P}{1-\phi}\right)^{\frac{\sigma}{\sigma-1}\frac{\sigma-1}{\sigma}}$$
$$= \frac{\tau_{RW,t}^{\sigma\frac{\sigma-1}{\sigma}} A_t^{\sigma\frac{\sigma-1}{\sigma}} \left(A_{RW,t}^{\star}\right)^{\frac{\sigma}{1-\sigma}\sigma\frac{\sigma-1}{\sigma}}}{\sigma^{\frac{\sigma}{1-\sigma}\frac{\sigma-1}{\sigma}} f_x^{\frac{\sigma}{1-\sigma}\frac{\sigma-1}{\sigma}}} \Upsilon_t^{\frac{\sigma-1}{\sigma}}.$$

We can therefore express intensive margin as:

$$\Upsilon_t = \left(\frac{w^P L_t^P}{1-\phi}\right) (\sigma-1)^{-1} \tau_{RW,t}^{1-\sigma} \left(\frac{A_{RW,t}^{\star}}{A_t}\right)^{\sigma} f_x^{-1}.$$

It is clearly determined by the part-time labor, which acts as a choice variable in the face of an exogenous shock to trade to Russia. To see the full effect, notice that

$$\frac{\partial \Upsilon_t}{\partial L_t^P} = \left(\frac{w^P}{1-\phi}\right) (\sigma-1)^{-1} \tau_{RW,t}^{1-\sigma} \left(\frac{A_{RW,t}^{\star}}{A_t}\right)^{\sigma} f_x^{-1}$$

and

$$\frac{\partial \Upsilon_t}{\partial \tau_{RU,t}(j)} = (1-\sigma)\, \tau_{RU,t}^{-\sigma}(j) \left(\frac{A_{RU,t}^{\star}}{A_t}\right)^{\sigma} < 0,$$

thereby yielding

$$\frac{\frac{\partial \Upsilon_t}{\partial \tau_{RU,t}(j)}}{\frac{\partial \Upsilon_t}{\partial L_t^P}} = \frac{\partial L_t^P}{\partial \tau_{RU,t}(j)} = \frac{(\sigma-1)(1-\sigma)\, \tau_{RU,t}^{-\sigma}(j)\, f_x}{\left(\frac{w^P}{1-\phi}\right) \tau_{RW,t}^{1-\sigma}} \left(\frac{A_{RU,t}^{\star}}{A_{RW,t}^{\star}}\right)^{\sigma} < 0,$$

as reported in the main text.

A.4.2 Revenue Share

Making use of the revenue share function, we get:

$$\mathcal{S}_t^{RW}(j) = \frac{r_t^{RW}(j)}{r_t^d(j) + r_t^{RU}(j) + r_t^{RW}(j)} = \frac{\Upsilon_t(j) - 1}{\Upsilon_t(j)} - \frac{\tau_{RU,t}^{1-\sigma}(j)\left(\frac{A_{RU,t}^{\star}}{A_t}\right)^{\sigma}}{\Upsilon_t(j)}.$$

It then follows that

$$\begin{aligned}
\frac{\partial \mathcal{S}_t^{RW}(j)}{\partial \tau_{RU,t}(j)} &= \frac{\frac{\partial \Upsilon_t(j)}{\partial \tau_{RU,t}(j)}\Upsilon_t(j) - \frac{\partial \Upsilon_t(j)}{\partial \tau_{RU,t}(j)}(\Upsilon_t(j)-1)}{(\Upsilon_t(j))^2} - \left[\frac{(1-\sigma)\tau_{RU,t}^{-\sigma}(j)\left(\frac{A_{RU,t}^{\star}}{A_t}\right)^{\sigma}\Upsilon_t(j) - \frac{\partial \Upsilon_t(j)}{\partial \tau_{RU,t}(j)}\tau_{RU,t}^{1-\sigma}(j)\left(\frac{A_{RU,t}^{\star}}{A_t}\right)^{\sigma}}{(\Upsilon_t(j))^2}\right] \\
&= \frac{\frac{\partial \Upsilon_t(j)}{\partial \tau_{RU,t}(j)}}{(\Upsilon_t(j))^2} - \left[\frac{(1-\sigma)\tau_{RU,t}^{-\sigma}(j)\Upsilon_t(j) - \frac{\partial \Upsilon_t(j)}{\partial \tau_{RU,t}(j)}\tau_{RU,t}^{1-\sigma}(j)}{(\Upsilon_t(j))^2}\right]\left(\frac{A_{RU,t}^{\star}}{A_t}\right)^{\sigma} \\
&= \frac{1}{(\Upsilon_t(j))^2}\left[\frac{\partial \Upsilon_t(j)}{\partial \tau_{RU,t}(j)} - (1-\sigma)\tau_{RU,t}^{-\sigma}(j)\,\Upsilon_t(j)\left(\frac{A_{RU,t}^{\star}}{A_t}\right)^{\sigma} + \frac{\partial \Upsilon_t(j)}{\partial \tau_{RU,t}(j)}\tau_{RU,t}^{1-\sigma}(j)\left(\frac{A_{RU,t}^{\star}}{A_t}\right)^{\sigma}\right] \\
&= \frac{1}{(\Upsilon_t(j))^2}\frac{\partial \Upsilon_t(j)}{\partial \tau_{RU,t}(j)}\left[1 - (1-\sigma)\tau_{RU,t}^{-\sigma}(j)\,\Upsilon_t(j)\left(\frac{A_{RU,t}^{\star}}{A_t}\right)^{\sigma}\left(\frac{\partial \Upsilon_t(j)}{\partial \tau_{RU,t}(j)}\right)^{-1} + \tau_{RU,t}^{1-\sigma}(j)\left(\frac{A_{RU,t}^{\star}}{A_t}\right)^{\sigma}\right].
\end{aligned}$$

Recall that

$$\frac{\partial \Upsilon_t}{\partial \tau_{RU,t}(j)} = (1-\sigma)\,\tau_{RU,t}^{-\sigma}(j)\left(\frac{A_{RU,t}^{\star}}{A_t}\right)^{\sigma},$$

therefore,

$$\frac{\partial \mathcal{S}_t^{RW}(j)}{\partial \tau_{RU,t}(j)} = \frac{1}{(\Upsilon_t(j))^2}\frac{\partial \Upsilon_t(j)}{\partial \tau_{RU,t}(j)}\left[1 - \Upsilon_t(j) + \tau_{RU,t}^{1-\sigma}(j)\left(\frac{A_{RU,t}^{\star}}{A_t}\right)^{\sigma}\right].$$

From the definition of the revenue share:

$$-\mathcal{S}_t^{RW}(j)\,\Upsilon_t(j) = 1 - \Upsilon_t(j) + \tau_{RU,t}^{1-\sigma}(j)\left(\frac{A_{RU,t}^{\star}}{A_t}\right)^{\sigma},$$

we obtain

$$\frac{\partial \mathcal{S}_t^{RW}(j)}{\partial \tau_{RU,t}(j)} = -\frac{\mathcal{S}_t^{RW}(j)}{\Upsilon_t(j)}\frac{\partial \Upsilon_t(j)}{\partial \tau_{RU,t}(j)}$$

or

$$\frac{\partial \mathcal{S}_t^{RW}(j)}{\partial \tau_{RU,t}(j)}\frac{\tau_{RU,t}(j)}{\mathcal{S}_t^{RW}(j)} = -\frac{\partial \Upsilon_t(j)\Upsilon_t(j)}{\partial \tau_{RU,t}(j)\tau_{RU,t}(j)},$$

just as stated in Proposition 2.

For completeness, note that the openness margin can be expressed as:

$$\frac{\partial \Upsilon_t}{\partial \tau_{RU,t}(j)} \frac{\tau_{RU,t}(j)}{\Upsilon_t(j)} = \frac{(1-\sigma)\tau_{RU,t}^{1-\sigma}(j)\left(\frac{A_{RU,t}^{\star}}{A_t}\right)^{\sigma}}{\Upsilon_t(j)} = \frac{(1-\sigma)\tau_{RU,t}^{1-\sigma}(j)\left(\frac{A_{RU,t}^{\star}}{A_t}\right)^{\sigma}}{\left(\frac{w^P L_t^P}{1-\phi}\right)(\sigma-1)^{-1}\tau_{RW,t}^{1-\sigma}\left(\frac{A_{RW,t}^{\star}}{A_t}\right)^{\sigma} f_x^{-1}}$$
$$= -\frac{(\sigma-1)^2}{\left(\frac{w^P L_t^P}{1-\phi}\right)} \left(\frac{\tau_{RU,t}(j)}{\tau_{RW,t}}\right)^{1-\sigma} \left(\frac{A_{RU,t}^{\star}}{A_{RW,t}^{\star}}\right)^{\sigma} f_x.$$

Making use of

$$\frac{\partial L_t^P}{\partial \tau_{RU,t}(j)} \frac{\tau_{RU,t}(j)}{L_t^P} = \frac{(\sigma-1)(1-\sigma)}{\left(\frac{w^P L_t^P}{1-\phi}\right)} \left(\frac{\tau_{RU,t}(j)}{\tau_{RW,t}}\right)^{1-\sigma} \left(\frac{A_{RU,t}^{\star}}{A_{RW,t}^{\star}}\right)^{\sigma} f_x,$$

we obtain

$$\frac{\partial \Upsilon_t}{\partial \tau_{RU,t}(j)} \frac{\tau_{RU,t}(j)}{\Upsilon_t(j)} = -\frac{(\sigma-1)^2}{\left(\frac{w^P L_t^P}{1-\phi}\right)} \left(\frac{\tau_{RU,t}(j)}{\tau_{RW,t}}\right)^{1-\sigma} \left(\frac{A_{RU,t}^{\star}}{A_{RW,t}^{\star}}\right)^{\sigma} f_x = \frac{\partial L_t^P}{\partial \tau_{RU,t}(j)} \frac{\tau_{RU,t}(j)}{L_t^P}.$$

Therefore, this analysis justifies the use of part-time employment as a proxy for the trade shock hit by the firm.

A.4.3 Large Shock and Full-time Labor

To shed light on key drivers of full-time labor layoffs, we focus on a closed-form solution for the production function (7), as reported in the main text. The following expression for the next period's (lower) level of full-time labor emerges:

$$\left(L_{t+1}^{F-}(j)\right)^{(1-\psi)\phi\frac{\sigma-1}{\sigma}-1} = \frac{\left(-\frac{1}{\rho}f + (1-p(j))f + w_{t+1}^F\right)(\sigma-1)^{\frac{1}{\sigma}} f_x^{\frac{1}{\sigma}} \tau_{RW,t+1}^{\frac{\sigma-1}{\sigma}}}{A_{RW,t+1}^{\star}\left(\frac{\sigma-1}{\sigma}\right)\left(L_{t+1}^P(j)\right)^{(1-\phi)\frac{\sigma-1}{\sigma}+\frac{1}{\sigma}}\left(\frac{w^P}{1-\phi}\right)^{\frac{1}{\sigma}} K_{t+1}(j)^{\psi\phi\frac{\sigma-1}{\sigma}}(1-\psi)\phi}.$$

To derive this result, we combine equations (29) and (33) and obtain:

$$-f = \rho\left(\Upsilon_{t+1}^{\frac{1}{\sigma}} A_{t+1}\left(\frac{\sigma-1}{\sigma}\right) \underline{q}_{t+1}^{-\frac{1}{\sigma}} \frac{\partial \underline{q}_{t+1}}{\partial L_{t+1}^F} - w_{t+1}^F - (1-p)f + ph\right), \tag{44}$$

where $\underline{q}_{t+1} \equiv q\left(L_{t+1}^{F-}, L_{t+1}^P\right)$ denotes *reduced* employment levels (thereby implying a negative H_t^F). This means that firing is optimal rather than waiting. That coincides with our definition of a large shock, i.e., a situation when the trade disruption is so large that paying firing costs is preferred.[19] In a good state:

$$h=\rho\left(\Upsilon_{t+1}^{\frac{1}{\sigma}}A_{t+1}\left(\frac{\sigma-1}{\sigma}\right)\bar{q}_{t+1}^{-\frac{1}{\sigma}}\frac{\partial\bar{q}_{t+1}}{\partial L_{t+1}^{F}}-w_{t+1}^{F}-pf+(1-p)\,h\right), \tag{45}$$

where $\bar{q}_{t+1}\equiv q\left(L_{t+1}^{F+},L_{t+1}^{P}\right)$ denotes *increased* employment levels (implying positive H_t^F). These two equations deliver the following result:

$$\begin{aligned}-\tfrac{1}{\rho}f+(1-p(j))\,f+w_{t+1}^{F}-p(j)\,h&=\Upsilon_{t+1}^{\frac{1}{\sigma}}A_{t+1}\left(\tfrac{\sigma-1}{\sigma}\right)\underline{q}_{t+1}^{-\frac{1}{\sigma}}\tfrac{\partial\underline{q}_{t+1}}{\partial L_{t+1}^{F}}\\ \tfrac{1}{\rho}h-(1-p(j))\,h+w_{t+1}^{F}+p(j)\,f&=\Upsilon_{t+1}^{\frac{1}{\sigma}}A_{t+1}\left(\tfrac{\sigma-1}{\sigma}\right)\bar{q}_{t+1}^{-\frac{1}{\sigma}}\tfrac{\partial\bar{q}_{t+1}}{\partial L_{t+1}^{F}}.\end{aligned}$$

Since we are dealing with a negative shock, we normalize $h=0$ to simplify expressions (we are not concern with costly hiring decisions). We can summarize the new level of full-time employment under the large sanctions shock as follows:

$$\begin{aligned}-\tfrac{1}{\rho}f+(1-p(j))\,f+w_{t+1}^{F}&=\Upsilon_{t+1}^{\frac{1}{\sigma}}A_{t+1}\left(\tfrac{\sigma-1}{\sigma}\right)\underline{q}_{t+1}^{\frac{\sigma-1}{\sigma}}(1-\psi)\,\phi\left(L_{t+1}^{F-}\right)^{\gamma-1}\Phi_{t+1}^{-\gamma}\\ w_{t+1}^{F}+p(j)\,f&=\Upsilon_{t+1}^{\frac{1}{\sigma}}A_{t+1}\left(\tfrac{\sigma-1}{\sigma}\right)\bar{q}_{t+1}^{\frac{\sigma-1}{\sigma}}(1-\psi)\,\phi\left(L_{t+1}^{F+}\right)^{\gamma-1}\Phi_{t+1}^{\gamma}.\end{aligned}$$

or

$$\begin{aligned}-\tfrac{1}{\rho}f+(1-p(j))\,f+w_{t+1}^{F}&=\Upsilon_{t+1}^{\frac{1}{\sigma}}A_{t+1}\left(\tfrac{\sigma-1}{\sigma}\right)\Phi_{t+1}^{\phi\frac{\sigma-1}{\sigma}}\left(L_{t+1}^{P}\right)^{(1-\phi)\frac{\sigma-1}{\sigma}}(1-\psi)\,\phi\left(L_{t+1}^{F-}\right)^{\gamma-1}\Phi_{t+1}^{-\gamma}\\ w_{t+1}^{F}+p(j)\,f&=\Upsilon_{t+1}^{\frac{1}{\sigma}}A_{t+1}\left(\tfrac{\sigma-1}{\sigma}\right)\bar{q}_{t+1}^{\frac{\sigma-1}{\sigma}}(1-\psi)\,\phi\left(L_{t+1}^{F+}\right)^{\gamma-1}\Phi_{t+1}^{\gamma}.\end{aligned}$$

To follow the steps, we collect required elements:

$$\begin{aligned}q_t(j)&=\left(K_t(j)^{\psi}\left(L_t^F(j)\right)^{1-\psi}\right)^{\phi}\left(L_t^P(j)\right)^{1-\phi}\\ \frac{\partial\underline{q}_{t+1}}{\partial L_{t+1}^{F}}&=(1-\psi)\,\phi K_{t+1}(j)^{\psi\phi}\left(L_{t+1}^{F-}(j)\right)^{(1-\psi)\phi-1}\left(L_{t+1}^{P}(j)\right)^{1-\phi}\\ \underline{q}_{t+1}^{-\frac{1}{\sigma}}&=K_{t+1}(j)^{-\frac{\phi}{\sigma}\psi}\left(L_{t+1}^{F-}(j)\right)^{-\frac{\phi}{\sigma}(1-\psi)}\left(L_{t+1}^{P}(j)\right)^{-\frac{(1-\phi)}{\sigma}}\end{aligned}$$

Hence,

$$\begin{aligned}&-\tfrac{1}{\rho}f+(1-p(j))\,f+w_{t+1}^{F}\\ &=(1-\psi)\,\phi\Upsilon_{t+1}^{\frac{1}{\sigma}}A_{t+1}\left(\tfrac{\sigma-1}{\sigma}\right)K_{t+1}(j)^{\psi\phi-\frac{\phi}{\sigma}\psi}\left(L_{t+1}^{F-}(j)\right)^{((1-\psi)\phi-1)-\frac{\phi}{\sigma}(1-\psi)}\left(L_{t+1}^{P}(j)\right)^{(1-\phi)-\frac{(1-\phi)}{\sigma}}\\ &=(1-\psi)\,\phi\Upsilon_{t+1}^{\frac{1}{\sigma}}A_{t+1}\left(\tfrac{\sigma-1}{\sigma}\right)K_{t+1}(j)^{\psi\phi\left(\frac{\sigma-1}{\sigma}\right)}\left(L_{t+1}^{F-}(j)\right)^{(1-\psi)\phi\left(\frac{\sigma-1}{\sigma}\right)-1}\left(L_{t+1}^{P}(j)\right)^{(1-\phi)\left(\frac{\sigma-1}{\sigma}\right)}\end{aligned}$$

The above expression allows us re-expressing:

[19]Technically, when μ_t drops below $-f$, an optimizing firm must fire full-time workers and do so until $\mu_t\geq -f$ is restored. That is why we only consider marginal values with equality.

$$\left(L^{F-}_{t+1}(j)\right)^{(1-\psi)\phi\left(\frac{\sigma-1}{\sigma}\right)-1} = \frac{-\frac{1}{\rho}f+(1-p(j))f+w^F_{t+1}}{(1-\psi)\phi\Upsilon^{\frac{1}{\sigma}}_{t+1}A_{t+1}\left(\frac{\sigma-1}{\sigma}\right)K_{t+1}(j)^{\psi\phi\left(\frac{\sigma-1}{\sigma}\right)}\left(L^P_{t+1}(j)\right)^{(1-\phi)\left(\frac{\sigma-1}{\sigma}\right)}}.$$

To get rid of the openness variable, we make use of

$$\Upsilon^{\frac{1}{\sigma}}_{t+1} = \left(\frac{w^P L^P_{t+1}}{1-\phi}\right)^{\frac{1}{\sigma}} (\sigma-1)^{-\frac{1}{\sigma}} \tau^{\frac{1-\sigma}{\sigma}}_{RW,t+1} \frac{A^\star_{RW,t+1}}{A_{t+1}} f_x^{-\frac{1}{\sigma}},$$

which leads to

$$\left(L^{F-}_{t+1}(j)\right)^{(1-\psi)\phi\left(\frac{\sigma-1}{\sigma}\right)-1} = \frac{\left(-\frac{1}{\rho}f+(1-p(j))f+w^F_{t+1}\right)(\sigma-1)^{\frac{1}{\sigma}} f_x^{\frac{1}{\sigma}}}{(1-\psi)\phi\left(\frac{w^P}{1-\phi}\right)^{\frac{1}{\sigma}}\tau^{\frac{1-\sigma}{\sigma}}_{RW,t+1}A^\star_{RW,t+1}\left(\frac{\sigma-1}{\sigma}\right)K_{t+1}(j)^{\psi\phi\left(\frac{\sigma-1}{\sigma}\right)}\left(L^P_{t+1}(j)\right)^{(1-\phi)\left(\frac{\sigma-1}{\sigma}\right)+\frac{1}{\sigma}}}.$$

A closed-form solution for the production function (7), therefore, follows:

$$\left(L^{F-}_{t+1}(j)\right)^{(1-\psi)\phi\frac{\sigma-1}{\sigma}-1} = \Psi_{t+1}\tau^{\frac{\sigma-1}{\sigma}}_{RW,t+1}K_{t+1}(j)^{-\psi\phi\frac{\sigma-1}{\sigma}}\left(L^P_{t+1}(j)\right)^{-(1-\phi)\frac{\sigma-1}{\sigma}-\frac{1}{\sigma}}, \tag{46}$$

where we used $q_t(j) = \left(K_t(j)^\psi \left(L^F_t(j)\right)^{1-\psi}\right)^\phi \left(L^P_t(j)\right)^{1-\phi}$, and denoted by Ψ_{t+1} a time-varying term, exogenous from the perspective of a firm.[20] This is an expression just as reported in the main text's equation (23).

Before learning how full-time employment adjusts, we have to first solve for the capital choice. From the first-order conditions, (43), and under the production function (7), we obtain:

$$K_{t+1} = \left(\frac{w^P}{1-\phi}\right)(\sigma-1)^{-1} f_x^{-1}\frac{\rho f_x \phi\psi(\sigma-1)}{1-\rho+\delta\rho}L^P_{t+1}, \tag{47}$$

yielding

$$I_t = \left(\frac{w^P}{1-\phi}\right)\frac{\rho}{1-\rho}\phi\psi\triangle L^P_{t+1} \tag{48}$$

where, for exposition purposes, we assume depreciation to be equal to zero.

[20] The term is given by $\Psi_{t+1} \equiv \frac{\left(-\frac{1}{\rho}f+(1-p(j))f+w^F_{t+1}\right)(\sigma-1)^{\frac{1}{\sigma}} f_x^{\frac{1}{\sigma}}}{A^\star_{RW,t+1}\left(\frac{\sigma-1}{\sigma}\right)\left(\frac{w^P}{1-\phi}\right)^{\frac{1}{\sigma}}(1-\psi)\phi}$.

A.4.4 Investment

Our starting position is the capital equation

$$K_{t+1} = \Upsilon_{t+1}\tau_{RW,t+1}^{\sigma-1}\left(\frac{A_{t+1}}{A^{\star}_{RW,t+1}}\right)^{\sigma}\frac{\rho f_x\phi\psi\left(\sigma-1\right)}{1-\rho+\delta\rho}.$$

Making use of

$$\Upsilon_{t+1} = \left(\frac{w^P L^P_{t+1}}{1-\phi}\right)\left(\sigma-1\right)^{-1}\tau_{RW,t+1}^{1-\sigma}\left(\frac{A^{\star}_{RW,t+1}}{A_{t+1}}\right)^{\sigma} f_x^{-1} \ ,$$

we find that

$$K_{t+1} = \left(\frac{w^P}{1-\phi}\right)\left(\sigma-1\right)^{-1} f_x^{-1}\frac{\rho f_x\phi\psi(\sigma-1)}{1-\rho+\delta\rho}L^P_{t+1} \ .$$

It therefore follows that

$$\triangle K_{t+1} = I_t = \left(\frac{w^P}{1-\phi}\right)\frac{\rho}{1-\rho}\phi\psi\triangle L^P_{t+1} \ ,$$

when $\delta = 0$.

A.4.5 Full-time Labor and Capital

We can re-express labor adjustment (46) in terms of the flexible adjustment margin, part-time employment, and exogenous (from the perspective of a firm) variables:

$$\left(L^{F-}_{t+1}\left(j\right)\right)^{(1-\psi)\phi\left(\frac{\sigma-1}{\sigma}\right)-1} = \widetilde{\Psi}_t\tau_{RW,t+1}^{\frac{\sigma-1}{\sigma}}\left(L^P_{t+1}\left(j\right)\right)^{-\frac{1}{\sigma}([1-\phi+\psi\phi](\sigma-1)+1)},$$

where $\widetilde{\Psi}_t$ is a mix of aggregate and exogenous terms. In fact, it is equal to:
$\widetilde{\Psi}_t \equiv \Psi_t\left(\left(\frac{w^P}{1-\phi}\right)\left(\sigma-1\right)^{-1} f_x^{-1}\frac{\rho f_x\phi\psi(\sigma-1)}{1-\rho+\delta\rho}\right)^{-\psi\phi\frac{\sigma-1}{\sigma}}$. We combine an expression for $\left(L^{F-}_{t+1}\left(j\right)\right)^{(1-\psi)\phi\left(\frac{\sigma-1}{\sigma}\right)-1}$

with K_{t+1} above:

$$\begin{aligned}
\left(L^{F-}_{t+1}(j)\right)^{(1-\psi)\phi\left(\frac{\sigma-1}{\sigma}\right)-1} &= \frac{\left(-\frac{1}{\rho}f+(1-p(j))f+w^F_{t+1}\right)(\sigma-1)^{\frac{1}{\sigma}}f_x^{\frac{1}{\sigma}}}{(1-\psi)\phi\left(\frac{w^P}{1-\phi}\right)^{\frac{1}{\sigma}}\tau_{RW,t+1}^{\frac{1-\sigma}{\sigma}}A^{\star}_{RW,t+1}\left(\frac{\sigma-1}{\sigma}\right)K_{t+1}(j)^{\psi\phi\left(\frac{\sigma-1}{\sigma}\right)}\left(L^P_{t+1}(j)\right)^{(1-\phi)\left(\frac{\sigma-1}{\sigma}\right)+\frac{1}{\sigma}}} \\
&= \Psi_{t+1}\tau_{RW,t+1}^{\frac{\sigma-1}{\sigma}}K_{t+1}(j)^{-\psi\phi\frac{\sigma-1}{\sigma}}\left(L^P_{t+1}(j)\right)^{-(1-\phi)\frac{\sigma-1}{\sigma}-\frac{1}{\sigma}} \\
&= \Psi_{t+1}\tau_{RW,t+1}^{\frac{\sigma-1}{\sigma}}\left(\left(\frac{w^P}{1-\phi}\right)(\sigma-1)^{-1}f_x^{-1}\frac{\rho f_x\phi\psi(\sigma-1)}{1-\rho+\delta\rho}L^P_{t+1}\right)^{-\psi\phi\frac{\sigma-1}{\sigma}}\left(L^P_{t+1}(j)\right)^{-(1-\phi)\frac{\sigma-1}{\sigma}-\frac{1}{\sigma}} \\
&= \Psi_{t+1}\left(\left(\frac{w^P}{1-\phi}\right)(\sigma-1)^{-1}f_x^{-1}\frac{\rho f_x\phi\psi(\sigma-1)}{1-\rho+\delta\rho}\right)^{-\psi\phi\frac{\sigma-1}{\sigma}}\tau_{RW,t+1}^{\frac{\sigma-1}{\sigma}}\left(L^P_{t+1}(j)\right)^{-\psi\phi\frac{\sigma-1}{\sigma}-(1-\phi)\frac{\sigma-1}{\sigma}-\frac{1}{\sigma}} \\
&= \widetilde{\Psi}_t\tau_{RW,t+1}^{\frac{\sigma-1}{\sigma}}\left(L^P_{t+1}(j)\right)^{-\frac{1}{\sigma}(\psi\phi(\sigma-1)+(1-\phi)(\sigma-1)+1)} = \widetilde{\Psi}_t\tau_{RW,t+1}^{\frac{\sigma-1}{\sigma}}\left(L^P_{t+1}(j)\right)^{-\frac{1}{\sigma}([1-\phi+\psi\phi](\sigma-1)+1)}.
\end{aligned}$$