1 Introduction

Increased globalisation through trade liberation is often associated with efficiency gains, partly since this is assumed to cut "red tape" costs. Supply chains red tape is associated with export loss of US $88 billion (Third way, 2022), they affect the extensive margin of trade (Maggi et al, 2018) and red tape barriers cost service exporters US $150 billions (OECD/WTO, 2021).[1] Many trade models incorporate add ad valorem trade costs (iceberg) and unit costs, which trade liberalisation might reduce.

In addition, reduced import tariffs reduce the marginal costs of foreign firms and the most productive of these will then enter the market. Domestic firms face increased import competition, and they will respond by cutting their prices and price-cost mark-ups. Trade liberalisation in the form of reduced tariffs will thus reallocate market share away from less productive (domestic) firms to more productive imports, and thereby improve aggregate welfare (Melitz, 2003; Egger and Kreickemeier, 2009). These procompetitive effects of trade liberalization have been thoroughly surveyed by Tybout (2008), De Loecker and Goldberg (2014) and De Loecker and Van Biesenbroeck (2018).

In this paper, we study the impact of free-trade agreements on Norwegian exporters' price-cost-margins and return-on-assets, as well the impact on wages for workers employed by these firms. The notion that free-trade agreements can affect the price-cost margin of exporters should not be controversial. Even within a country, Dhyne et al. (2022a) have shown (and modelled) that firms markups increase in the average input share among their buyers. During our period of observation, Norway established free-trade agreements with several countries. The establishment of these agreements provide exogeneous variation over time in the costs of exporting goods for

[1] Brexit is an example, admittedly an extreme case, how red tape could soar', e.g. as indicated in the media: https://www.politico.eu/article/uk-business-fear-brexit-checks-food-price-inflation/ or https://www.ft.com/content/015e1f25-0725-49f1-9a7d-bf9ec0dc4678, https://www.thetimes.co.uk/article/the-cost-of-brexit-red-tape-tensions-and-lack-of-labour-qfqvw8kx9

Norwegian exporters, and allow us to answer the question: Do these incumbent exporters and their workers benefit from these free-trade agreements?

By answering this question, we also shed light on the relationship between potential market power in the product market and market power in the labour market. Admittedly, we are not the first paper addressing this, but the literature is scarce. Early in the 1990s, Abowd and Lemieux (1993) found that competition shocks to Canada from abroad strongly affected the negotiated wage. Dodini et al. (2022) find on Norwegian data that high levels of unionisation mitigate the negative wage and employment effects of imperfect competition. Kroft et al. (2022) analysis of the U.S. construction industry, where they conclude that the incentives of firms to mark down wages and reduce employment due to wage-setting power are attenuated by their price-setting power in the product market.

Similarly, many authors have pointed out (e.g., Dobbelaere and Kiyota, 2018; Syverson, 2019; Dobbelaere and Wiersma, 2020) that the product-market mark-up of the ratio-estimator, might be influenced by factor-market market power. For example, Du and Wang (2020) find that the minimum wage in China increases firm markup. Soares (2019) estimates price-cost margins and bargaining power in the European Union, finding that product and labour market imperfections are positive and strongly correlated. Furthermore, Bond et al. (2021) and Doraszelski and Jaumandreu (2021) emphasize identification issues affecting the ratio estimator of De Loecker and Warzynski (2012) used to identify price-cost margins[2], arising from using a revenue elasticity in place of the output elasticity.

Instead of relying on the ratio estimator to identify price-cost margins, we propose another empirical strategy to identify the impact of free trade agreements on markups. Our estimations utilise the recent development of multi-product production function estimation (Dhyne et al., 2022b), based on the Ackerman et al. (2015) approach to estimation of production functions (see

[2] The ratio estimator of a firm's mark-up is the ratio of the output elasticity of a variable input to that input's cost share in revenue.

Gandi et al., 2020). Furthermore, our analysis pertains to Norwegian exporters only, thus avoiding the danger that input changes in Norway affect the product demand in foreign countries.

Next, we explore the relationship between the establishment of free-trade agreements on firms' operating margin and return on assets.

Finally, we study how these free-trade agreements influence firms' pay policies and affect workers' hourly wages. To answer this question, we draw on insights from the theoretical models of Dobbelaere and Kiyota (2018), Abowd and Lemieux (1993) and Dodini et al. (2022), while using empirical job level wage information for those employed by these Norwegian exporters.

We do not argue that Norwegian exporters constitute a random sample of firms. For example, they are manufacturing incumbent exporters, and we restrict our analyses to firms which we observe at least 14 years (4 years before the establishment of an agreement and 9 full years after the agreement was signed). However, for our purpose they seem ideal since by restricting analyses to these firms one solves the identification issues as well as can address highly important policy questions. Public policy reforms and business cycle variations in these foreign export markets can hardly be attributed to the behaviour of Norwegian firms.

The structure of the remainder of the paper is as follows: Section 2 briefly reviews the previous literature. Section 3 describes the institutional background and free-trade agreements. Section 4 describes the data. The theoretical motivation is presented in Section 5. Section 6 presents the empirical strategy related to estimation of mark-up of price over marginal costs. Section 7 presents the result regarding the impact of free-trade agreement on mark-ups, while Section 8 present the corresponding results on firm performance. In Section 9, we then study the impact of free-trade agreements on hourly wages. Section 10 briefly concludes.

2 Previous literature

The impacts of trade liberations have been widely analysed in the literature, partly reflecting how increased globalisation the recent decades has affected industry composition, jobs and wages. Early literature on trade liberalisation mixed physical efficiency and price/markup effects. Exporters might be more productive and/or they might behave differently. De Loecker and Warzynski (2012) observed that exporters tend to have higher markups than non-exporters, and they related this to higher productivity of exporters compared to other firms. Firms in the food-processing sector with a greater ability to discriminate across markets mark their products up even more (Gullstrand et al., 2013). Amiti and Konings (2007) found that lower input tariffs raise firm-level total factor productivity in Indonesia, but this might comprise price effects. Later works do not share this shortcoming, yielding mixed results. On one hand, De Loecker et al. (2016) find that a similar result for India is not due to higher efficiency, but an incomplete pass-through of input price reductions. On the other hand, the productivity raising impact of reduced output tariffs in China even survives controls for input tariffs and price changes (Brandt et al., 2017), although this does not imply that tariff reductions have switched firms away from exercising product and labour market power (Dobbelaere and Wiersma, 2020). Abraham et al. (2009) observe that increased import competition in Europe caused downward pressure on markups. Similarly, Feenstra and Weinstein (20170) find that between 1992 and 2005 globalisation caused many U.S. to exit, while import shares rose, implying reduced markups but increased product variety. Several of these studies referred above apply the ratio estimator of De Loecker and Warzynski (2012) to identify the price-cost margins.

Trade liberalisation might induce heterogeneous impacts on the economy, not all is affected equally. Topolova (2010) observed that poverty in rural regions exposed to Indian trade liberation in the 1990s experienced slower decline and reduced consumption growth. On aggregate data for 40 countries with 35 sectors, Fajgelbaum and Khandelwal (2016) conclude that trade typically benefits the poor. Motivated by the pricing-to-market (PTM)-literature, Asprilla et al. (2019) find that PTM is observed, particularly for large firms. However, trade policies yield ambiguous effects, since non-tariff measures yield more PTM, while tariffs reduce PTM. Such heterogeneous effects also influence labour demand. Verhoogen (2008) observe that Mexican trade liberalisation caused already more productive firms to quality upgrade, thus inducing increased wage inequality. Similarly, Guadalupe (2007) observes increased competition yields increased return to skills, while Cunãt and Guadalupe (2009) find that increased foreign competition leads to more incentive provision among U.S. executives. In Japan during the period 1994-2012, Dobbelaere and Kiyota (2018) find that Japanese exporters are more likely to be found in product markets characterised by imperfect competition, and they are more likely to share rents based on the bargaining power of workers.

One aspect of globalisation is trade with China and China's growth to become an economic superpower. The effect of China entering the world market has naturally sparked massive interest. In the USA, Autor et al. (2013) found that Chinese competition caused unemployment, lowered labour force participation and reduced wages, but as pointed out by Magyari (2017), this might provide a too bleak view, since U.S. firms have reorganized and diversified. Still, Autor et al. (2016) conclude that at the national level, employment has fallen in import exposed industries, but employment gains in other industries have not yet materialized. In Norway, Balsvik et al. (2015) find similar results as Autor et al., except that these negative effects primarily affect low educated workers and no wage effects where observed. This latter phenomenon they attribute to the Nordic bargaining model. In France, Aghion et al (2022), decompose the "China shock" into a output shock for firms selling competing goods and an input shock affecting firms using inputs similar to Chinese imports. They find that the output shock is detrimental to firms' sales, employment and innovation, while the input shock yields ambiguous impacts.

Finally, we should point out that there is a literature linking growing product-market markups over time to wage inequality. For example, a recent study on US data from 1950 to today, De Loecker et al. (2020) identify that the mark-ups of firms started to increase over time from the 1980s, and this increase has been particularly driven by the growth in prevalence of high mark-up firms. Van Reenen (2018) argues that this follows from a "winner take most/all" transformation of industries, due to globalisation and technology, and is not caused by weakened competition, relaxed anti-trust rules or rising regulation. This argument is further elaborated by Autor et al. (2020), who find that industries will be increasingly dominated by superstar firms and the aggregate mark-up will rise more than the typical firm's mark-up. Since the product-market mark-up appears negatively related to wages (Syverson, 2019; DeLoecker et al., 2020), changing markups could affect wages. Even when taking into consideration efficient bargaining and monopsonistic wage setting by employers, such a negative relationship appears (Dobbelaere and Kiyota, 2018).[3]

3 Institutional background

Norway negotiated free trade agreements with other countries primarily through the European Free Trade Association (EFTA). Of 29 bilateral agreements with 41 countries, 27 are negotiated with the other EFTA-countries. EFTA is an inter-governmental organisation established in 1960. Since then, the European Union (EU) has absorbed six of ten EFTA members. Today, EFTA consists of Iceland, Liechtenstein, Switzerland and Norway. All except Switzerland are members of the European Economic Agreement (EEA) with EU. EFTA was founded on the premise of free trade as a means of achieving growth and prosperity amongst its Member States as well as promoting closer economic co-operation between the Western European countries. Furthermore, EFTA was created to be an alternative to the EC's (EU) ambitions on economic integration. EFTA's negotiations with third party countries secure that EFTA businesses enjoy the same rights

[3] It is, however, possible to provide a contrasting view. The model of Kaplan and Zock (2022) describes an economy comprising two kinds of producers: a wholesaler producing upstreams and a retailer, selling goods downstream, and given the right circumstances, the downstream seller is able to sell the products to consumers at a mark-up on marginal costs, while this is not possible for the upstream producers. This "hurts" wages of the upstream workers, while the wages of downstream workers benefits.

and privileges as businesses from the EU in third country markets. In recent times, the EFTA states have prioritised negotiations based on economic considerations, regardless of the EU's trade relations with the third-party country in question. The free trade agreements secure Norwegian access to international markets and facilitate trade with partner countries. Therefore, they are an important part of the Norwegian trade policy.

One of the main priorities of Norwegian trade policy is to increase market access for manufactured goods, fish, and services. Norway exports about 40 per cent of its goods and services. The main export products are oil, gas, minerals and seafood. Norway is among the world leaders in a wide range of industries such as energy, environment technology, aquaculture, maritime industries, hydropower, technology and telecommunications. Norway's highly educated population and the development of pools of expertise make the export of services increasingly important for the Norwegian economy. By 2020, Norway has trade agreements, partly together with the other EFTA-countries, with Albania, Bosnia-Hercegovina, Canada, Chile, Colombia, Costa Rica, Guatemala og Panama, Equador, Egypt, Philippines, Gulf Cooperation countries, Hong Kong, Indonesia, Israel, Lebanon, Jordan, North-Makedonia, Mexico, Montenegro, Palestine, Peru, Serbia, Singapore, South-Korea, Botswana, Lesotho, Namibia, South-Africa, Swaziland, Tunis, Turkey, Ukraine and the EU countries. Information on Norwegian free trade agreements taken from the web pages of the Norwegian government.[4]

Our data comprise the period 2000-2018, and we are to study the impact of Norway entering into new free trade agreements on firms and workers outcomes during these years. Norway is a small open economy, and Norway have established free-trade agreements since World War II with many countries. To evaluate the impact on incumbent firms, we discard agreements where we, by definition, have limited information on firms before and after a treaty was signed (we

[4] See https://www.regjeringen.no/no/tema/naringsliv/handel/nfd---innsiktsartikler/frihandelsavtaler/partner-land/id43884.

require at least 4 years before and 9 years after). Therefore, in our analyses, we have excluded firms exporting to countries where Norway has established agreement in the late nineties and early/late in the 2000s. These excluded countries comprise the EU enlargement. In the first round of EU enlargement, in 2004, the following countries joined the EU: Estonia, Latvia, Lithuania, Poland, Czech Republic, Slovakia, Slovenia, Hungary, Malta, and Cyprus. In 2007, Bulgaria, Rumania and Croatia joined the union. In addition, we exclude firms exporting to Bosnia-Herzegovina (2013), Chile(2003), Costa Rica(2013), Ecuador (2018), Philippines (2016), Georgia (2016), Guatemala (2013), Hong Kong (2011), Indonesia (2018), Jordan (2001), Lebanon(2004), North-Macedonia (2000), Montenegro (2011), Panama (2013), Mexico (2000), Peru (2010), Singapore (2002), Ukraine (2010) (year in parentheses indicate when the treaty was signed).

Our firm control group still comprises over 2000 firms exporting to countries where trade agreements were put in place for over 50-150 years ago (eg., the original EU-countries, EFTA-countries) or those that do not have an agreement. The European Economic Area (EEA) unites the EU member states and the three EEA-EFTA states (Iceland, Liechtenstein and Norway). In the mid 1990-ties, EU comprised the following countries: Denmark, Ireland, UK, Greece, Portugal, Spain, , Belgium, France, Italy, Luxembourg, Netherlands, Germany, Austria(1995), Finland (1994) and Sweden (1994) (trade agreements with Sweden and Finland were signed 1874 and 1937, respectively). In addition to the time argument, a separate argument for this, is that the integration of Norway and the other EFTA-countries into the inner market of EU is something different than a standard trade agreement. Table 1 lists information on the treatment agreements. As is easily seen, these agreements reduce tariffs facing exports to these countries, and should facilitates improved trade.

Table 1 Selected free-trade agreements between Norway and trading countries outside the European Economic Area

Country	Signed	In force	Key points
Albany	17.12.2009	1.08.2011	Improved market access, removal of all tariffs on industry goods
Canada	26.01.2008	1.07.2009	Improved market access, removal of all tariffs on industry goods
Colombia	25.11.2008	1.09.2014	Improved market access, removal of all tariffs on industry goods
Egypt	27.01.2007	1.08.2007	Improved market access, equal tariff as EU on industry goods
Bahrain	27.06.2009	1.07.2014	Improved market access, removal of all tariffs on all goods
United Arabic Emirates	27.06.2009	1.07.2014	Improved market access, removal of all tariffs on all goods
Kuwait	27.06.2009	1.07.2014	Improved market access, removal of all tariffs on all goods
Oman	27.06.2009	1.07.2014	Improved market access, removal of all tariffs on all goods
Qatar	27.06.2009	1.07.2014	Improved market access, removal of all tariffs on all goods
Saudi-Arabia	27.06.2009	1.07.2014	Improved market access, removal of all tariffs on all goods
Serbia	17.12.2009	1.07.2011	Improved market access, removal of all tariffs on industry goods
South Korea	15.12.2005	1.09.2006	Improved market access, removal of all tariffs on 99% of industry goods
South Africa	1.06.2006	1.05.2008	Improved market access, equal tariff as EU on industry goods
Botswana	14.07.2006	1.05.2008	Improved market access, equal tariff as EU on industry goods
Lesotho	7.08.2006	1.05.2008	Improved market access, equal tariff as EU on industry goods
Namibia	14.07.2006	1.05.2008	Improved market access, equal tariff as EU on industry goods
Swaziland	7.08.2006	1.05.2008	Improved market access, equal tariff as EU on industry goods
Tunis	17.12.2004	1.08.2005	Improved market access, removal of all tariffs on 99% of industry goods

Note: We focus on key points in trade agreements affecting industry export, since we are focussing on industry exporters. Most of these agreements also affect fishery, services, immaterial rights.

4 Data

The primary data set we use is the Statistics Norway's Structural Statistics linked to the Accounting Registers. The Structural Statistics provide information on value added (operating income less operating costs, wage costs, depreciation and rental costs) and industry for almost all workplace and firms in Norway. Most private-sector firms are required to report to the Accounting registers (all limited liability firms, not single-person firms and foundations). From this register, we get information on capital assets, investments, depreciation, and return-on-assets. Capital is measured as total assets. From the merged data set we then information on key firm characteristics such as value added, capital, different kinds of costs and revenues, employment and industry-code (5-digit). It is linkable to the other data by a firm-specific identifying number

Then, we link these data to the Export and Import Register, comprising information on exporting and importing goods. Each transaction (import or export) is registered, type of product, the value, with the destination country (exports) and the country of origin (imports). For each product, we always know the weight of the exported goods, sometimes the quantum if this is the relevant unit (for a couple of percent of the transactions, the transactions are measured in volume), depending on the product. For example, although product such as air compressors, optical instruments, bras and bathing suits are measured in quantum in addition to weight, products such as copper debris, flour, butt-welding pipe-fittings are only measured by weight. Close to 80 percent of the export has weight-based units. Thus, in the regression analysis, we use weight in kilo as our universal measure of the quantum. For goods imported, we know the transportation costs, thus from the importers' declarations, we can measure the transportation cost per kilo to each country and use this measure in our analyses of the exporters.

By linking these data to the Central Population Register and the Tax Authorities Registers of jobs (through the firm identifying number), our data comprise a full panel of firms and their employees, with detailed information on workers and firms. For example, data comprise weekly working hours and job-spell specific earnings, thus making it possible to derive hourly wages. Note also that the earnings reported to the Tax Authorities comprise taxable fringe benefits.

In auxiliary regressions before any analysis, all firm level variables are a priori residualized taking into account year and industry variation (based on the Frisch-Waugh-Lovell theorem).

Finally, we utilise data from OECD, World Bank and ILO as controls. From the OECD (https://stats.oecd.org), we use information on product market regulation index (PMR index) and the yearly Labour Force Employment index (100=2015). The PMR index is described in detail in Koske et al (2015). It is based on questionnaires responded by OECD-countries and 21 major non-OECD countries 1998, 2003, 2008 and 2013, comprising several hundred questions on different aspects of product market regulations. We link the 1998-values to 2000-2002, 2003-values to 2003-2007, 2008-values to 2008-2012, and 2013-values to 2013-2018. The national PMR indicator is constructed by first assigning numerical values assigned to each question and aggregate these into 18 low-level indicators. These low-level indicators are then aggregated into seven mid-level indicators, which are in turn aggregated into three high-level indicators. At each step of aggregation, the composite indicators are calculated as weighted averages of their components. The aggregate PMR indicator is the simple average across the three high-level indicators state control, barriers to entrepreneurship and barriers to trade and investment. From the World Bank (https://data.worldbank.org/indicator/PA.NUS.FCRF) we use yearly average data on official exchange rates (LCU per US$). Annual country employment (in 1000) is downloaded directly from ILO (https://ilostat.ilo.org/topics/employment/). In the regressions, we apply the pre-treatment year 2000-values of the employment, pmr-index and exchange rates interacted with the yearly dummies as balancing controls.

Although we have the complete population of Norwegian firms and workers, we focus on manufacturing exporters and require at the firms should be exporting to a country for at least 14 years. For our treatment firms, this implies 4 years before a free-trade agreement was established and 9 full years after. Similarly, we require that we the sampled workers should be employed by these firms for at least 10 years. This is necessary to study the development before and after the establishment of the free-trade agreement. This means that our treatment group comprises only 90 firms, employing 11828 workers, and exporting to 186 countries. These are large firms. Our control group comprises also smaller firms, with roughly 2000 firms employing 61000 workers and exporting to 156 countries. To take into account size differences between the populations, we conduct coarsened exact matching(CEM)(Blackwell et al., 2009; Iacus et al., 2017). For firms facing new trade agreements 2004-7, we consider 2003 a pre-year, while for firms facing new trade agreements 2008-9, we consider 2005 as a pre-year. For each of these years, we then conduct matching to non-treated firms based on log employment, log capital, log number of export countries, and a dummy for importer. The continues variables are grouped into 4 equal sized bins. This strategy allows us to match each treated firm to at least 1 non-treated firm. The matching-procedure provides us with weights, taking the value of zero if a firm is not matched, the value of 1 if it is treated, and a value between 0 and 1 for matched non-treated firms. We apply the same set of weight to all analyses.

In Table 2, we show descriptive statistics on all firms and on the matched sample of firms. Under Panel A); we focus on our firm-data. This is the level that we have conducted the matching on. In the first column, we see the treated firms average across the pre-treated years. In the third column, we see the averages across all years for the control firms. The table shows that the treatment firms are bigger (larger workforce and more capital) and are less likely to be an importer.

Table 2 Firm and worker outcomes, market conditions and free trade agreements.

	Treat		Control	
	Pre	Post	All	CEM-weighted
A) Firms				
Log employment	4.339	4.445	3.107	4.302
	(1.236)	(1.227)	(1.210)	(1.316)
Log capital	18.837	19.102	17.179	18.898
	(1.525)	(1.618)	(1.641)	(1.789)
Log number of export countries	3.431	3.594	1.181	2.901
	(0.514)	(0.514)	(1.052)	(0.901)
Importer	0.356	0.453	0.609	0.499
	(0.482)	(0.498)	(0.488)	(0.500)
Operating margin	0.247	0.392	0.002	0.317
	(1.176)	(1.174)	(0.912)	(1.469)
Return on assets	0.079	0.089	0.074	0.073
	(0.122)	(0.129)	(0.156)	(0.140)
N	347	865	33121	10121
B) FirmXcountry				
Log employment	4.478	4.784	3.696	4.518
	(1.314)	(1.230)	(1.362)	(1.298)
Log capital	19.258	19.553	18.057	19.178
	(1.628)	(1.613)	(1.826)	(1.753)
Importer	0.357	0.440	0.564	0.486
	(0.479)	(0.496)	(0.495)	(0.499)
Log weight	8.794	9.232	7.264	7.671
	(2.521)	(2.388)	(3.036)	(3.061)
Log revenue	14.127	14.496	12.658	13.066
	(1.936)	(1.897)	(2.352)	(2.425)
Log number of Norw. competitors	5.512	5.527	6.768	6.044
	(0.665)	(0.659)	(1.349)	(1.565)
Elasticity of price w.r.t weight	-0.697	-0.738	-0.368	-0.428
	(0.158)	(0.135)	(0.227)	(0.209)
N	954	1954	156343	89507
C) Jobs (workerXfirm)				
Log hourly wage	5.634	5.867	5.617	5.686
	(0.405)	(0.456)	(0.442)	(0.416)
Blue	0.404	0.358	0.634	0.627
	(0.491)	(0.480)	(0.483)	(0.484)
Union	0.688	0.700	0.662	0.794
	(0.463)	(0.456)	(0.472)	(0.405)
Vacancy-unemployment rate	5.252	7.148	3.937	4.017
	(7.916)	(7.293)	(5.246)	(5.566)
N	36072	100976	772230	473335

Note: Population: Panel A): All exporting Manufacturing firms 2000-2018 with at least 2 employees with at least 14 observations to export-destination country. Panel B): All exporting Manufacturing firmsXexporting country 2000-2018 with at least 2 employees with at least 14 observations to export-destination country. Panel C): workers employed by the manufacturing firms given by Panel A) which are observed 10 consecutive years.

In the fourth column, we apply the CEM-weights. Although the differences do not completely disappear, they diminish dramatically. The table also shows for the treatment firms the averages across the post-treatment years. For our outcome variables, the operating margin and the returns on assets, these appears to grow weakly.

In Panel B) and Panel C), we present similar statistics on key background and outcome variables from the firm-country panel and job panel data, which will be applied to analyses in the next sections. Descriptive statistics on other key measures is otherwise presented in Table A1.

5 The impact of free-trade agreements on firms' export

How do we expect our exporters react to the establishment of a free-trade agreement with a country that these exporters already export to? If the free-trade agreement reduces red-tape and implicitly the price of intermediates including transportation, this will in isolation increase the demand for labour and increase exports. However, a free-trade agreement between two or more countries, might also affect the number of competitors present in the destination country, thereby not only affecting product demand and product prices. At the end of the day, the overall impact will have to be resolved empirically.

To answer this, we estimate of a set of linear regressions of firms' outcomes on controls using detailed export data, i.e.

6) $$Y_{cft} = \delta_0 + \sum_{t=y-4}^{t=y-2} \delta_t B_{cft} + \sum_{t=0}^{t=y+9} \delta_t P_{cft} + t_t + \delta_c X_{cft} + \theta_{cf} + \nu_{cft},$$

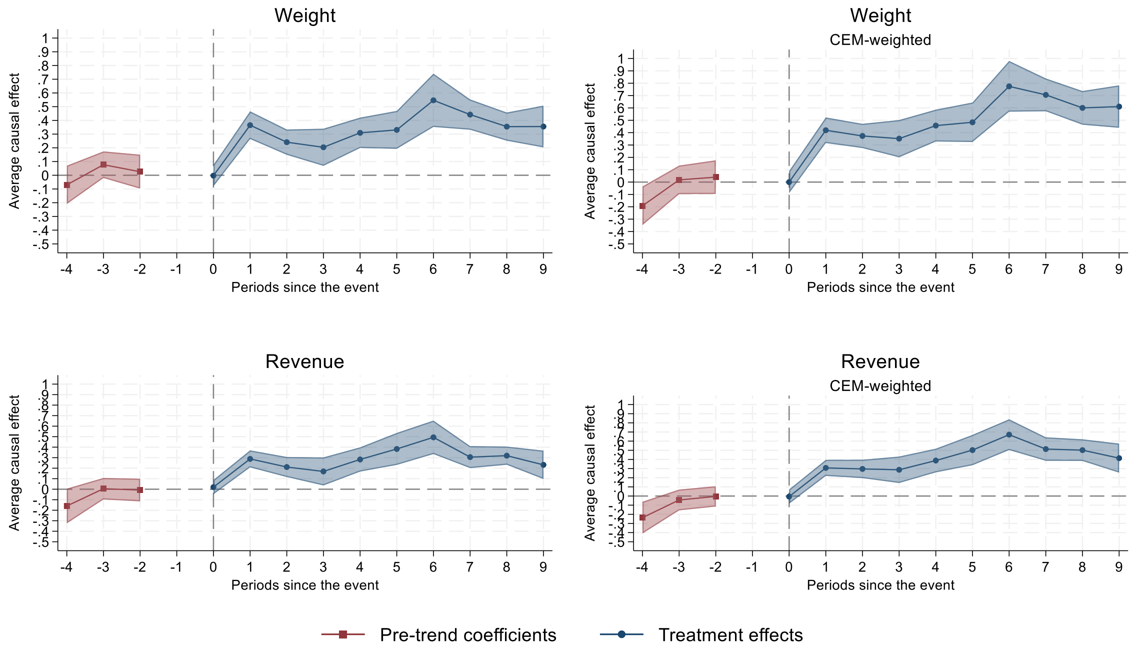
where Y_{cft} expresses outcomes for firm f from exports to country c at time t. These outcomes are log total export weight, log total export revenue, log total number of competitors and log transport cost per kilo exported.

B_{cft} expresses a vector of dummies taking the value 1 for the 4 years before if a new free trade agreement with country c has come into action (we are excluding the year before the free trade agreement is signed), P_{cft} expresses a vector of dummies taking the value 1 for the 9 years after a new free-trade agreement with country c has come into action, , X_{cft}comprises a vector of other potential firm and country characteristics (if) needed for balancing, t_t expresses time dummies, Δ_{ct} express export market country fixed effects and linear time trends, ω_n expresses industry fixed effects, while ν_{cit} expresses a normal distributed error term. Thus, Equation 6) depicts a standard difference-in-difference regression in an event study form, with the additional complication that the free trade agreements (or treatments) are introduced staggered.

The X-vector should take into account changes not related to the trade agreement, but could act as confounding factors and affect export, mark-ups and wages. Our X-vector comprises destination-country product market regulation, its exchange rate to dollar, and business-cycle variation expressed by aggregate employment (Griffith et al., 2007; Guadalupe, 2007; Fiori et al., 2012; Berman et al., 2012; Amiti et al., 2019). Since free-trade agreements also might affect these measures, we use the year 2000-values of destination country employment, log currency (w.r.t. U.S.$) and product market competition index interacted with the year dummies as controls. Standard errors are clustered on firm and export destination country.

Recently, the standard approach has been criticized for not taking into account spurious correlations arising when the same objects are part of both the control and treatment group over time (de Chaisemartin and D'Haultfœuille, 2020; Borusyak et al., 2023; Callaway and Sant'Anna 2021, Sun and Abraham, 2021). Our regressions in this paper are primarily are based on the IW-estimator of Sun and Abraham (2021), however, for completeness purposes, in Figure A1 we compare several of the estimates from these other estimators based on the weight-regressions (full results available upon request). Here we just note that they appear qualitatively very similar. Our key results on exports are presented in form of Figure 1, which summarize the regression results presented in Table A3. We show the results for all firms, as well as for the matched sample.

Figure 1 Free-trade agreements and the development of export



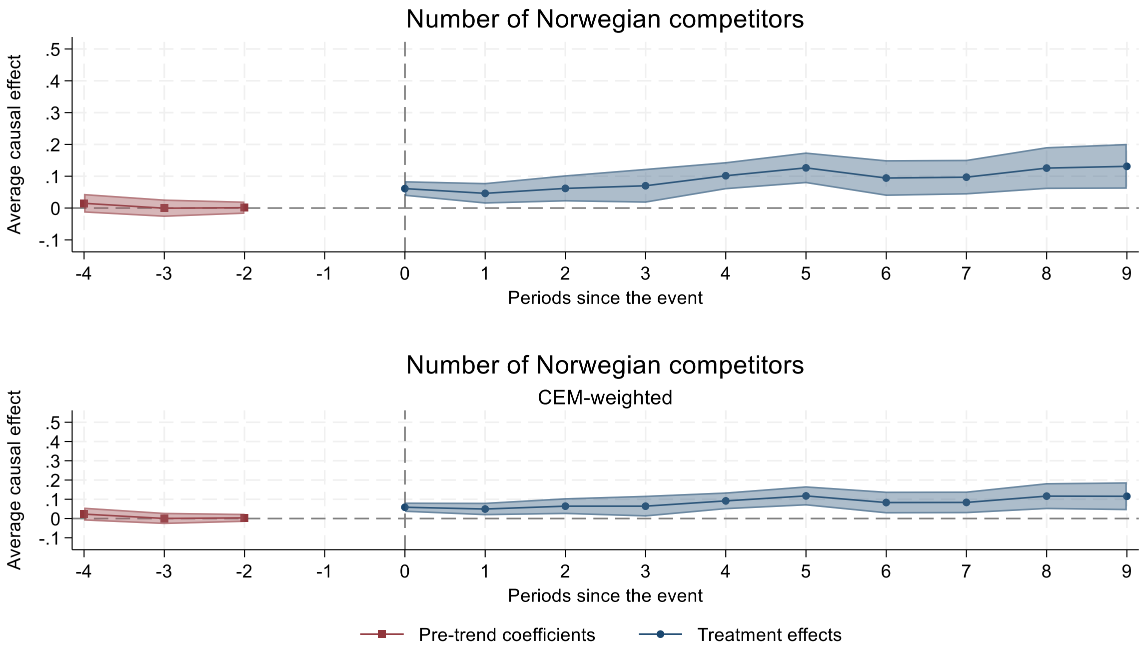
Note: Population: All exporting Manufacturing firms 2000-2018 with at least 2 employees and with at least 14 observations to export-destination country. The graphs report estimates from difference-in-difference regression of the establishment of a free-trade agreement on log firm total export weight/log firm total export revenue in event-study form. Regressions are based on the IW-estimator of Sun and Abraham (2021). In addition to year dummies, the regressions comprise 2000-values of destination country employment, log currency (w.r.t. U.S.$) and product market competition index interacted with year dummies. Standard errors are clustered on firm and export destination country.

Figure 1 shows that the establishment of a free-trade agreement, slowly but surely, increases exports of firms, both when it comes to export revenues and when it comes to total weight. The impact appears slightly stronger for weight than for revenue. The matched sample reveals if anything, slightly stronger impact of the establishment of a free-trade agreement.

In Figure 2, we repeat the analyses, but focus on the log number of Norwegian competitors in the export market. The number of Norwegian competitors increases, when the free-trade agreement is signed. Thus, since two of the key targets of a free-trade agreement is to stimulate and increase export volumes, as well as to strengthen the presence of Norwegian firms abroad, these sub-targets appear satisfied.

In the next sections, we follow up these results, by asking in what manner do firms adapt to free-trade agreements. How does such an agreement benefit the firms and their workers? To answer these questions, we conduct empirical analyses of firm price-setting, firm performance and worker pay.

Figure 2 Free-trade agreements and the development of Norwegian competitors



Note: Population: All exporting Manufacturing firms 2000-2018 with at least 2 employees and with at least 14 observations to export-destination country. The graphs report estimates from difference-in-difference regression of the establishment of a free-trade agreement on log number of Norwegian competitors in event-study form. Regressions are based on the IW-estimator of Sun and Abraham (2021). In addition to year dummies, the regressions comprise 2000-values of destination country employment, log currency (w.r.t. U.S.$) and product market competition index interacted with year dummies. Standard errors are clustered on firm and export destination country.

6 The impact of trade agreements on the mark-up of firms

In a single product-setting, De Loecker and Warzynski (2012) estimate Cobb-Douglas- and Translog-production function based on revenues using the control function approach of

Ackerberg et al (ACF)(2015), as the starting point when they derived their empirical measure of firm's mark-up. This measure has been applied in numerous studies (e.g., Dobbelaere and Kiyota, 2018; Peters, 2020; De Loecker et al.., 2020; De Ridder et al., 2021). This estimator is called the *Ratio estimator.*

Recently, however, this approach has been criticized (Bond et al, 2022; Doraszelski and Jaumandreu, 2021) since it rests on price. Although a universal aggregate across products, firm revenues comprise aggregated over prices and quantum. Bond et al. (2022) suggest that the markup of price relative to marginal costs could be estimated as the output elasticity of labour relative to the revenue elasticity of labour.

To shed light on the impact of trade agreement on the mark-up, we propose another simple strategy. Since we have explicit knowledge of the weight that is produced or more specifically, the weight of what is exported, we can utilize information on exported weight as another aggregate across products, derive a measure of the elasticity of price w.r.t. weight, and thus avoid the critique above.[5] In Appendix A, we describe this strategy in detail. Since we can differentiate between weight and value added in export- and domestic markets, we can treat this as multi-product production (see Dhyne et al., (2022). The essence in our approach is then to estimate simple multiproduct Cobb-Douglas production functions (based on log weight and one log value added as dependent variables) based on the control function approach of ACF, as implemented by Rovigatti and Mollisi (2018). This estimation yields for firm f exporting to country c at time t a destination-country-time specific estimate of total factor productivity associated with log export weight and log value added, $\widehat{\omega_{cft}^{Q}}$ and $\widehat{\omega_{cft}^{R}}$, respectively. Since we assume that these firm faces an inverse product demand curve in each export market, P(Q), then these firms' value added (revenue) can be expressed by:

[5] From the exporting declaration, we know whether the product that is exported, is sold as truly quantum (cars, computers, bras), as weight (e.g., flour, grain, ferro-silicon) or volume (oil- and gas). 80 percent of the export is primarily by weight, and we know the export weight even when the declaration indicates that the product is sold in quantum or volume. The important distinction is that this is not expressed in the form of revenue, which comprises prices.

R(Q)=P(Q)Q. Thus, we derive a measure of P by utilizing our estimated TFP-measures: $\widehat{\omega^P_{cft}}(\widehat{\omega^Q_{cft}})=\widehat{\omega^R_{cft}}$- $\widehat{\omega^Q_{cft}}$.

Since a profit maximizing firm chooses L to equate marginal profit to marginal costs, i.e., : $\frac{\partial R(Q)}{\partial L} = \frac{\partial C(Q)}{\partial L}$, or rather $\frac{\partial C(Y)/\partial Q}{P} = 1 + \epsilon^P_Q$, i.e., the markup of price relative to marginal costs can be expressed as $\mu = \frac{P}{\partial C(Y)/\partial Y} = \frac{1}{1+\epsilon^P_Q}$. Thus, we can draw inference on the markup by studying an empirical measure of ϵ^P_Q. We measure ϵ^P_Q by estimating the regression:

7) $$\widehat{\omega^P_{cft}} = \gamma_{cf} + \beta_{ct}\omega^Q_{cft} + \xi_{cft},$$

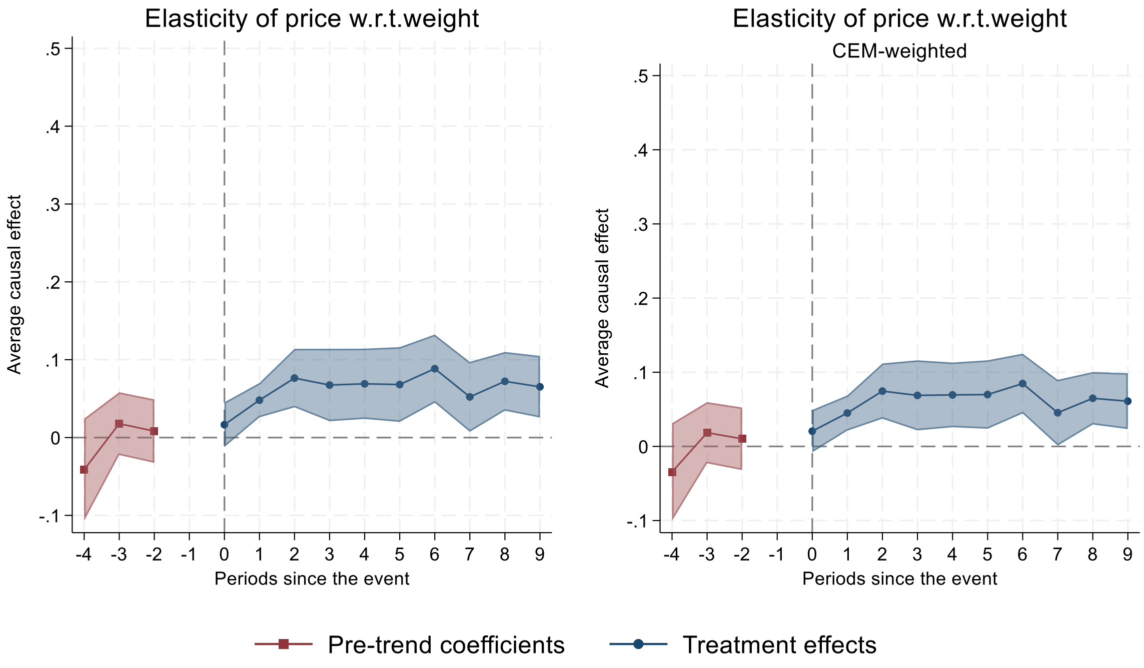
yielding estimates of the fixed country-firm effect $\hat{\gamma}_{cf}$ and the residual $\hat{\xi}_{cft}$. β_{ct} is a country and time-specific parameter associated with ω^Q_{cft} (weight), which we do not try to directly estimate.

Next, we derive an estimate of ϵ^P_Q by $\hat{\epsilon}^P_{Qfct} = (\widehat{\omega^P_{cft}} - \hat{\gamma}_{cf} - \hat{\xi}_{cft})/\omega^Q_{cft}$. This yields an

an average country- and time-specific estimate of the elasticity of price w.r.t. weight added firm and time-noise. This approach does not require information on the market structure in the country that these firms' goods are exported to. Furthermore, data are often limited in that they do not split cost into the different markets. This approach does not require such splitting.

Next, we apply the IW-regression described by Equation 6) to the price elasticity measure of $\hat{\epsilon}^P_{Qfct}$. The estimates are presented in Table A3 and in the form of Figure 3.

Figure 3 Free-trade agreements and the elasticity of price w.r.t. weight.



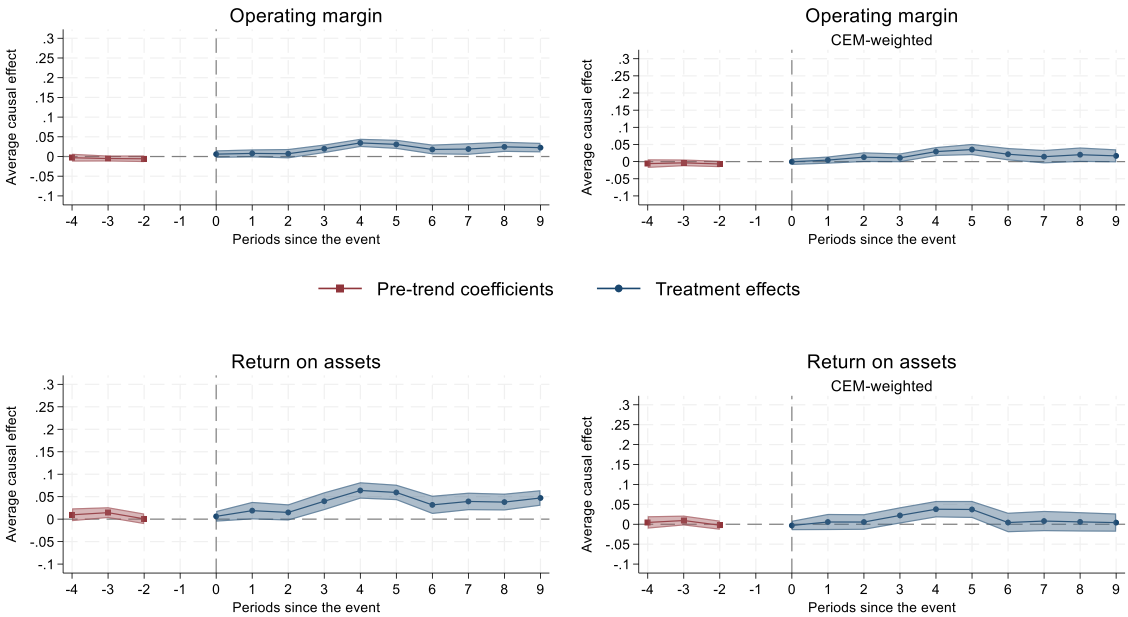
Note: Population: All exporting Manufacturing firms 2000-2018 with at least 2 employees with at least 14 observations to export-destination country. Panel unit: FirmXExport destination country. Figures are constructed from the regression results presented in Table A3, Model 6.

Years before the establishment of a free-trade agreement, we see no strong trend. When the free-trade agreement is introduced, our estimate of the price elasticity w.r.t. weight increases significantly. Thus, since the free-trade agreements increase the elasticities of price w.r.t. weight, our results imply a reduced mark-up of firms in these countries. Over time, these incumbent exporters face stronger competition after the establishment of the free-trade agreement, and as new entrants are established in these export markets (we have previously shown that the number of Norwegian competitors grow), these incumbents face reduced the demand for their products, and they will respond by reducing their markups (implied by the impact on the elasticity of price w.r.t. weight).

7 The impact of free-trade agreements on the performance of exporting firms

Our empirical strategy in this section is to apply the IW-estimator of Sun and Abraham (2021) to our firm data. We study how these firms' operating margin (OM) and return on assets (ROA) develop before and after the establishment of the free-trade agreement. Since some of our treatment firms are exposed to the establishment of several free-trade agreements (they export to multiple countries), we focus on the establishment of the first free-trade agreement. All models account for firm FE, and year dummies. To avoid the importance of outliers and measurement errors, we discard observations below the 1-percentile and above the 99-percentile of the OM- and ROA- distributions. Figure 4 summarizes our results, with the estimates presented in Table A4.

Figure 4 Free-trade agreements, operating margin and the return on assets



Note: Population: manufacturing exporting firms 2000-2018 with at least 2 employees with at least 14 observations to export-destination country. Unit of observation: firm. Dependent variables: operating margin/return-on-assets. Standard errors are adjusted for firm clustering and presented in parentheses. Figures are constructed from regression results presented in Table A4.

The general picture provided by Figure 4 is that the establishment of a free-trade agreement with a country appears to increase the operating margin and the return-on-assets for those firms that export to this country after a couple of years. The impact on these two firm performance measures are quite similar, and thus we might deduct that the free-trade agreements do not affect firm total asset turnover strongly. On average, the return-to-assets increases by maximum 5 percentage points after 4-5 years. Furthermore, since CEM-matching reduces the long-term effects, it is likely that some of these gains appear to be related to firm size. Still, employers, firms and owners appear to benefit from the establishment of free-trade agreements. In the next section, we ask whether this is also true for workers as well.

8 The impact of free-trade agreements on workers' wages

The wage-setting in Norway is defined by Oecd (2018) as *Organised decentralised and Co-ordinated.* Sector-level agreements are important, with coordination across sectors and bargaining units, but with room for lower-level agreements. Local bargaining in addition to sector-level bargaining is particularly common in manufacturing, and it is reasonable to assume that our exporting firms set wages through bargaining.

Dobbelaere and Kiyota (2018) derive wages both under the assumption of efficient bargaining with risk-neutral workers and risk-neutral employers or for wages set by monopsonistic employers. Abowd and Lemieux (1993) derive quite similar expressions given wage bargaining, while Dodini et al. (2022) utilise this and in addition introduce monopsonistic employer behaviour.

If we follow Dobbbelaere and Kiyota and assume that wages are set by efficient bargaining, where we incorporate a term expressing that employers might mark-down wages, the Nash-bargaining problem can be expressed as:

7) $$\max_{W^U, L} (LW^U + (\bar{L} - L)W\bar{L}W - \bar{L}W)^{\gamma}(R - WL)^{1-\gamma} ,$$

where W=$\bar{W} - g(\epsilon_W^L)$, which expresses employers' ability to push worker outside options downwards from competitive wages. The elasticity of labour supply facing the firm is expressed by ϵ_W^L, and g'()>0 and varies between 0 and 1. The two first order conditions found by maximizing the generalised Nash product w.r.t. wages and labour, can be expressed as:

8) $$W^U = \bar{W} - g(\epsilon_W^L) + \frac{\gamma}{1-\gamma}\left[\frac{R - W^U L}{L}\right],$$

where γ expresses the part of the economic rents that goes to the workers. The first order condition for labor can be expressed as:

9) $$W^U = \frac{\partial R}{\partial L} + \gamma\left[\frac{R - \frac{\partial R}{\partial L}L}{L}\right].$$

Solving Equation 8) and 9), yields an equilibrium condition of $\bar{W} - g(\epsilon_W^L) = \frac{\partial R}{\partial L}$. Inserting this in Equation 8) yields:

10) $$W^U = \left\{\frac{1}{\mu}\frac{\epsilon_L^Q}{(1+\theta)} + \frac{\theta}{1+\theta}\right\}\frac{R}{L}, \theta = \frac{\gamma}{1-\gamma}.$$

We see that by taking logs and differentiating Equation 10) by μ, then we find $\frac{\partial lnW^U}{\partial \mu} < 0$, i.e., as mark-ups increases, the share that goes to workers is reduced, but the negative impact is offset by stronger workers during the bargaining process. However, W^U is not related to $g(\epsilon_W^L)$.

What if unions only bargain about wages? Equation 7) is then rewritten:

11) $$\max_{W^U} (W^U - W)^{\gamma}(R - W^U L)^{1-\gamma},$$

where W=$\bar{W} - g(\epsilon_W^L)$. Maximation yields directly:

12) $$W^U = \left\{\frac{\epsilon_L^Q}{\mu} - g(\epsilon_W^L)\frac{L}{R} + \theta\right\}\frac{R}{L}, \theta = \frac{\gamma}{1-\gamma}, \text{ and } \bar{W} = \frac{\epsilon_L^Q}{\mu}\frac{R}{L}.$$

Once more, we see that $\frac{\partial lnW^U}{\partial \mu} < 0$, but in this case $\frac{\partial lnW^U}{\partial \epsilon_W^L} > 0$. Furthermore, as pointed out by Dodini et al. (2022), union power and employer monopsonistic power (partly) offset each other.

Let use start in this section by analysing the overall impact on wages from the introduction of new free trade agreements, i.e., we estimate

13) $$lnW_{ift} = \delta_0 + \sum_{t=y-4}^{t=y-2}\delta_t B_{ift} + \sum_{t=0}^{t=y+9}\delta_t P_{ift} + t_t + \theta_{if} + \nu_{ift},$$

where lnW_{ift} expresses log hourly wage for worker i employed by firm f at time t. As before, Bs and Ps express dummies indicating relative time (before and after the introduction of the free-trade agreement). In all the remaining analyses, we focus on the CEM-matched sample, i.e., all regressions comprise weights. To make our population as comparable as possible to the firm-analyses, we discard observations of firms (and their employees) below the 1-percentile and above the 99-percentile of the OM- and ROA- distributions. The results of these regressions are presented in Table 4.

Table 4 The impact of free-trade agreements on log hourly wages. FirmsXworker panel. CEM-weighted.

	All		White collar	Blue collar	Union	Non-union
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
F4event	-0.021	-0.033**	-0.036**	-0.013^{x}	-0.022*	-0.058**
	(0.020)	(0.010)	(0.014)	(0.006)	(0.008)	(0.014)
F3event	0.0001	-0.003	0.006	-0.008	-0.003	0.001
	(0.014)	(0.004)	(0.009)	(0.009)	(0.005)	(0.007)
F2event	-0.006	-0.006	-0.007	-0.001	-0.003	-0.017
	(0.015)	(0.007)	(0.006)	(0.006)	(0.005)	(0.007)
L0event	0.015	0.013**	0.023**	-0.005^{x}	0.013**	0.007
	(0.015)	(0.004)	(0.005)	(0.003)	(0.004)	(0.005)
L1event	0.030	0.023**	0.031**	0.001	0.012**	0.033**
	(0.020)	(0.003)	(0.003)	(0.003)	(0.003)	(0.007)
L2event	0.041^{x}	0.033**	0.045**	-0.005	0.019**	0.047**
	(0.022)	(0.008)	(0.011)	(0.005)	(0.006)	(0.015)
L3event	0.045*	0.042**	0.048**	0.003	0.026**	0.061**
	(0.020)	(0.011)	(0.012)	(0.015)	(0.009)	(0.018)
L4event	0.056^{x}	0.053**	0.061**	-0.005	0.034**	0.082**
	(0.028)	(0.014)	(0.011)	(0.019)	(0.013)	(0.017)
L5event	0.052	0.048**	0.055**	-0.009	0.034**	0.072**
	(0.031)	(0.014)	(0.013)	(0.018)	(0.013)	(0.016)
L6event	0.055	0.051*	0.057**	-0.012	0.038^{x}	0.076**
	(0.034)	(0.019)	(0.013)	(0.030)	(0.018)	(0.022)
L7event	0.039	0.039^{x}	0.048**	-0.025	0.027	0.064**
	(0.028)	(0.019)	(0.012)	(0.031)	(0.020)	(0.019)
L8event	0.036	0.038^{x}	0.042**	-0.027	0.034	0.058*
	(0.026)	(0.022)	(0.009)	(0.038)	(0.024)	(0.022)
L9event	0.038	0.040^{x}	0.044**	-0.029	0.033	0.058*
	(0.029)	(0.023)	(0.009)	(0.038)	(0.025)	(0.026)
Average treatment effect	0.041	0.038**	0.045**	-0.011	0.027*	0.056**
	(0.024)	(0.012)	(0.008)	(0.020)	(0.012)	(0.015)
Estimation method	FE	IW-FE	IW-FE	IW-FE	IW-FE	IW-FE
R^2-adj.	0.691	0.691				
WxF	72566	72566	32795	42795	50874	30874
N (WxFxT)	922742	922742	371400	549609	614441	302441

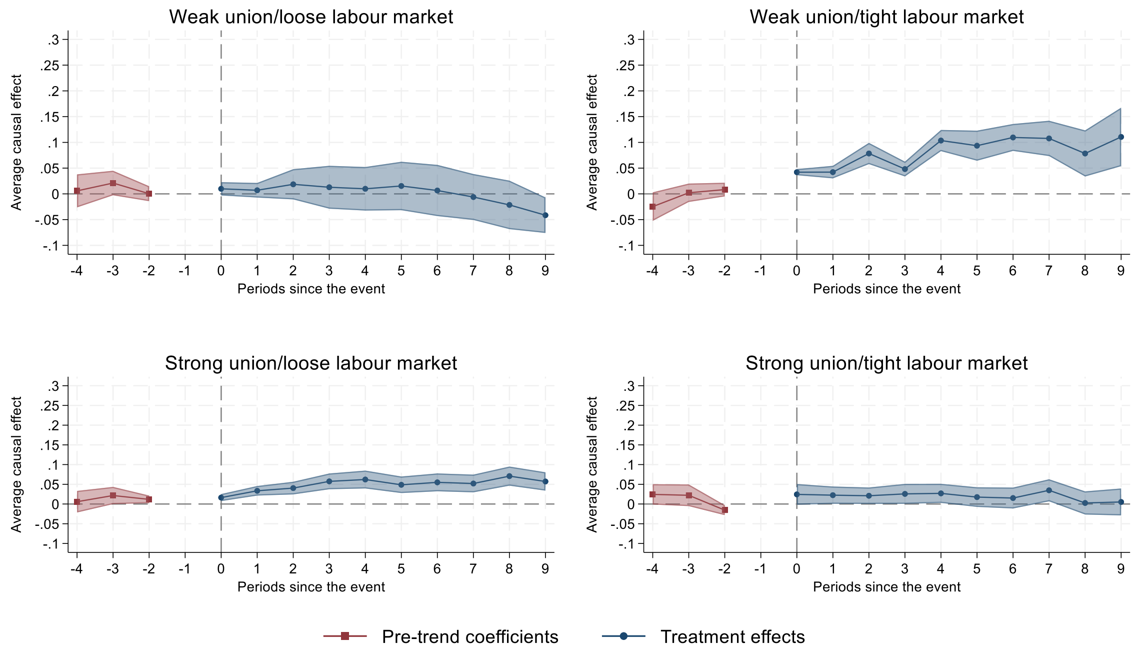
Note: Unit of observation: worker(W)Xfirm(F). Population: Selected exporting manufacturing firms 2000-2018 with at least 2 employees. All models comprise workerXfirm FEs. Reported standard errors are clustered on firm and on year (2168/19).

In Model 1 of Table 4, we start out with a simple difference-in-difference approach, estimating simple linear log hourly wage regressions on different fixed effects and controls (year fixed effects, and job fixed effects). Thus, we follow each worker within their job and study the impact of the free-trade agreement. In Model 2, we apply the IW-method to the same regression. In Models 3-6, we continue using IW-regressions, but focus on white and blue collar (Models 3 and 4) and union and non-union workers (Models 5 and 6).

While the standard FE-regression indicates no significant impact from the establishment of a free-trade agreement, the IW-regressions yield, with one exception, strongly significant and positive wage impacts from the introduction of a free-trade agreement. The average post-period treatment effects vary between 2.5-5.6 percent. The exception is found for blue collar workers, that appear not to benefit from free-trade agreements. Our previous analyses have shown that the introduction of free-trade agreements imply reduced export-market markups. Thus, these results are as expected. However, as seen by Equations 10) and 12), strong unions offset changes in the mark-up as well as employer monopsonistic powers.

Our strategy to shed light on this is to split the labour market into four parts, and conduct separate analyses for: 1)weak union-loose labour market, 2)weak union-tight labour market, 3) strong union-loose labour market, and 4) strong union-tight labour market. We let the occupational vacancy-unemployment rate express labour market tightness, while union density expresses union strength. Tighter labour market implies less employer monopsonistic power. Higher union density implies stronger union. Given the predictions from Equation 10) and 12), we expect to find that free-trade agreements affect wages for weak unions and tight labour markets, or for strong unions and loose labour markets. This is exactly what we see in Figure 5 (estimates presented in Table A5). Furthermore, since both labour market tightness and union strength (and the interaction) influence how free-trade agreements affect wages, this indicates that unions in these exporting manufacturing firms primarily bargain over wages.

Figure 5 Free-trade agreements and hourly wage



Note: Unit of observation: worker(W)Xfirm(F). Population: Selected exporting manufacturing firms 2000-2018 with at least 2 employees. All models comprise workerXfirm FEs. Reported standard errors are clustered on firm and on year (2168/19). Separate analyses for four combination of union strength and labour market tightness. See Table A5 for estimates.

10 Conclusion

In this paper, we have studied how public trade policies affect exports, the price-to-marginal cost mark-ups of Norwegian exporting firms, their performance and pay to workers. Increased globalisation through trade liberation is often associated with efficiency gains. Reduced import tariffs and red tape costs through free-trade agreements in foreign markets will reduce the marginal costs of all exporters to these markets. New productive exporters also enter the market reallocating the market share away from less productive exporters (Melitz, 2003; Egger and Kreickemeier, 2009). For the Norwegian exporting firms already present in the foreign market, this alters their markups.

Our analyses show that these free trade agreements increase Norwegian firms' exports, both revenues and total weight increases, but their export mark-ups in exporting markets decline.

These free trade agreements comprise both tariff- and non-tariff-measures, which in the literature have been identified to have contrasting effects, but in our case, the overall impact implies reduced exercised market power for Norwegian firms. However, as exports increase, so do return-on-assets. Thus, employers, firms and owners appear to benefit from the establishment of free-trade agreements. The same is also true for many workers. On average, all workers appear benefit, but no significant wage growth is observed for blue collar workers. This is partly a consequence of the bargaining structure in these manufacturing exporting firms.

Finally, we should point out that one cannot draw inference from these analyses to how free-trade agreements in general affect economies. First, our data are restricted to a selected group of Norwegian exporters, and Norway is just one part of these agreements. Second, we cannot even draw inference on the Norwegian economy in general, neither for firms nor workers. We limit the analyses to Manufacturing sector only. Furthermore, and equally important, we limit the analyses to the incumbent firms. This means that only firms already exporting to these countries are included in the analyses. Potentially these new entries might behave very differently than the incumbents. Thus, markups, return-on-assets and pay might deviate considerably when comparing new entries with old incumbent firms. Future research should remedy this shortcoming.

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Appendix

A) Drawing inference on the export mark-up

In a single product-setting, estimation of revenue and quantum total factor productivity is fairly established. One could estimate a simple Cobb-Douglas production function, expressed as Equation A1):

(A1) $$lnY_{ft} = \beta^L lnL_{ft} + \beta^k lnK_{ft} + \gamma_t + \omega_{ft}^Y + \varepsilon_{ft},$$

Y is value added for firm f at time t, ω_{ft} is a firm-specific productivity level known to the workplace as they choose the level of transitory inputs and make decisions, but not observed by us, γ_t represents technological change, L expresses labour, K is capital, and ε is a stochastic term representing idiosyncratic shocks that are unknown to the firm when it makes its decisions. Similarly, one could estimate the same equation replacing value added with a quantum measure.

The classical problem associated with the estimation of A1) is the *endogeneity of transitory inputs*. This is solved by the control function approach of ACF, where we include a proxy for time-varying productivity, ω_{ft}^j, j=Y,Q, using lagged values of capital and materials (including exporting/transport costs) and their interactions (third order polynomial) directly in the production function (as implemented by Rovigatti and Mollisi (2018). ACF consistently estimates A1) even if labour and materials are allocated simultaneously at time t, after the productivity shock. Implicitly it is assumed that firms observe their productivity shock and adjust intermediate inputs such as materials according to optimal demand conditional on the productivity shock and the state variable(s).[6] Capital is treated as the state variable, where capital evolves following an investment policy, determined at time t-1. Time varying productivity, ω_{ft}, evolves following a first-order Markov process: $\omega_{ft} = E(\omega_{ft} \mid \Omega_{ft-1}) + \xi_{ft} = E(\omega_{ft}, \mid \omega_{ft-1}, u_{ft-1}) + \xi_{ft} = g(\omega_{ft-1}, u_{ft-1}) + \xi_{ft}$.

[6] Gandi et al. (2020) show that applying this approach to the estimation of gross production function (in contrast to value added production functions) requires additional sources of variation in the demand for flexible inputs (e.g., prices) to successfully achieve identification. In our regressions later, our analyses utilise information on the country-specific export/import transportation costs.

However, free-trade agreements affect exporters only when they export to the involved countries, and exporters might export to many countries (most do so). This creates a multi-product setting. We follow Dhyne et al. (2022b), who show how to apply the ACF-framework to estimation of multiproduct production functions. This replace Y with a transformation g(Y_1, .., Y_n), which in the case of three products, can be represented by $A_y Y_1^{\theta 1} Y_2^{\theta 2} Y_3^{\theta 3}$ (θ_1=export to country c, θ_2=export to all other countries, and θ_3 =domestic sales). Then we transform Equation A1) to Equation A2), where we have normalized the output with respect to the export value to country c to 1 (by assuming $1= \theta_1+ \theta_2+ \theta_3$):

$$\text{(A2)} \quad lnR_{cft}^{exp} = \beta^L lnL_{ft} + \beta^k lnK_{ft} + \beta^{RD} ln(\frac{R_{ft}^{dom}}{R_{cft}^{exp}}) + \beta^{RE} ln(\frac{R_{E\not\ni c,ft}^{export}}{R_{cft}^{exp}}) + \gamma_t + \omega_{cft}^R + \varepsilon_{cft}$$

where lnR_{cft}^{exp} , $lnR_{E\not\ni c,ft}^{export}$ and lnR_{ft}^{dom} express log export value to country c, log aggregated export value added to all other countries than c and log value added to domestic marked, respectively. These latter two variables are treated as endogenous variables. Otherwise, the estimation follows a standard approach, but note that our proxy based on intermediate goods incorporate country-specific export and transport costs, i.e., it varies over both across firms and within firms between export countries. The time varying productivity, ω_{cft}^R, evolves following a first-order Markov process: ω_{cft} = E(ω_{cft} $|\Omega_{ft-1}$) + ξ_{ft} = E(ω_{cft}, $|\omega_{cft-1}, lnR_{ft-1}^{dom}, lnR_{E\not\ni c,ft-1}^{export}$) + ξ_{cit}=g($\omega_{cft-1}, lnR_{cft-1}^{dom}, lnR_{E\not\ni c,ft-1}^{export}$)+$\xi_{cit}$. Thereby we can measure productivity changes conditional on the level of the endogenous variable. The estimation of A2) yields a set of estimated parameters, among others also the country-specific total factor productivity, $\widehat{\omega_{cft}^R}$, for each firm at time t.

From the exporting declaration, we know whether the product that is exported, is sold as truly quantum (cars, computers, bras), as weight (e.g., flour, grain, ferro-silicon) or volume (oil- and gas). 80 percent of the export is primarily by weight, and we know the export weight even when the declaration indicates that the product is sold in quantum or volume. For our purpose, the important distinction is that this is not expressed in the form of revenue, which comprises prices. Thus, we replace lnR_{cft}^{exp} with lnQ_{cft}^{exp}, i.e., log weight exported to country c, in Equation A2), and estimate this as Equation A3):

A3) $$lnQ_{cft}^{exp} = \alpha^{L} lnL_{ft} + \alpha^{k} lnK_{ft} + \alpha^{Q} \ln\left(\frac{Q_{ft}^{dom}}{Q_{cft}^{exp}}\right) + \beta^{Q} \ln\left(\frac{Q_{E\not\ni c,ft}^{export}}{Q_{cft}^{exp}}\right) + \gamma_{t} + \omega_{cft}^{Q} + \varepsilon_{cft},$$

where lnQ_{cft}^{exp} , $lnQ_{E\not\ni c,ft}^{export}$ and lnQ_{ft}^{dom} express log export weight to country c, log aggregated export quantum to all other countries, and log approximated weight to domestic marked (approximated by the average weight-revenue relationship across all export countries for a firm), respectively. The estimation of A3) yields a set of estimated parameters, among others also the country-specific total factor productivity, $\widehat{\omega_{cft}^{Q}}$, for each firm at time t.

Table A2 presents the results from estimating the Cobb-Douglas production functions applying the approach of Ackerman et al. (2015) and Dhyne et al. (2021). Descriptive statistics on key measures on the firmXexport country panel data set is presented in Table A1. The first three models present the results from where the dependent variable expresses log exporting revenue. Model 1 shows the parameter estimates of the basic Cobb-Douglas production function excluding log domestic sales and log export to other countries. In Model 2, we add log domestic sales and log export to other countries to the regression as exogenous controls, while in Model 3 we treat log domestic value added and log value added to other countries as endogenous variables. We see that adding log domestic value added and log value added to other countries to the regressions, increases the elasticities of labour and capital. As expected, the parameter associated with log domestic sales and log export to other countries are negative, significant, implying a positive contribution to total production. The final three models present the results from where the dependent variable expresses log exporting weight. These parameters resemble the estimated parameters associated with revenue, but particularly the parameter associated with log domestic weight is clear more negative.

Under an assumption of constant elasticity of scale, $1=\theta_1+\theta_2+\theta_3$, thus our estimates from Model 3 imply $\theta_1=0.675$, $\theta_2=0.250$ and $\theta_3=0.075$. Similar figures based on Model 6 yields $\theta_1=0.140$, $\theta_2=0.150$ and $\theta_3=0.710$.

If we assume that the firm faces an inverse product demand curve, P(Q), then a firm's revenue can be expressed by: R(Q)=P(Q)Q. Since a profit maximizing firm chooses L to equate marginal profit to marginal costs, i.e., : $\frac{\partial R(Q)}{\partial L}=\frac{\partial C(Q)}{\partial L}$, or rather $\frac{\partial C(Y)/\partial Q}{P}=1+\epsilon_Q^P$, i.e., the markup of price relative to marginal costs can be expressed as $\mu=\frac{P}{\partial C(Y)/\partial Y}=\frac{1}{1+\epsilon_Q^P}$. We can derive a measure of P by utilizing our estimated TFP-measures: $\widehat{\omega_{cft}^P}(\widehat{\omega_{cft}^Q})=\widehat{\omega_{cft}^R}-\widehat{\omega_{cft}^Q}$. Then we follow the description given by the text.

B) Tables

Table A1 Descriptive statistics – firmsXcountry panel

LnR^ex^-direct	LnQ^ex^-direct	LnQ^ex^-others	LnQ^dom^	LnVA^ex^-direct	LnVA^ex^-others	LnVA^ex^-domestic	LnInt +transport	LnL	LnC	ϵ_{ct}^{P}
A)Free-trade firmXcountry[3342]										
14.391	9.107	4.860	2.691	13.793	4.451	0.067	13.789	4.610	19.462	-0.728
(1.915)	(2.431)	(2.272)	(3.697)	(2.338)	(2.003)	(7.987)	(3.190)	(1.312)	(1.671)	(0.142)
B) Control[156134]										
12.652	7.261	3.226	3.438	12.025	2.593	2.965	12.807	3.696	18.057	-0.368
(2.353)	(3.030)	(3.826)	(2.376)	(2.487)	(4.696)	(6.709)	(3.746)	(1.363)	(1.826)	(0.227)
C) Matched control[89597]										
13.066	7.672	3.329	5.359	12.726	4.826	-0.235	13.232	4.518	19.177	-0.428
(2.425)	(3.061)	(3.003)	(4.269)	(2.537)	(2.513)	(9.048)	(4.104)	(1.298)	(1.753)	(0.209)

Note: Population: All exporting Manufacturing firms 2000-2018 with at least 2 employees and at least 14 years of observations in destination export country. Table elements report mean, standard deviation (in parentheses) and number of observations (in brackets). Panel A) reports for the free-trade firms (treatment), while Panel B) reports for the control firms. LnR^{direct} and LnQ^{direct} express log export revenue and log export weight to the specific country. LnQ^{ex}, and LnQ^{dom} and LnQ^{dom} express log weight direct to a specific country, log domestic weight and log weight to all other countries. $LnVA^{-others}$ and $LnVA^{dom}$ express log export value-added to all other export countries and log domestic value added, respectively. LnL , LnK and Ln Int incl transport express log workforce size, log capital and log intermediates incl transport, respectively..

Table A2 Estimation of firms' Cobb-Douglas production functions

	Revenue(value added)			Weight		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Ln L	0.301**	0.501**	0.471**	0.388**	0.435**	0.499**
	(0.002)	(0.004)	(0.106)	(0.002)	(0.022)	(0.001)
Ln C	-0.042**	0.253**	0.233**	0.037**	0.353**	0.340**
	(0.011)	(0.048)	(0.071)	(0.009)	(0.015)	(0.001)
$Ln(R^{allothercountries}/R^{export\ country})$		-0.239**	-0.250**			
		(0.036)	(0.057)			
$Ln(Q^{allothercountries}/Q^{exportcountry})$					-0.126**	-0.150**
					(0.015)	(0.002)
$Ln(R^{domestic}/R^{export\ country})$		-0.153**	-0.075**			
		(0.012)	(0.006)			
$Ln(Q^{domestic}/Q^{export\ country})$					-0.736**	-0.710**
					(0.009)	(0.001)
Endogenous:			$Ln(\frac{R^{dom}}{R^{exp}})$ $Ln(\frac{R^{allother\ countries}}{R^{exp}})$			$Ln(\frac{Q^{dom}}{Q^{exp}})$ $Ln(\frac{Q^{allother\ countries}}{Q^{exp}})$
FXC	51909	51909	51909	48589	48589	48589
N (FxT)	238282	238282	238282	242144	248222	248222

Note: Unit of observation: export destination country(C)Xfirm(F). Population: All exporting manufacturing firms 2005-2018 with at least 3 employees. All variables are apriori residualized taking into account year and detailed industry variation (based on the Frisch-Waugh-Lovell theorem). Dep. Variable: Model 1-3: Log value added from exports to country C; Model 4-6: Log weight exported to country C. Controls: lnL and lnC express log employment and log capital, respectively. $Ln(R^{domestic}/R^{export\ country})$ expresses log (domestic value added relative to value added to export country). $Ln(Q^{allothercountries}/Q^{exportcountry})$ expresses log (aggregated weight exported to other countries relative to weight to export country). $Ln(Q^{domestic}/Q^{export\ country})$ expresses log (aggregated domestic weight relative to weight to export country). $Ln(R^{allothercountries}/R^{export\ country})$ expresses log (aggregated export value added to other countries relative to export value to country). In Model 3 and 6 these are treated as endogenous. Method: Estimation of the production function is based on Ackerberg et al (2015), Rovigatti and Molisi (2018) and Dhymes et al (2020) control function approach for multiproduct production (see text). Bootstrapped standard errors are based on 100 repetitions adjusted for firm clustering and presented in parentheses. ^{x}, * and ** denote 10, 5 and 1 percent level of significance, respectively.

Table A3 IW-regressions on the firmsXdestination country panel

	All				CEM-weighted			
	Log export revenue	Log export weight	Log number of competitors	Elasticity of price w.r.t weight	Log export revenue	Log export weight	Log number of competitors	Elasticity of price w.r.t weight
F4event	-0.159	-0.070	0.015	-0.041	-0.159	-0.070	0.015	-0.041
	(0.100)	(0.085)	(0.018)	(0.039)	(0.100)	(0.085)	(0.018)	(0.039)
F3event	0.005	0.077	-0.001	0.017	0.005	0.077	-0.001	0.017
	(0.062)	(0.059)	(0.017)	(0.025)	(0.062)	(0.059)	(0.017)	(0.025)
F2event	-0.008	0.026	0.001	0.008	-0.008	0.026	0.001	0.008
	(0.065)	(0.075)	(0.012)	(0.025)	(0.065)	(0.075)	(0.012)	(0.025)
L0event	0.020	-0.002	0.061**	0.016	0.020	-0.002	0.061**	0.016
	(0.042)	(0.047)	(0.014)	(0.017)	(0.042)	(0.047)	(0.014)	(0.017)
L1event	0.289**	0.365**	0.046*	0.048**	0.289**	0.365**	0.046*	0.048**
	(0.049)	(0.061)	(0.020)	(0.013)	(0.049)	(0.061)	(0.020)	(0.013)
L2event	0.211**	0.241**	0.062*	0.076**	0.211**	0.241**	0.062*	0.076**
	(0.058)	(0.056)	(0.025)	(0.023)	(0.058)	(0.056)	(0.025)	(0.023)
L3event	0.169*	0.204**	0.070*	0.067*	0.169*	0.204**	0.070*	0.067*
	(0.081)	(0.082)	(0.033)	(0.028)	(0.081)	(0.082)	(0.033)	(0.028)
L4event	0.283**	0.309**	0.101**	0.069*	0.283**	0.309**	0.101**	0.069*
	(0.070)	(0.067)	(0.026)	(0.027)	(0.070)	(0.067)	(0.026)	(0.027)
L5event	0.383**	0.331**	0.126**	0.068*	0.383**	0.331**	0.126**	0.068*
	(0.092)	(0.083)	(0.030)	(0.029)	(0.092)	(0.083)	(0.030)	(0.029)
L6event	0.494**	0.546**	0.094**	0.089**	0.494**	0.546**	0.094**	0.089**
	(0.096)	(0.118)	(0.034)	(0.027)	(0.096)	(0.118)	(0.034)	(0.027)
L7event	0.306**	0.442**	0.097**	0.052^{x}	0.306**	0.442**	0.097**	0.052^{x}
	(0.064)	(0.067)	(0.033)	(0.027)	(0.064)	(0.067)	(0.033)	(0.027)
L8event	0.319**	0.354**	0.126**	0.072**	0.319**	0.354**	0.126**	0.072**
	(0.053)	(0.063)	(0.040)	(0.023)	(0.053)	(0.063)	(0.040)	(0.023)
L9event	0.232**	0.355**	0.131**	0.065**	0.232**	0.355**	0.131**	0.065**
	(0.082)	(0.092)	(0.043)	(0.024)	(0.082)	(0.092)	(0.043)	(0.024)
FXC	16740	16740	16740	16740	15597	15597	15597	15597
N (FxT)	190345	190345	190345	190345	60248	60248		

Note: Unit of observation: export (destination) country(C)Xfirm(F). Population: All exporting manufacturing firms 2000-2018 with at least 2 employees. All models comprise destination country-firm FEs and year dummies. Reported standard errors are clustered on country(170) and year.

Table A4 IW-regressions of return on assets – for the firm panel

	OM-all	OM-CEM	ROA-all	ROA-CEM
F4event	0.012	0.004	0.012	0.004
	(0.010)	(0.016)	(0.010)	(0.016)
F3event	-0.010	0.011	-0.010	0.011
	(0.008)	(0.015)	(0.008)	(0.015)
F2event	0.008	-0.009	0.008	-0.009
	(0.010)	(0.012)	(0.010)	(0.012)
L0event	0.013	-0.015	0.013	-0.015
	(0.007)	(0.014)	(0.007)	(0.014)
L1event	0.016	-0.003	0.016	-0.003
	(0.018)	(0.017)	(0.018)	(0.017)
L2event	0.022*	0.002	0.022*	0.002
	(0.010)	(0.022)	(0.010)	(0.022)
L3event	0.025	0.018	0.025	0.018
	(0.017)	(0.022)	(0.017)	(0.022)
L4event	0.081**	0.037	0.081**	0.037
	(0.015)	(0.026)	(0.015)	(0.026)
L5event	0.066**	0.050*	0.066**	0.050*
	(0.011)	(0.019)	(0.011)	(0.019)
L6event	0.043*	0.030	0.043*	0.030
	(0.016)	(0.021)	(0.016)	(0.021)
L7event	0.037*	0.029	0.037*	0.029
	(0.014)	(0.028)	(0.014)	(0.028)
L8event	0.031x	-0.058x	0.031x	-0.058x
	(0.016)	(0.028)	(0.016)	(0.028)
L9event	0.052**	0.042x	0.052**	0.042x
	(0.012)	(0.024)	(0.012)	(0.024)
R^2-adj.	0.401	0.361	0.401	0.361
N (FxT)	34610	2301	34610	2301

Note: Unit of observation: firm(F). Population: All exporting manufacturing firms 2000-2018 with at least 2 employees, with at least 14 observations. All models comprise year and firm FEs. Reported standard errors are clustered on firm.

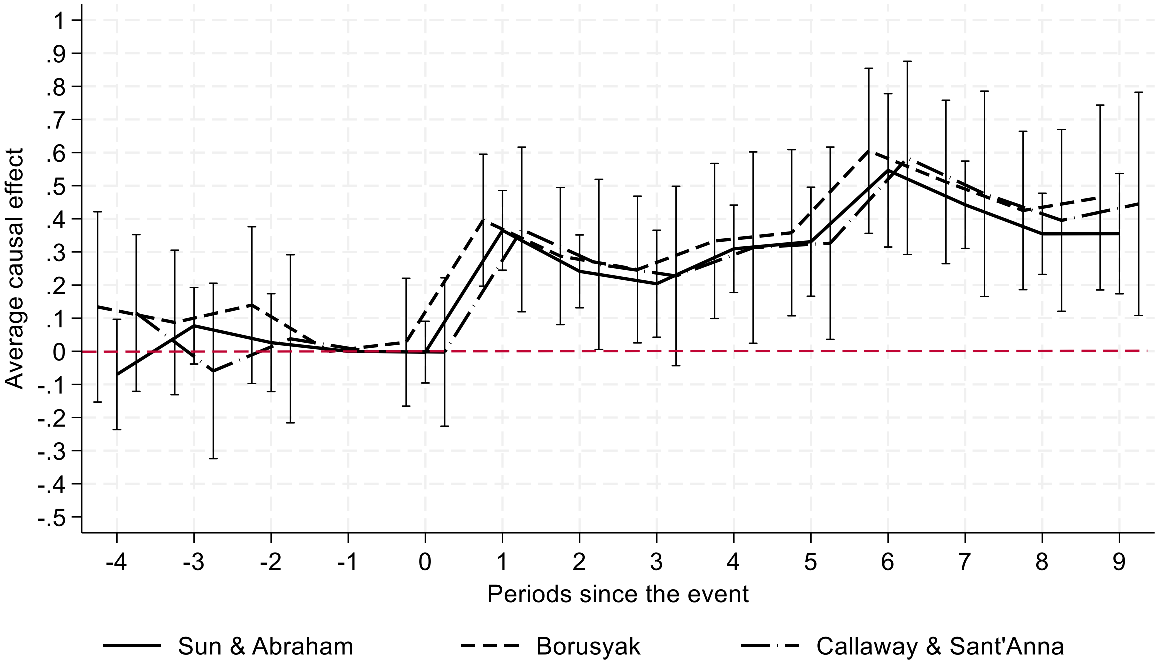
Table A5 The impact of free-trade agreements on log hourly wages.

FirmsXworker panel. Only CEM-weighted.

	Weak union/loose labour market	Weak union/tight labour market	Strong union/loose labour market	Strong union/tight labour market
F4event	-0.001	-0.043**	0.018	0.020
	(0.014)	(0.012)	(0.013)	(0.014)
F3event	0.016^{x}	-0.010	0.030*	0.006
	(0.009)	(0.009)	(0.009)	(0.015)
F2event	-0.009	-0.007	0.005	-0.013
	(0.021)	(0.008)	(0.008)	(0.008)
L0event	-0.013	0.055**	0.011	0.014
	(0.013)	(0.004)	(0.008)	(0.009)
L1event	-0.011	0.072**	0.019**	-0.003
	(0.007)	(0.007)	(0.003)	(0.008)
L2event	-0.001	0.116**	0.019	0.009
	(0.017)	(0.009)	(0.011)	(0.011)
L3event	-0.006	0.083**	0.042**	0.026
	(0.033)	(0.007)	(0.012)	(0.017)
L4event	-0.003	0.150**	0.049**	0.024^{x}
	(0.040)	(0.012)	(0.009)	(0.013)
L5event	-0.001	0.157**	0.036**	0.018
	(0.036)	(0.013)	(0.009)	(0.014)
L6event	-0.020	0.163**	0.049**	0.014
	(0.054)	(0.014)	(0.013)	(0.018)
L7event	-0.034	0.122**	0.047**	0.013
	(0.057)	(0.014)	(0.012)	(0.011)
L8event	-0.051	0.085**	0.065**	0.016
	(0.068)	(0.009)	(0.013)	(0.013)
L9event	-0.059	0.109**	0.064**	0.018
	(0.077)	(0.011)	(0.013)	(0.022)
Estimation method	IW-FE	IW-FE	IW-FE	IW-FE
R^2-adj.	0.649	0.730	0.720	0.788
N (WxFxT)	294512	141739	336785	144166

Note: Unit of observation: worker(W)Xfirm(F). Population: Selected exporting manufacturing firms 2000-2018 with at least 2 employees. All models comprise workerXfirm FEs. Reported standard errors are clustered on firm and on year (2168/19).

Figure A1 Free-trade agreements, the development of export weight and the comparison of different estimators



Note: Population: All exporting Manufacturing firms 2000-2018 with at least 2 employees and with at least 14 observations to export-destination country. The graphs report estimates from difference-in-difference regression of the establishment of a free-trade agreement on log firm total export weight in event-study form. Regressions are based on the IW-estimator of Sun and Abraham (2021), the Borusyak (2023)-estimator, and the estimator of Callaway and Sant'Anna (2021). In addition to year dummies, the regressions comprise 2000-values of destination country employment, log currency (w.r.t. U.S.$) and product market competition index interacted with year dummies. Standard errors are clustered on firm and export destination country. Note in the figure, the time indicator for the Borusyak-estimator is shifted -0.25 time units (to the left), while the Callaway and Sant'Anna-estimator is shifted +0.25 (to the right). This is done, so the confidence intervals associated with each estimator can be differentiated from each other. Full regression results available from the author upon request.