CESifo WORKING PAPERS

11041
2024

March 2024

Heterogeneous Impacts of Trade Shocks on Workers

Patrick Arni, Peter H. Egger, Katharina Erhardt, Matthias Gubler, Philip Sauré

CESifo

Impressum:

CESifo Working Papers
ISSN 2364-1428 (electronic version)
Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH
The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute
Poschingerstr. 5, 81679 Munich, Germany
Telephone +49 (0)89 2180-2740, Telefax +49 (0)89 2180-17845, email office@cesifo.de
Editor: Clemens Fuest
https://www.cesifo.org/en/wp
An electronic version of the paper may be downloaded
· from the SSRN website: www.SSRN.com
· from the RePEc website: www.RePEc.org
· from the CESifo website: https://www.cesifo.org/en/wp

CESifo *Working Paper No. 11041*

Heterogeneous Impacts of Trade Shocks on Workers

Abstract

This paper identifies the causal effects of trade shocks on worker outcomes. We exploit a unique setting based on three pillars: (i) a large, unanticipated appreciation of the Swiss franc in 2015, (ii) detailed data with firm-level exposure to trade via output markets (both domestic and foreign) and imported inputs (distinguished by their foreign labor content), which we match to (iii) worker-level panel data with rich information on labor-market outcomes. We find that increased competition in output markets induces negative effects on earnings for workers of affected firms. Conversely, a price drop of foreign inputs generates positive effects for workers of importing firms, but less so the higher the labor content of these imported inputs. All these patterns are consistent with a parsimonious model of task-based production. Moreover, positive and negative earnings effects are especially strong for workers in the lower tail of the within-firm wage distribution and, in particular, for workers who change their employer, pointing at involuntary (voluntary) job separations from firms that are negatively (positively) affected by the exchange rate appreciation.

JEL-Codes: F140, F160, J460.

Keywords: trade and labor, exchange rate shock, matched employer-employee data.

Patrick Arni
University of Bristol / United Kingdom
patrick.arni@bristol.ac.uk

Peter H. Egger
ETH Zurich / Switzerland
pegger@ethz.ch

Katharina Erhardt
University of Düsseldorf / Germany
erhardt@dice.hhu.de

Matthias Gubler
Swiss National Bank, Zurich / Switzerland
matthias.gubler@snb.ch

Philip Sauré
Johannes Gutenberg-University Mainz / Germany
philip.saure@uni-mainz.de

March 27, 2024
We would like to thank Rodrigo Adão, Treb Allen, Costas Arkolakis, Raphael Auer, Arnaud Costinot, Lorenzo Caliendo, Rafael Dix-Carneiro, Hartmut Egger, Michael Graber, Ina Jaekel, Brian Kovak, Andreas Lichter, John McLaren, Marc-Andreas Muendler, Marcelo Olarreaga, Fernando Parro, Ariell Reshef, Esteban Rossi-Hansberg, Jens Suedekum, Felix Tintelnot, Farid Toubal, the participants at the ETSG in Groningen, FIW Workshop 'Firms andWorkers in the Global Economy' in Linz, the FIWWorkshop on Regional Economics in Vienna, the workshop on 'Globalization and Workforce Composition' at Paris Dauphine, the Venice Summer Institute, the CES ifo Global Area Conference in Munich, the workshop on 'International Economics' in Goettingen as well as seminar participants at the University of Chicago, the University of Duesseldorf, the University of Mainz, the University of Trier, the University of Aarhus, LMU Munich, the University of Lugano and the University of Bristol for helpful comments and discussions. We would also like to thank Sebastiano Papini and Michael Barczay for excellent research assistance. The views expressed in this paper are those of the authors and do not necessarily reflect those of the SNB. Katharina Erhardt and Philip Sauré gratefully acknowledge funding by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - No. 523703559.

1 Introduction

The distributional consequences of trade for workers are of key interest to scholars in international economics and policymakers alike. While trade integration can generate important aggregate gains, these gains are rarely equally distributed but give rise to winners and losers. Identifying these winners and losers is essential, e.g., to compensate the disadvantaged and to maintain social cohesion. At the same time, the distributional consequences of trade unfold through complex channels, rendering their identification challenging.

Gains from trade emerge as some segments of the economy expand while others contract. For individual workers, earnings gains or losses are largely dictated by their employment in one or the other segment. Whether a segment expands or contracts depends, on the one hand, on changes in the competitive environment of domestic and foreign *output markets*. On the other hand, changes in sourcing opportunities change the environment of *input markets*. The trade literature has shown that in both, output and input markets, heterogeneous firms are affected differently by trade shocks, and even within narrowly defined industries some firms expand while others contract (Melitz, 2003; Antràs and Helpman, 2004). As different forces originating from output and input markets transmit trade shocks to workers, individual firms emerge as the relevant unit determining the distributional consequences of trade for workers.

This paper identifies the impact of trade on workers' earnings through different channels, making use of an exceptionally sharp, unanticipated, and persistent appreciation of the Swiss franc that occurred in January 2015. We will refer to this exchange rate appreciation as a *trade shock*, as it entailed a shock to relative import and export prices.[1] To identify the impacts on worker outcomes, we exploit a novel and unusually rich panel dataset of employer-employee social-security data matched to firm-level customs data.

Guided by a parsimonious conceptual framework of task-based production and firm-specific export and import participation, our empirical analysis focuses on four channels that determine workers' outcomes emerging through firms' labor-demand exposure to the trade shock. The first two channels relate to the impact of the trade shock on firms' *output markets*: firms experience increased competition on (i) domestic markets (i.e., import competition) and (ii) export markets. The two other channels relate to the effect of the shock on firms' *input markets*. Specifically, firms experience (iii) a positive productivity effect due to cheaper imported intermediate inputs, which should increase demand for workers if imported inputs complement labor (Antràs et al., 2017), while (iv) an opposing and simultaneous labor-substitution effect operates if workers are substituted by imported inputs (Boehm et al., 2020). Our data allow us to precisely measure the four channels by means of pre-shock data on (i) import penetration of products at the 4-digit sector level, (ii) firm-level exporting status, (iii) firm-level importing status and (iv) the foreign-labor content of firms' imported inputs.

Our results show that all four output- and input-market channels matter and determine how the Swiss trade shock affects workers. We document well-known effects of import competition to be present: employment in a sector with a one standard deviation higher import competition involves a decline in earnings growth of 2.5 percentage points. But even within narrowly defined sectors and within labor-market regions, workers' earnings responses strongly depend on their respective

[1] This shock, which we discuss in detail below, has been exploited in earlier influential work to analyze the exchange rate pass-through (Bonadio et al., 2020, Auer et al., 2021, Auer et al., 2023), the role of sticky wages (Funk and Kaufmann, 2022) and responses in cooperate finance (Efing et al., 2023).

firm's engagement in international trade. Workers employed at exporting firms prior to the shock see an average decline in earnings growth of 1.9 percentage points. Employment at input-importing firms, in contrast, results in relative earnings gains of 2.1 percentage points if input imports only consist of materials (complementing labor). The latter effect drops to 0.9 percentage points if input imports only consist of processed inputs (substituting labor).

Estimates of the firm-level responses to the trade shock corroborate the mechanisms of the conceptual framework that guides our empirical analysis. Ex ante input-importing firms expand their workforce, while firms with ex-ante exporting reduce their workforce. Again, the positive effect of input importing declines with a higher share of processed input content in imports, suggesting labor substitution. Firms adjust their organizational structure by altering the composition of their labor force and by expanding the range of product categories they source from abroad.

Finally, we exploit detailed data on worker characteristics, documenting substantial heterogeneity of worker responses within firms. Workers in the lowest quartile of the within-firm wage distribution are affected the strongest by the trade shock. In particular, workers in the bottom wage quartile of an exporting firm prior to the shock see a decline in earnings growth of more than 6 percentage points. Tenure mitigates positive as well as negative earnings responses to the shock. Moreover, we see that the effects of input importing are more pronounced among workers in professions that are closer to the production process of manufacturing firms.

We further show that the negative earnings effects for workers employed at exporting firms are entirely born by those who leave their employers and experience very large relative earnings losses, while those who stay with their employers are shielded from losses. The latter result is confirmed by the fact that firms do not change their wage setting in response to the negative labor-demand shock. Conversely, positive earnings responses are more pronounced for more mobile workers, pointing at voluntary job separation and a positive selection of leavers. In our firm-level analysis, we also document gains for stayers at positively treated firms, suggesting rent sharing between firms and workers.

Despite the reduced-form nature of our analysis, we argue that the results reveal important information about specific characteristics of the underlying labor market and may thus inform future modeling choices. We observe important wage differentials across firms and substantial earnings losses for workers who (have to) leave high-wage firms. The strong concentration of earnings losses among these workers points at downward wage rigidities within surviving job matches. Moreover, differential earnings responses to the two import channels and across worker types indicate that labor markets are segmented by tasks in the production process. Finally, our results suggest that a firm's organizational structure depends on its direct trade exposure, and we provide evidence of rent-sharing between firms and workers in case of positive productivity shocks.

This paper relates to various strands of the literature. First, we contribute to a large body of research examining the effects of trade shocks on labor-market outcomes with a focus on output-market trade exposure. Sparked by Autor et al. (2013), much of this literature studies shocks to import competition defined at the sector level (e.g., Acemoglu et al., 2016 and the work reviewed in Autor et al., 2016) or uses shift-share designs with regional labor markets as the unit of observation (Dauth et al., 2014, Autor et al., 2015, Balsvik et al., 2015, Dix-Carneiro and Kovak, 2017, Fischer et al., 2023). Some recent studies use structural general equilibrium models to trace the effects of import competition on local labor markets (Caliendo et al., 2019, Adão et al., 2020, Galle et al., 2023). Several contributions further exploit sector-region variation in import competition to study worker-level outcomes (Autor et al., 2014, Hakobyan and McLaren, 2016, Dix-Carneiro and Kovak,

2019, Dauth et al., 2021). Part of the literature extends the analysis to export-market access (e.g., Dauth et al., 2014, Costinot et al., 2022), with a small body actually exploiting information on firm-level trade exposure (Utar, 2018, Keller and Utar, 2022, Aghion et al., 2022, Costinot et al., 2022).[2] We add to this literature in three ways. First, we show that firm-level differences in trade exposure matter even within narrowly defined sectors and channel trade shocks to workers.[3] Second, we account for the fact that trade shocks alter the output- and input-market environment simultaneously.[4] Addressing all channels is particularly important for firm-level analyses, in view of the fact of a strong correlation between firms' export- and input-import exposure (Kasahara and Lapham, 2013; Aghion et al., 2022). Finally, our analysis benefits from the sharp, unanticipated, and lasting Swiss exchange rate appreciation and, thus, a shock to relative prices of traded goods. The shock's unanticipated nature has the clear benefit of excluding possible anticipatory effects. Akin to shocks to trade frictions (as in Dix-Carneiro and Kovak, 2017; Utar, 2018; Dix-Carneiro and Kovak, 2019; Keller and Utar, 2022), this price shock has the additional advantage of measuring the pure change in prices without directly affecting quantities. This distinction is especially relevant when measuring trade exposure at the firm level, where price changes induce quantity responses depending on firm technology (e.g., Halpern et al., 2015, Antràs et al., 2017, Oberfield, 2018, Gimenez-Perales, 2024) or may induce competitive pressure without any quantity responses (e.g., Auer et al., 2018).

A second, closely related literature studies the effects of input sourcing on labor demand (e.g., Harrison and McMillan, 2011, Hummels et al., 2014, Ebenstein et al., 2014, Antràs et al., 2017, Feenstra and Sasahara, 2018, Costa et al., 2019, Boehm et al., 2020). While adverse shocks to a firm's export opportunities have unambiguously negative effects for its employees, shocks to input-import opportunities do not generate the mirror image. Indeed, a lower price of foreign inputs may reduce the demand for domestic workers, who produce inputs locally (see Feenstra and Hanson, 1996, 1997; Boehm et al., 2020). Accordingly, recent studies document that offshoring tends to reduce firms' labor demand to various degrees, depending on firms' sourcing countries and on their workers' skill level (e.g., Harrison and McMillan, 2011, Ebenstein et al., 2014, Hummels et al., 2014, Pierce and Schott, 2016, Boehm et al., 2020). However, foreign input sourcing also generates productivity gains that raise labor demand in the remaining segments of the value chain (Kohler, 2004; Grossman and Rossi-Hansberg, 2008, Harrison and McMillan, 2011, Antràs et al., 2017). The resulting net effect of a price reduction of foreign inputs then depends on complementarities among

[2]Earlier work on the labor-market effects of trade adopts a pure sector-level perspective (see Klein et al., 2003, and Egger et al., 2007 for overviews). One strand of that work considers the effects of trade on net employment, documenting mostly negative effects (see Grossman, 1986, Revenga, 1992). Other work documents limited effects of trade on gross job or worker flows between sectors (Boeri and Cramer, 1992, Davis et al., 1998, Gourinchas, 1998 and Klein et al., 2003). Together, both observations suggest that stable job counts go hand in hand with significant worker flows underneath (see also Goldberg and Knetter, 1999, Kletzer, 2000, 2002, Egger et al., 2007), which points at the relevance of using matched employer-employee panel data.

[3]In our baseline regressions, sectors are defined at the 4-digit level. The effect of increased output-market competition on firm-level employment is much reduced in Aghion et al. (2022), when controlling for effects of sectors at 2-digit level already. Related theoretical work studies rent-sharing between employers and employees in Melitz-type models. Under selection into exporting, adverse shocks to export opportunities affect wages by eroding exporters' wage premia (see Irarrazabal et al., 2013, Helpman et al., 2016, Egger et al., 2022). Irarrazabal et al. (2013) and Egger et al. (2022) highlight the role of worker ability, selection and sorting, analyzing within-firm wage dispersion related to skills. Our work provides evidence that adverse trade shocks erode existing exporter wage premia through job destruction.

[4]Magyari (2017) and Aghion et al. (2022) are rare examples of studies addressing the export and the input imports simultaneously, but they do not distinguish between labor-substitution and overall productivity effects of inputs.

production factors and is ambiguous and possibly weak or insignificant on average in empirical work (compare, e.g., Hummels et al., 2014; Aghion et al., 2022). Close to our work, Hummels et al. (2014) use matched employer-employee data to document that offshoring results in wage changes within employment spells, especially for low-skilled workers and for routine-task jobs. Our results reconcile the ambiguous earlier results, by disentangling the substitution from the productivity effect of imported inputs on domestic worker outcomes, documenting that both opposing forces operate simultaneously.

Third, our work also relates to research on how trade shocks impact firms' decisions and their organizational structure (e.g., Ekholm et al., 2012, Alfaro et al., 2023, and Blaum, 2023). Close to our paper in its empirical design, Ekholm et al. (2012) show how a real exchange rate appreciation affects firms' production processes and productivity growth via both, export- and import-exposure.[5] Recently, Alfaro et al. (2023) document that trade-related productivity growth is linked to innovation, in line with models by Aw et al. (2011) and Halpern et al. (2015). Blaum (2023) reports that firm size adapts after devaluation episodes and highlights the role of import and export intensities, while Colella (2022) uses the Swiss exchange rate shock to study the effect on firms' skill requirements as identified in their job postings. Our work confirms these broad messages regarding changes in the size of a firm's labor force in response to the shock. It further adds to the literature by simultaneously tracing the job trajectories of affected workers and highlighting heterogeneous impacts on workers within firms. Our findings also provide evidence in support of trade models highlighting the organizational structure and, particularly, the endogenous workforce composition of firms (see Helpman et al., 2010, Caliendo and Rossi-Hansberg, 2012, and Sampson, 2014). In line with the theoretical mechanisms underlying these models, we document that firms not only adjust their employment size in response to trade shocks, but that they also change their workforce composition and the set of products sourced from abroad.

Finally, we add to a recent strand of work in international and regional economics, which, sparked by Artuç et al. (2010) and Artuç and McLaren (2015), addresses the role of frictions in models with imperfectly mobile workers in dynamic general equilibrium. This literature focuses on labor-market aggregates and documents limited worker mobility in reaction to wage differentials across jobs within regions, sectors, or occupations (Caliendo et al., 2018, Caliendo et al., 2019, Adão et al., 2020, Caliendo et al., 2021, and Caliendo et al., 2023). We inform this literature with evidence in favor of strong downward wage rigidities conditional on the survival of employer-employee matches, as earnings gains and losses in our data are almost entirely realized through job switching. Our results suggest, in line with Costinot et al. (2022) and McLaren (2022), that it may be fruitful to introduce nominal frictions in Caliendo-Parro-type frameworks, as proposed in recent studies, e.g., by Rodríguez-Clare et al. (2022) and Fadinger et al. (2024).[6] Relatedly, an important strand of work in labor economics studies the long-run worker-level effects of adverse shocks and highlights the importance of workers switching to lower-paying firms in explaining their results (Pytka and Gulyas, 2021, Gulyas et al., 2023, Schmieder et al., 2023).

The remainder of the paper is structured as follows. Section 2 provides the context and a short

[5] See also Bernard and Jensen (1999) and Pavcnik (2002) on related mechanisms.

[6] Our results extend the findings in McLaren and Parks (2022), who document strong downward wage rigidities with shocks to import competition. In addition, we add to the growing literature that documents that macroeconomic conditions at the date of labor-market entry have persistent effects on individuals' wages (see, e.g., Kahn, 2010 and the work reviewed in Wachter, 2020). Our work is also complementary to recent work on job switching in the presence of input-output linkages (Cardoza et al., 2023), but we measure such input-output linkages only through the affiliation with common sectors and through input imports from abroad.

background of the Swiss exchange rate shock. Section 3 introduces a conceptual framework, and Section 4 gives an overview of the data and measurement. Section 5 presents our results, which we discuss in Section 6. Section 7 concludes.

2 Background: Exchange-rate shock and the Swiss labor market

This section briefly describes the background of the sharp, unanticipated, and lasting appreciation of the Swiss franc against the euro in January 2015 (for a more detailed summary of the exchange rate shock and its economic environment see Bonadio et al., 2020). In addition, it describes central features of the Swiss labor-market institutions and conditions, providing the context in which workers were faced with and took employment decisions within the episode analyzed in this paper.

2.1 Exchange-rate Shock and Firms' Expectations

On September 6, 2011 the Swiss National Bank (SNB) enforced a minimum exchange rate of 1.20 Swiss francs per euro.[7] This unconventional policy was introduced in response to strong appreciation pressures on the Swiss franc, associated with large safe-haven flows arising, in particular, from the European sovereign debt crisis (Jordan, 2015, 2016). The duration of the minimum exchange-rate policy was not communicated, and the SNB declared repeatedly that it was fully committed to the policy (Bonadio et al., 2020). During the years following this policy announcement, the EUR-CHF exchange rate stayed relatively close to the mentioned minimum rate. Due to an absence of significant inflation differentials, the real exchange rate was also quite stable between 2012 and 2014, and the impact of the exchange rate on firms' input- and output-market environment was muted. Even at the beginning of 2015, financial-market participants and CFOs of firms based in Switzerland did not expect a departure from the prevailing regime.[8]

Yet, on January 15, 2015, the SNB unexpectedly announced the discontinuation of the minimum exchange rate. According to the SNB, maintaining the minimum exchange rate was no longer justified mainly due to expectations about diverging monetary policies of the two major currency areas (Jordan, 2015).[9] For market participants, this policy change occurred after a period of a relatively stable macroeconomic environment, and it took markets by surprise (Bonadio et al., 2020).

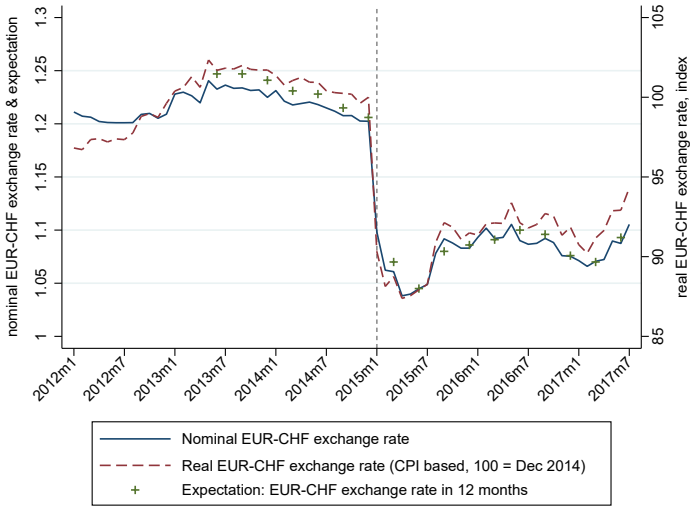
Figure 1 portrays the dynamics of the nominal EUR-CHF exchange rate (drawn as solid blue) and the monthly real EUR-CHF exchange rate (drawn as dashed red) between 2012 and 2017. It shows that the appreciation of the Swiss franc after the discontinuation of the minimum exchange rate was sudden, large, and persistent. The expectations of CFOs about the future EUR-CHF exchange rate (drawn as green pluses) also dropped suddenly and markedly. Hence, a quick depreciation to the pre-shock level was not expected.

[7] Throughout this paper, we will measure and report on the exchange rate shock in terms of price of a euro in terms of Swiss francs. Hence, an exchange rate of 1.20 means that it took 1.20 francs to purchase one euro. As a shorthand, we will refer to this rate as the EUR-CHF exchange rate. A drop in this rate will measure an appreciation of the Swiss franc against the euro.

[8] Figure 1 plots the expectation of CFOs of firms based in Switzerland regarding the EUR-CHF exchange rate in one year (indicated by green plus signs). Bonadio et al. (2020) showed that the shock was also not anticipated by financial market participants.

[9] There was evidence for further easing in the euro area, and, conversely, signs of tightening in the US.

Figure 1: EUR-CHF exchange rate, 2012 to 2017



Sources: SNB, Deloitte CFO Survey Switzerland (www.deloitte.com/ch/cfosurvey). The EUR-CHF exchange rate is measured as the amount of Swiss francs needed to purchase one euro.

2.2 Labor-market Institutions and Conditions in Switzerland

For Swiss workers, unemployment insurance serves as the core protection against adverse labor-market shocks. The entitlement duration regarding unemployment-insurance benefits in Switzerland is 400 days for prime-aged individuals who meet specific contribution and employability requirements.[10] The replacement ratio typically amounts to 70% of the last-insured earnings, but it can be as high as 80% of the insured earnings, e.g., for workers caring for children. Full entitlement is conditional on having paid unemployment insurance contributions for at least 18 months. Moreover, individuals must be available and fully able to meet the requirements of a regular job (i.e., they must be 'employable'). If a jobseeker is found not to be employable, or after exhaustion of unemployment-insurance benefits, there is the possibility to collect social assistance.[11]

These benefits are complemented by active labor-market policies. Compared to other OECD countries, the Swiss system is quite supportive but strict in terms of enforcing individual compliance criteria. These criteria include explicit job-search requirements (e.g., a monthly number of required job applications is specified) and compulsory participation in counseling meetings and active labor-market programs (see Arni et al., 2022). Non-compliant behavior is strictly subject to benefit sanctions.[12]

Swiss employment protection is moderate by international standards. In 2015, the OECD indicator of the Strictness of Employment Protection Legislation stood at 1.43 for Switzerland, while the OECD average was 2.07.[13] There are no legally required severance payments, while

[10] Individuals aged below 25 without children are normally only entitled to 200 days of benefits. Persons above age 55 may draw up to 520 days of benefits (those beyond 60 can get additional 120 days).

[11] Social assistance is means-tested and equals about 76% of the unemployment benefits for an individual who is single and has no other sources of earnings.

[12] The benefit-sanctioning rate in the Swiss unemployment insurance is among the highest in the OECD.

[13] The scale of the index ranges from 0 to 6, with 6 indicating highest protection. The maximum index in

notice periods are comparable to the European average.

3 Conceptual framework: Labor-market effects of trade shocks

We consider a small open economy, populated by firms and workers with heterogeneous features and abilities. This economy will be subject to an unanticipated appreciation of the local currency that – akin to a trade shock – induces a change of relative imports prices and export prices. These price changes alter firms' labor demand and thereby affect workers' job trajectories. To investigate the various channels through which the trade shock affects labor demand, we consider a simple model, in which firms convert different types of labor and inputs into output.

In our conceptual framework, we aim to capture the essence of task-based production, introduced in the trade literature by the seminal work of Grossman and Rossi-Hansberg (2008) and developed further since (e.g., in Acemoglu and Restrepo, 2022, Restrepo, 2023). In these models, firms produce by performing a range of different tasks. A firm may complete all of these tasks in-house by its employees or outsource some tasks by purchasing processed inputs, which contain other firms' labor. In the latter case, a firm's own workers only perform the remaining tasks. A firm's decision to outsource a set of tasks leads to a reduction of in-house demand for labor and potentially to job separation (a central force in Borcherding and Silberberg, 1978 labeled the 'substitution effect' in Grossman and Rossi-Hansberg, 2008 and the 'displacement effect' in Restrepo, 2023). The simultaneous increase in productivity, however, induces an increase in output and, thus, in demand for the type of workers remaining in the firm (the 'productivity effect' in Grossman and Rossi-Hansberg, 2008 and Antràs et al., 2017). In partially segmented labor markets, reductions in the price of imported inputs may thus lead to a drop in demand for some labor types and to an increase for others.

Let us think of a firm to produce aggregate output Q. The firm may produce output for Home (q) and for Foreign (q^*), so that $Q = q + q^*$. Under CES demand with elasticity $\rho > 1$, a firm's demand in Home and Foreign output markets (*) exhibits the well-known form[14]

$$q^{(*)} = \left(\frac{p}{P^{(*)}}\right)^{-\rho} \Theta^{(*)},$$

where $P^{(*)}$ is the usual ideal price index of customers and $\Theta^{(*)}$ the according aggregate demand.

We now introduce the exchange rate e, which measures the price of the Foreign currency in units of the Home one and consider the case of an exchange-rate appreciation in Home, i.e., a drop in e. Standard implications of this shock are

$$\frac{d\ln q^{(*)}}{d\ln P^{(*)}} = \rho, \qquad \frac{d\ln P}{d\ln e} = s_{IC}, \qquad \frac{d\ln P^*}{d\ln e} = 1.$$

The equations in the middle and the right-hand side show that an exchange-rate change affects the *output-market* environment of firms through their effect on local price indices. In Home, this occurs at the rate of import competition, i.e., the share of foreign sales in the domestic market, s_{IC}. In Foreign, the price index is reduced one-to-one (reflecting our small economy assumption).

2015 applied to Czechia with 3.26, and the minimum to the United States with 0.09. For further details, see https://www.oecd.org/employment/emp/oecdindicatorsofemploymentprotection.htm.

[14] We initially suppress firm indexes to avoid overloading notation but introduce the firm dimension in our notation further below.

Additionally, a change in the exchange rate will affect the prices firms charge, because their *input-market* environment is impacted by the exchange-rate shock. In particular, marginal costs of production are effected by the change of imported-input prices. Using the fact that the price pass-through of marginal costs C into the output price p is unity (a direct implication of constant markups) and denoting the export share by $\nu = q^*/Q$, the effect of an exchange-rate change on total firm output Q is then

$$\frac{d\ln Q}{d\ln e} = \nu\frac{\partial \ln q^*}{\partial \ln \Pi^*} + (1-\nu)\frac{\partial \ln q}{\partial \ln \Pi}s_{IC} + \frac{\partial \ln Q}{\partial \ln p}\left(\frac{d\ln C}{d\ln e}\right) = \rho\left[\nu + (1-\nu)s_{IC} - s_{M^*}\right], \qquad (1)$$

where s_{M^*} denotes the cost share of imported inputs.

Labor demand of firms is not only affected through changes in output reflected in (1) but also through changes in factor employment shares in production. These changes depend on the production technology used. To fix ideas, consider firm-specific technologies, according to which input type i, which is sourced domestically (M_i) or in Foreign (M_i^*), is combined with labor type i (L_i) to produce output Y. We will distinguish between two types of inputs and labor $i = 1, 2$. Total factor productivity of a firm is proportional to A:

$$Y = \frac{A}{\alpha_1^{\alpha_1}\alpha_2^{\alpha_2}}X_1(M_1, M_1^*, L_1)^{\alpha_1}X_2(M_2, M_2^*, L_2)^{\alpha_2} \qquad (2)$$

where the bundles X_i are defined by

$$X_i(M_i, M_i^*, L_i) = \left[a_i M_i^{1-1/\varepsilon_i} + a_i^*(M_i^*)^{1-1/\varepsilon_i} + L_i^{1-1/\varepsilon_i}\right]^{\varepsilon_i/(\varepsilon_i-1)}$$

with $\alpha_i > 0$, $\varepsilon_i > 1$. Parameters a_i and a_i^* denote each input's weight in the production of a bundle. These parameters may vary across firms and may be endogenously determined as in Antràs et al. (2017). We assume constant returns to scale production and thus $\alpha_1 + \alpha_2 = 1$.

We compute changes in a firm's labor demand arising through adjustments in the factors employed in each bundle, applying Shepard's Lemma. To that end, we return to technology (2), noting that marginal production costs of an optimizing firm are

$$C = A^{-1}\Pi_1^{\alpha_1}\Pi_2^{\alpha_2} \qquad (3)$$

with $\Pi_i = (a_i^{\varepsilon}\pi_i^{1-\varepsilon_i} + (a_i^*)^{\varepsilon}(\pi_i^*)^{1-\varepsilon_i} + w_i^{1-\varepsilon_i})^{1/(1-\varepsilon_i)}$ being the prices of the bundles X_i, w_i are wages of the respective labor types, and π_i and π_i^* the prices of domestic and foreign inputs.

Denoting unit labor demand for type i by l_i, the cost share of this type of labor is $s_{L_i} = w_i l_i/C$. The latter can also be expressed as the cost share of bundle X_i (i.e., α_i) times the cost share of L_i within bundle X_i, i.e., $s_{L_i} = \alpha_i w_i l_i/\Pi_i = \alpha_i(w_i/\Pi_i)^{1-\varepsilon_i}$. Combining these expressions with (3) yields an expression for unit labor demand of

$$l_i = \frac{\alpha_i}{A}\left(\frac{w_i}{\Pi_i}\right)^{1-\varepsilon_i}\frac{\Pi_1^{\alpha_1}\Pi_2^{\alpha_2}}{w_i}.$$

Now consider the case when Home's exchange rate appreciates, i.e., e drops. This drop induces changes in prices, and, hence, affects the firm's demand for the different labor types i. We thereby assume that the exchange-rate pass-through into factor prices is complete ($d\ln(\pi_i^*)/d\ln(e) = 1$)

and that changes of local factor prices are negligible ($d\ln(w_i)/d\ln(e) = d\ln(\pi_i)/d\ln(e) = 0$). Under these assumptions, the expression for unit labor demand implies

$$\frac{d\ln l_i}{d\ln e} = (\varepsilon_i - 1 + \alpha_i)\frac{d\ln \Pi_i}{d\ln \pi_i^*} + \alpha_{-i}\frac{d\ln \Pi_{-i}}{d\ln \pi_{-i}^*} = (\varepsilon_i - 1)s_{M_i^*}/\alpha_i + s_{M^*} \tag{4}$$

where we used that $d\ln \Pi_i/d\ln \pi_i^* = (a_i^*)^{\varepsilon}(\pi_i^*/\Pi_i)^{1-\varepsilon_i} = \pi_i^* M_i^*/X_i\Pi_i = s_{M_i^*}/\alpha_i$, and we set the cost share of all imported inputs to $s_{M^*} = s_{M_1^*} + s_{M_2^*}$. Intuitively, equation (4) shows that a decrease in e (and, hence, in π_i^*) reduces unit demand for labor type i more strongly, the more this type of labor can be substituted by imports (the larger is ε_i). This is the well-known substitution effect (Antràs et al., 2017), weighted by the import share within the respective bundle ($s_{M_i^*}/\alpha_i \in [0, 1]$).

The total effect of the exchange-rate shock on firms' labor demand materializes through the combination of the change in output through output-market channels and the more ambiguous effect through input-market channels. On the one hand, the unit costs of production decline due to cheaper imported inputs with direct effects on prices and, hence, demand. On the other hand, the labor demand per unit of produced output changes. The total effect of an exchange-rate change on the firm's labor demand is the combination of both the effect via unit labor demand (4) and quantity demanded (1). Finally, adding firm subscripts (f) to explicitly indicate firm-specific export- and input-import-intensities, the combination of the equations above yields

$$\frac{d\ln L_{i,f}}{d\ln e} = \frac{d\ln(Q_f l_{i,f})}{d\ln e} = \rho(1-\nu_f)s_{IC} + \rho\nu_f + (1-\rho)s_{M^*,f} + (\varepsilon_i - 1)s_{M_{i,f}^*}/\alpha_{i,f} \tag{5}$$

The four terms on the right-hand side capture the different effects of an appreciation of Home's exchange rate for labor demand – two operating via the firm's output markets and two via input markets. The first two terms reflect the effects of demand for the firm's output in its domestic markets ($\rho(1-\nu_f)s_{IC}$) and its export markets (ν_f). In either market, the exchange rate appreciation entails a cost advantage for foreign competitors, which makes the domestic firm contract and thus reduce its demand for all labor types. The output effects depend on firm f's export share (ν_f) and its domestic market share ($1-\nu_f$). Both effects are scaled by the substitutability among products in the output market (ρ). They depend, in addition, on the respective weight of foreign competitors in the respective market, which is equal to the import share of foreign producers in the domestic output market (s_{IC}) but is equal to unity in export markets.

Two additional effects are induced by the price drop of the firm's imported inputs. Specifically, the third term on the right-hand side of (5), $(1-\rho)s_{M^*,f}$, reflects a size effect induced by the cost reduction due to cheaper inputs from Foreign (M_f^*). This effect is induced by all imported inputs and is, just as the first two size effects, scaled by the demand elasticity ρ. The last effect is related to a firm's imports as well, but captures, instead, the negative 'substitution effect' ($(\varepsilon_i - 1)s_{M_{i,f}^*}/\alpha_{i,f}$). It reflects that, as the price of imported inputs drops, firms substitute away from labor. Notably, this second effect is generated only by goods that are substitutes to a specific labor type ($M_{i,f}^*$ for i-type labor), and it is, crucially, scaled by the substitutability between labor and inputs.

Our preferred interpretation of this model with finite production-bundle-specific elasticities, ε_i, is that of an aggregate version of task-based models, where tasks are performed in order to produce the bundles X_i (as in Grossman and Rossi-Hansberg, 2008, Acemoglu and Restrepo, 2022). Each single task is either entirely outsourced or entirely performed in-house, but the share of tasks that is outsourced is smaller than one (see, e.g., Restrepo, 2023). More specifically, we interpret L_2 as a

labor aggregate which performs a specific set of tasks in X_2 that can easily be substituted through inputs from other firms. If a drop in input prices replaces a fraction of these tasks, while others remain in-house, then the demand for the aggregate L_2 exhibits a (potentially large but) finite elasticity, ε_2. At the same time, L_1 represents an aggregate of labor types that are less prone to be displaced by processed inputs from other firms. Accordingly, we will think of input $i = 1$ as *materials* with low embodied labor content and little potential to substitute labor, consequently assuming that the elasticity of substitution is small ($\varepsilon_1 \gtrapprox 1$). Conversely, we think of input $i = 2$ as *processed* with a high embodied labor content and assume, accordingly, that the elasticity of substitution is large ($\varepsilon_2 \gg 1$ and, in particular, $\varepsilon_2 > \varepsilon_1$).

In sum, this framework predicts that workers are affected heterogeneously by a trade shock due to their employer's heterogeneous trade exposure. There are heterogeneous effects, in particular, of exchange-rate shocks on an employer's labor demand, as those notoriously operate at output and input markets simultaneously. Our conceptual framework has illustrated four direct channels through which an exchange rate shock affects firm-level labor demand.[15] We group these four channels into two broader ones, which we label the *output-market channel* and the *input-market channel*.

According to the output market channels, an exchange-rate appreciation increases price competition in export and domestic markets to different degrees, so that firms contract, resulting in a proportional reduction of a firm's labor demand. For our empirical specification, the output market channels are described in the following way.

(i) Workers employed by firms operating in markets with stronger import competition prior to the shock are more exposed to adverse consequences of an appreciation of the local currency.

(ii) Workers employed by firms selling more of their output to foreign countries prior to the shock are more exposed to adverse consequences of an appreciation of the local currency.

According to the input-market channels, an exchange-rate appreciation causes domestic firms to benefit from cheaper imports but affects workers via a productivity and a substitution effect. For our empirical specification, these input-market channels are represented in the following way.

(iii) Workers employed by firms sourcing more imported materials prior to the shock are more exposed to the positive consequences of an appreciation of the local currency.

(iv) Workers employed by firms sourcing inputs that substitute in-house tasks are expected to be exposed to the adverse consequences of an appreciation of the local currency.

Overall, firm-level output and labor demand are positively correlated via the output-market channels, as lower output demand lowers firms' labor demand. However, firm-level output and firm-level labor demand are not necessarily positively correlated through the input-market channel. Firms generally benefit from cheaper imported inputs, but they might *expand or contract* their labor demand in response to these cheaper imported inputs. Precisely measuring the exposure to the two opposing labor-demand effects of the shock is key to our empirical strategy.

In this section, we have laid out a conceptual framework, which indicates the appropriate measurement of exposure to the trade-induced labor-demand shock and which will thus guide our

[15] Here, we abstract from general-equilibrium responses. In the empirical analysis, we will account for general-equilibrium repercussions by conditioning on a large set of fixed effects.

empirical approach and provide insights regarding the relevant margins of adjustment. In the empirical analysis of worker-level outcomes (earnings, wages and unemployment), we will adopt a reduced-form approach. We explicitly recognize, however, that additional factors outside of our model will determine how the changes in firms' labor demand translate into endogenous worker-level outcomes. These factors include search and matching frictions, nominal wage rigidities, monopsony power on the labor market, broader labor-market competition, and workers' outside options. All of these factors can be specific to labor-market segments and may thus vary across worker and task characteristics. In the interpretation of the empirical results, we will highlight and discuss such factors that are likely to help explain the empirical findings.

4 Data description

Our empirical analysis is based on two distinct samples. First, we build a *worker-level sample* from linked employer-employee data to examine worker-level responses to the trade shock. Second, we construct a *firm-level sample*. The latter will allow us to investigate firm-level adjustments to the trade shock. The following section describes the primary data sources used to build the linked employer-employee data, describes the regression samples, defines theory-consistent exposure and outcome variables and provides summary statistics.

4.1 Data Sources

Our analysis draws on a panel dataset of linked employer-employee data, which we construct from three primary data sources: the *Swiss social security register* covering the universe of Swiss working-age individuals, the *Swiss unemployment insurance register* with socio-demographic and employer-specific information covering all workers that ever interacted with the unemployment agency, and *Swiss Customs Administration* data with firm-level information on exports and imports.[16]

4.1.1 Social security register

The core data set for our analysis is the universe of entries in the Swiss social security register from 2000 to 2018 which provides each individual's monthly employment or unemployment status. The social security register covers all individuals above age 17 living or working in Switzerland. We restrict the sample to individuals between 20 and 60 years of age. The social security register data include any income (subject to social security contributions) from employment, self-employment, military service, disability and unemployment insurance. Income from employment is not top-coded and includes wages but also other forms of compensation such as bonuses and non-cash benefits. Each individual in the social security register is identified by its social security number. Each spell in the social security data is linked to a social security reporting number that can be related to an employer (usually the establishment/local entity).[17]

[16] All used worker-level and linked firm-level data are anonymized.

[17] Multi-location employers may have multiple reporting numbers. Thus, the mapping between reporting number and employer is not always perfect. However, the resulting match is reliable. The reporting number has been used by Egger et al. (2022) to match the social security register to firm-level data. E.g. Arni et al. (2013) and later studies using Swiss social security register data have used the reporting number to define individual job spells (i.e., employment duration with the same employer).

Based on this information, we define, for any given month, an individual's employing *firm* through the employer's social security reporting number. If an individual has multiple employers in a given month, the employer that generates the highest income is defined as her employing firm. We define an individual's monthly earnings as total income from employment at her employing firm. Each period, there are three possible employment statuses for an individual: (i) employed when they receive earnings from at least one employer, (ii) unemployed when they are not employed and receive unemployment benefits, and (iii) non-employed otherwise. We thus obtain a panel-data set of individuals' employment and earnings at monthly frequency.

4.1.2 Unemployment insurance register

The second data source is the Swiss unemployment insurance register, which contains administrative information on all spells of registered joblessness at the Public Employment Service (PES) in Switzerland. Individuals are recorded in the unemployment insurance register data set if they are registered at the PES at least once during the period from 2000 to 2018. Individuals who have been registered at the PES are not necessarily unemployed, but may register during their training or towards the end of a contract in order to avoid delayed benefits in case of unemployment. From the unemployment insurance registry, we retrieve detailed information on the socio-demographic variables of workers, such as age, gender, education, nationality, and residence status. Individuals also report the occupation in their last and new job around an unemployment spell.[18] These occupations are recorded at the 5-digit SBN 2000 classification of the Swiss Statistical Office. We subsume these professions into 26 broader categories, reported in Table 16. Finally, the unemployment insurance register contains the company name, sector, and address of the previous and the new employer.

4.1.3 Trade data

Our third data source is provided by the Swiss Customs Administration. The respective data contain firm-level information on the universe of trade in goods between 2012 and 2017, recorded at the Harmonized System (HS) 2-digit product-level by partner country at yearly frequency. The data include information on the value, quantity (mass or units), and invoicing currency of imports and exports.[19] As the unemployment insurance register, data from the Swiss Customs Administration contains the firm's name and address.

4.2 Linking Employer and Employee Data

The backbone of the linked employer-employee data is the Swiss social security register. All individuals in the unemployment registry can be linked to the social security data through their social security number. Since there is no unique identifier available that links firm-level trade data

[18] Information on individuals' occupations at their current employer can be proxied for roughly 46% of individuals who were registered at PES offices. We do not observe monthly data on employees' current occupation, but we infer the occupation information by using the unemployment insurance register data on the occupation at their new employer, which represents the occupation at the first employer after the registered unemployment spell. By using data on their past occupation, we can infer the occupation at their last employer prior to having been registered at the PES. In instances, where we can infer the occupations from reports of occupations at both the last employer and the new employer, we choose the information that is closest in time to the respective month in the monthly panel.

[19] See Kropf and Sauré (2014) or Auer et al. (2019) for a detailed description of these data.

directly to the employers in the social security data, we rely on the unemployment registry as an intermediary data set to establish this link. The unemployment insurance register contains information on the name and address of workers' previous and next employer. We use this information to construct a file linking employers as identified in the social security data with their names and addresses. Based on this file we assign names and addresses to all employers in the social security registry for those individuals that are covered in the unemployment registry at least once.[20] In this way, we construct a linked employer-employee data set, covering all employment information from 2000-2018 for a subset of the universe of individuals covered in the social security registry and including employers' name and address information. We can link employer-level information on imports and exports to this linked employer-employee data. This sample covers more than one third (33.7%) of all working-age individuals (i.e., those covered in the social security register) in December 2014. In order to ensure the representativeness of this data set, we construct weights from the universe of social security data and use them to ensure that all estimates are representative for the universe of individuals of the Swiss labor force (in the social security register). We will use two types of weights reflecting the probability of an individual to be included in the sample based on (i) her wage-bin level[21] or (ii) her employer. Note that the latter approach is statistically equivalent to using the full social security data and linking the trade data using the link file described above.[22]

4.3 Worker-level and Firm-level Data Sets

Our empirical analysis will be based on two data sets constructed from the linked employer-employee data. First, the worker-level data set is directly based on the linked employer-employee data set described above. In our analysis, we focus on all individuals employed in December 2014 – one month prior to the exchange rate shock – as we use their employer in December 2014 to measure the individual's labor-demand shock exposure. Summary statistics of the worker-level data are presented in Table 1. From the unemployment register data we obtain further information on worker characteristics. We present information on worker demographics in Table 15 and on their (inferred) occupations in Table 16.

Second, we construct a firm-level data set from all three data sources. A firm's headcount of employees and the wages it pays are defined based on end-of-year data (December of each year) from the universe of workers, i.e., the *full* social security register. Information on the firm's sector stems from the unemployment insurance register and information on the firm's location in one of Switzerland's 18 labor-market regions ('Arbeitsmarktgrossregionen' defined by the Swiss statistical office in 2018) is inferred from its employees. Specifically, we assign each employer to one labor-market region based on the residency of the majority of its employees as reported in the unemployment insurance register. We match yearly information on imports and exports to those data from the Customs data. Firms that are not matched to Customs data are non-exporters and non-importers by definition. For our analysis, we use information on total yearly export and import values, as well as the number of imported 2-digit product categories and the type of imported products. Summary statistics of the firm-level data are presented in Table 2.

[20] According to our data-protection contract, we are not allowed to use this link for the universe of workers but only those that are observed in the unemployment registry at least once.

[21] A bin for every 100 CHF increase in monthly wages, categories are combined to broader categories for monthly wages above 10,000 CHF to ensure coverage.

[22] According to our data protection contract, we are allowed to construct weights based on the social security reporting number, but we are not allowed to use the social security reporting number to link the trade data.

4.4 Trade-exposure Measures

This section defines the central trade-exposure variables. In Section 3, we identified four channels, through which trade exposure affects labor demand. These four channels are (i) the extent of foreign competition in the domestic output market, or *import competition*, (ii) export exposure and (iii) input-import exposure, where the latter is differentiated by the (iv) substitutability of input imports with labor. All four measures refer to exposures at the time of the shock, and we measure them through averages across the three pre-shock years (2012-2014). We define them in what follows.

(i) **Import competition** measures how vulnerable to increased competition from abroad firms are in their domestic market. We define import competition at the 4-digit industry (or sector) level using the intensity of pre-shock import penetration:

$$\text{Import competition}_s = \log\left(\frac{1}{\text{Employees}_{s,pre}}\sum_p \theta_{ps,pre}\text{Imports}_{p,pre}\right),$$

where $\text{Employees}_{s,pre}$ is the number of employees in sector s, $\theta_{ps,pre}$ is the share of Swiss export sales of product p originating from sector s, and $\text{Imports}_{p,pre}$ is the value of imports of product p, all measured in the pre-shock period. In this definition, we use $\theta_{ps,pre}$ to assign all product-level imports to Switzerland prior to the shock to the sector that produces the same products as outputs and, hence, is in competition with them in the domestic market. We use sector-level employment for scaling the total import value. Finally, we normalize the resulting variable to exhibit a zero mean and a unit standard deviation to facilitate the interpretation (not shown in the formula).

(ii) **Export exposure** measures how strongly firm f depends on sales in export markets. In most of the empirical specifications, we use a binary indicator for a firm's export status:

$$\text{Exporter}_f = \mathbb{I}\left[\text{Export value}_{f,pre} > 0\right].$$

Firm f's input-market-driven labor-demand response to the trade shock depends on its input importing and the degree of substitutability of these imported inputs with domestic labor.

(iii) **Import exposure** measures to which extent a firm f can benefit from cheaper imported inputs. As with exporting, we use a binary indicator:

$$\text{Importer}_f = \mathbb{I}\left[\text{Import value}_{f,pre} > 0\right].$$

(iv) **Labor-substitution intensity** of foreign input imports measures the substitutability of a firm's input imports with domestic labor. According to our discussion in Section 3, some input types have a higher propensity to substitute labor than others, such that a drop in their price has a relatively stronger adverse effect on labor demand. We argue that labor is not outsourced and replaced by *every* kind of input alike but rather by inputs with a high content of embodied foreign labor. In Section 3, we labelled these goods 'processed inputs' as opposed to pure 'materials'. To appropriately distinguish between these two types of imported inputs, we use the classification in the Broad Economic Categories (BEC, Rev.5) of the United Nations Statistics Division. This classification distinguishes between 'processed' and 'primary' products. We argue that this distinction

is well suited to measure the content of foreign labor embedded in an imported-input product.[23] We define the respective variable as

$$\text{Labor-substitution intensity}_f = \frac{1}{P_{f,pre}} \sum_{p \in \mathbb{P}_{f,pre}} \text{Processed}_p.$$

where $P_{f,pre}$ and $\mathbb{P}_{f,pre}$ denote the number and set, respectively, of imported product categories of firm f in the three years prior to the shock, and Processed_p is a binary indicator for whether product p is processed or not. Hence, this measure reflects the fraction of processed inputs in all imported inputs of the firm. As an alternative measure, we use the ratio of the processed-product imports in all imported inputs in terms of their value to construct the variable.

Finally, we observe that, as input-importing opportunities expand with the shock, firms that did not import inputs prior to the shock might start doing so in response to the shock and also adjust their labor demand through the input-channel exposure. To account for such adjustments at the extensive input-importing margin, we define an imported input intensity at the sector level prior to the shock as

$$\text{Imported-input intensity}_s = \log\left(\frac{\text{Imports}_{s,pre}}{\text{Employees}_{s,pre}}\right),$$

where $\text{Imports}_{s,pre}$ and $\text{Employees}_{s,pre}$ are the imported-input value and the number of employees in sector s, both measured prior to the shock. The latter measure captures the vulnerability of the average workers in sector s to displacement through imported inputs. We normalize the variable to a zero mean and a unit standard deviation to facilitate interpretation.

4.5 Descriptive Statistics

In order to understand the consequences of the trade shock for an individual worker i, we are interested in measuring how the earnings of this worker are impacted depending on the labor-demand shock they face through their employment at firm f in December 2014. Note that the exposure measures of any worker i are time-invariant and independent of potential employer switching after the shock. Our main outcome of interest are (log) aggregate annual earnings of workers in Switzerland. To shed light on the extensive- and intensive-margin changes behind these aggregate earnings, we additionally measure the unemployment propensity as the share of months in unemployment in any given year and the monthly wage measured in December of each year. We present summary statistics of these three outcome variables as measured in December 2014 as well as the differences in pre-shock (2012-2014) to post-shock (2015-2017) years in Table 1. We present raw summary statistics for the linked employer-employee data that cover 1,228,446 workers employed in December 2014 as well as the appropriately re-weighted statistics. As expected, the linked employer-employee sample, which excludes individuals that have never been registered at the PES, is negatively selected in terms of earnings. Note that this selection is only a concern for the representativeness of the sample – which can be perfectly tackled using appropriate weights

[23] According to the classification manual, 'primary goods' are those which characteristically are products of primary sectors of the economy such as farming, forestry, fishing, and extractive industries. However, goods which characteristically are products of other sectors, such as manufacturing, where the product underwent only a minor change, are still classified as "primary in cases where nearly all of the value of the product is contributed by one of the primary sectors of the economy" (Department of Economic and Social Affairs Statistics Division (2016), p. 16–17).

– but it does not constitute an endogeneity concern. In 2015-2017, aggregate earnings are 9.5% higher, while the unemployment propensity has increased by 2.2 percentage points relative to the pre-shock period.

Table 1: Summary statistics of worker-level outcomes and characteristics

Variable	Mean	Std.dev.	Min.	Max.	Weighted mean (firm-weighted)	Weighted mean (wage-weighted)	Obs.
(pre-shock) Exporter	0.108	0.310	0	1	0.112	0.113	1,228,446
(pre-shock) Importer	0.173	0.378	0	1	0.185	0.177	1,228,446
(pre-shock) Labor-substitution intensity	0.152	0.312	0	1	0.159	0.154	1,228,446
(pre shock) log(Annual earnings)	10.662	0.849	4.615	15.14	10.72	10.84	1,228,446
(pre shock) log(Wage)	8.329	0.707	4.094	12.655	8.371	8.483	1,228,446
(pre shock) Unemployed	0.040	0.102	0	0.972	0.035	0.035	1,228,446
Δ log(Annual earnings)	0.095	0.631	-6.500	5.976	0.114	0.089	1,228,446
Δ log(Wage)	0.067	0.457	-5.379	4.568	0.068	0.055	1,228,446
Δ Unemployed	0.022	0.162	-0.944	0.972	0.014	0.019	1,228,446

Note: The summary statistics pertain to the worker-level regression sample. All pre-shock levels measure the average of these variables in the three years prior to the shock (2012-2014). Differences are denoted by Δ and refer to differences in outcomes between the averages in the three years after the shock (2015-2017) and prior to the shock (2012-2015). Earnings, monthly wages and unemployment propensity are based on information in the social security data. Annual earnings are total earnings from employment in a given year. Wage refers to the monthly wage as measured in December of each year. Unemployed denotes the share of months of a year a person is recorded as being unemployed. Exporter and Importer are dummy variables that indicate the export and input-importing status of the firm workers are employed at in December 2014. Labor-substitution intensity is the share of processed imported inputs in all imported inputs according to the Broad Economic Categories Rev. 5 classification of products.

Table 3 reports how workers' earnings vary by exposure to the labor-demand shock induced by the trade shock. In line with a large literature on exporter (and importer) wage premia, workers employed at firms engaged in exporting (and importing) earn substantially more. In our sample, average earnings of employees of exporting firms are more than 20% higher than those of workers employed at firms that are not engaged in exporting. Overall, only 11% of the workers are employed in exporting firms as of December 2014.

Table 4 summarizes the expected labor-demand responses to the shock across various dimensions as derived from a task-based model of production and international trade. Comparing Tables 3 and 4, workers that are expected to experience a stronger negative labor-demand shock are largely earning higher wages prior to the shock. This is an important feature of the Swiss exchange rate shock: while many studies of labor-market effects of trade shocks have focused on settings where trade-exposed workers were negatively selected, the opposite holds true for the event we focus on. Therefore, the current study provides important insights regarding the resilience of workers earning higher wages.

We complement the worker-level analysis by a firm-level analysis that examines various margins of adjustment as suggested by the conceptual framework. In particular, we consider three types of adjustments at the firm level. (i) We explore the extensive hiring margin by considering the number of workers employed as well as the share of employees working at the firm that has been hired within the last year. (ii) In order to understand if firms indeed substitute tasks and particular types of workers, we consider the composition of the firms' workforce in terms of their workers' wage in the initial sample year of 2012. The latter implicitly depends on the type of workers in the workforce, e.g., on particular skills, professions, or worker productivity. Moreover, we measure the number of

Table 2: Summary statistics of firm-level outcomes and characteristics

Variable	Mean	Std.dev.	Min.	Max.	Obs.
(pre-shock) Exporter	0.069	0.254	0	1	156,907
(pre-shock) Importer	0.130	0.336	0	1	156,907
(pre-shock) Labor-substitution intensity	0.111	0.283	0	1	156,907
(pre-shock) log(No. of employees)	1.897	1.247	0	13.289	156,907
(pre-shock) log(Avg. wage)	8.343	0.59	4.324	12.795	156,907
(pre-shock) Share of new employees	0.245	0.239	0	1	156,907
(pre-shock) log(Avg. wage of employees in 2012)	8.378	0.593	4.419	13.757	154,001
(pre-shock) Count of imported product categories (2-digit HS)	0.987	3.654	0	78.333	156,907
Δ log(No. of employees)	-0.029	0.564	-7.608	6.965	156,907
Δ log(Avg. wage)	0.004	0.406	-6.406	4.483	156,907
Δ Share of new employees	-0.054	0.259	-1	1	156,907
Δ log(Avg. wage of employees in 2012)	0.042	0.361	-5.474	4.656	151,210
Δ Count of imported input products (2-digit HS)	0.106	1.186	-29	36	156,907

Note: The summary statistics pertain to the firm-level regression sample. All pre-shock levels measure the average of these variables in the three years prior to the shock (2012-2014). Differences are denoted by Δ and refer to differences in outcomes between the averages in the three years after the shock (2015-2017) and prior to the shock (2012-2015). Number of employees, their average wages paid in 2012-2014 and in 2012, and the share of new employees are calculated based on the social security data aggregated to the firm level. Exporter, Importer, types of input imports and number of imported-input product categories are obtained from the universe of export and import transactions of Swiss firms. These variables assume a value of zero for firms that are not exporting or importing. Exporter and Importer are dummy variables that indicate the exporting and input-importing status of the firm prior to the shock. Labor-substitution intensity is the share of processed imported inputs in all imported inputs of the according to the Broad Economic Categories Rev. 5 classification of products. The number of imported-input product categories is the count of 2-digit product categories according to the Harmonized System Classification of goods.

Table 3: (log) Annual earnings by trade exposure

(pre-shock) log(Annual earnings)				
	Mean	**p50**	**Std.dev.**	**Obs.**
Total	10.66	10.86	0.85	1,228,446
Output-market exposure				
Import competition (sector-level)	**Mean**	**p50**	**Std.dev.**	**Obs.**
$\leq$ Mean	10.53	10.72	0.88	642,958
$>$ Mean	10.81	10.98	0.79	585,488
Exporting (firm-level)	**Mean**	**p50**	**Std.dev.**	**Obs.**
0	10.64	10.84	0.86	1,096,276
1	10.85	11.01	0.74	132,170
Imported-input-market exposure				
Importing (firm-level)	**Mean**	**p50**	**Std.dev.**	**Obs.**
0	10.64	10.84	0.86	1,015,673
1	10.77	10.95	0.78	212,773
Processed-product share of imports (firm-level)	**mean**	**p50**	**Std.dev.**	**Obs.**
$\leq$ Median	10.82	10.99	0.77	106,408
$>$ Median	10.72	10.91	0.79	106,365

Note: The summary statistics pertain to the worker-level regression sample and to log(Annual earnings) for different sample splits based on the trade-exposure variables. The levels reported reflect the average of annual earnings in the three years prior to the shock (2012-2014). Exposure variables measure the exposure of the firm these workers are employed at in December 2014. They are defined in Section 4.4.

Table 4: Expected sign of the impact of the labor demand shock on workers' annual earnings

Exposure type	**Expected sign**
Output-market exposure	
Import competition	Negative effect
Export status	Negative effect
Input-market exposure	
Import status	Positive effect
Labor-substitution intensity	Negative effect

tasks that are sourced from abroad by the number of imported-input product categories. (iii) We measure the wage-setting behavior of firms in different segments of the firm-level wage distribution to understand whether and where positive and negative shocks are transmitted to workers' wages. Summary statistics of these outcomes are presented in Table 2. Comparing the pre- and post-shock periods, we see that average wages did barely change, but we observe an increase in imported-input product categories.

Combining worker-level and firm-level results allows us to paint a rich picture of the responses to the trade shock and the underlying mechanisms. In particular, the comparison of worker-level earnings responses and firm-level wage-setting responses allows us to understand how workers who remained employed at the same firm were affected differently from ones who changed their employer.

5 Empirical Strategy and Results

In this section, we outline the empirical strategy and discuss the results. We present the central estimation results documenting the main effects of trade exposure on workers, heterogeneous responses of different worker groups and the effects pertaining to firms.

5.1 Empirical Strategy

We will mainly rely on difference-in-differences estimates. For a clean identification of average-treatment-effect parameters, the latter requires that the outcomes of interest do not differ between the treated and the untreated in trend prior to the shock but only after the shock.

Before delving into the main analysis, let us assess this common-trend assumption by tracking workers' earnings, say, y_{it} for worker i in year t, annually as a function of their trade exposure in 2014 for the six years around the timing of the shock. To that end, we are interested in the coefficients on the export-exposure and input-import-exposure indicators over time based on linear-regressions of the form:

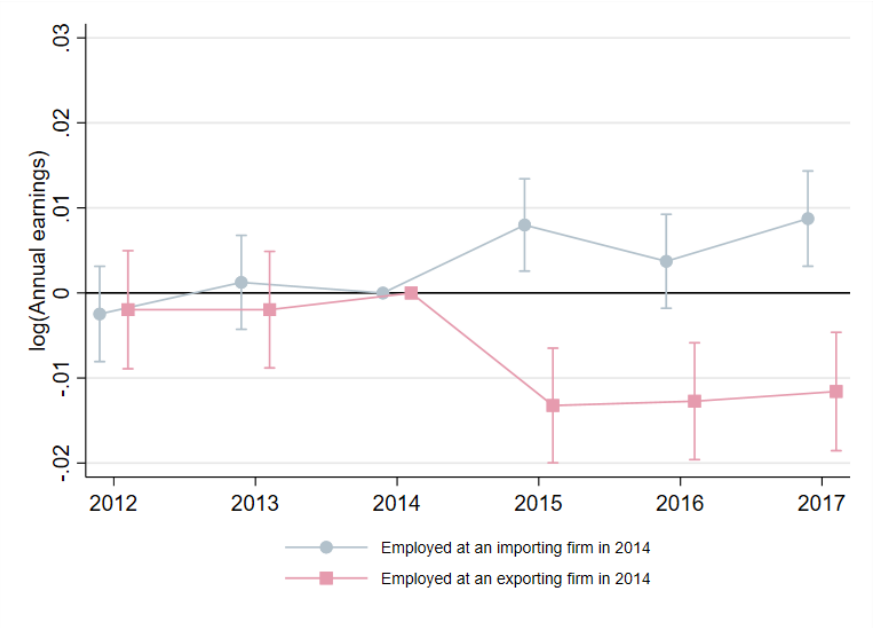
$$y_{i,t} = \sum_{\tau=2012}^{2017} \mathbb{I}\left[\text{Exporter}_{f^{2014}} = 1\right] \times \mathbb{I}\left[year = \tau\right] \beta_2^\tau + \mathbb{I}\left[\text{Importer}_{f^{2014}} = 1\right] \times \mathbb{I}\left[year = \tau\right] \beta_3^\tau + \gamma_{s^{2014},t} + \delta_i + e_{i,t} \quad (6)$$

where we control for worker-level fixed effects, δ_i, and sector-time fixed effects, $\gamma_{s^{2014},t}$, with s^{2014} referring to the 4-digit sector of the firm f^{2014} that worker i is employed at in 2014. The sector-year fixed effects absorb any trends for the workers in the control group, so that the coefficients of interest, β_2^τ and β_3^τ, pick up the differential evolution of the treated workers' outcome from the untreated ones' as a function of time τ around the shock.

Figure 2 illustrates the estimates of β_2^τ and β_3^τ, together with the 95% confidence intervals.[24] The figure provides two main insights. First, there is no indication of differential trends between the exposed and non-exposed workers prior to the shock, irrespective of whether we consider exporting or input importing. Second, the full extent of the adjustment to the shock occurs within a year, without sluggish multi-year adjustment or transition.

[24] Additional results for pre-trends including coefficients on import competition and the labor-substitution intensity are relegated to the Appendix.

Figure 2: Event study: Trends of annual earnings by exposure



Note: This graph plots the coefficients obtained in a worker-level regression of log(Annual earnings) absorbing worker fixed effects and 4-digit-sector times year fixed effects. The coefficients are year-specific coefficients on the input-importing and exporting status of the firm a worker is employed at in 2014. The regression is based on Equation (6).

Figure 2 thus suggests that an application of difference-in-differences estimation with annual data is justified in the present context. Moreover, the estimates are stable within three-year windows prior to (2012-2014) and after the shock (2015-2017). Hence, pooling or averaging the data within such windows and estimating differential effects between the post-shock and pre-shock data reveals medium-to-long-run effects of the shock which are not different from immediate, annual responses.

We attribute the immediate effects of the shock on labor-market outcomes to two facts that support our identification strategy: the shock was particularly abrupt and unanticipated, sizable, and lasting. Such an environment is rare, and it prevents customary struggles with a clean identification of the timing and the separation of one shock from other influences.[25] While prices are known to respond relatively quickly to shocks (see Bonadio et al., 2020 and Cavallo et al., 2023), we observe that even real adjustments in the labor market materialized rapidly in the present context.[26] Hence, even for real adjustments, frictions which are present elsewhere, such as search costs, firing costs and nominal wage rigidities, do not seem to have caused sluggish adjustment and slow transition in our setting.

With these observations in mind, we resort to data averages in three-year time windows prior (2012-2014) and after the exchange rate shock (2015-2017). We use $\Delta\bar{y}_i$ to refer to individual-specific differences in those average in the post-to-pre-shock period. Each worker i's exposure depends on the firm she is employed at in December 2014. We refer to this firm as f^{2014}, and we

[25] E.g., analyzing the persistent effects of the China trade shock, Autor et al. (2021) ask "[w]hy has the China trade shock had such enduring consequences?" and remark that a "logical explanation is that the shock itself never stopped intensifying."

[26] A key reason behind this finding may be seen in the rather flexible Swiss labor-market institutions with weak employment protection as mentioned above.

denote the sector and labor-market region this firm belongs to by s^{2014} and r^{2014}, respectively.[27] Using $\gamma_{s^{2014},r^{2014}}$ to denote sector-region fixed effects (to capture differential labor-market trends in the post-to-pre-shock phase), we postulate the following linear regression equation:

$$\begin{aligned}\Delta\bar{y}_i =& \text{Import competition}_{s^{2014}}\beta_1 + \mathbb{I}\left[\text{Exporter}_{f^{2014}} = 1\right]\beta_2 \\ &+\mathbb{I}\left[\text{Importer}_{f^{2014}} = 1\right]\beta_3 + \text{Labor-substitution intensity}_{f^{2014}}\beta_4 \\ &+\gamma_{s^{2014},r^{2014}} + \varepsilon_i. \end{aligned} \tag{7}$$

With this regression, we differentiate between the four dimensions of trade exposure highlighted in Section 3: the in output markets (import competition or channel (i) in Section 3 and exporting or channel (ii)) and the two operating via input markets through productivity (importing or channel (iii)) and labor substitution (or channel (iv)). Recall the discussion in Section 4 for details on the definition of these exposure variables.

We will control for sector effects at the 2- and at the 4-digit level. Whenever we control for 4-digit sector fixed effects, the effect of the trade shock through the first output channel cannot be identified, as import competition is measured at the 4-digit sector level. The three remaining exposures, however, (export exposure as well as both input-market-exposure effects) are defined at the firm level and can still be identified.

5.2 Average Annual Worker-level Earnings Effects

At first, we focus on the average treatment effects of different trade-exposure variables on log annual earnings at the worker level. Table 5 reports results for six specifications of the basic model in (7), focusing on the first dimension of exposure heterogeneity: output- and input-market exposure without disentangling the opposing mechanisms behind the effects of input-market exposure. Columns (1), (3), and (5) employ fixed effects at the 2-digit-sector-region level allowing for an identification of the effects of import competition. Columns (2), (4), and (6) control for effects of the more fine-grained sector definition at the 4-digit level and identify only the effects from firm-level variation in exporting and input-importing prior to the shock. The first two specifications present unweighted estimates. The remaining specifications use two types of weights to ensure representativeness of the results. Generally, the results presented in Table 5 are quite robust across columns. Our preferred specification is the one in Column (2). It exhibits a standard weighting scheme and controls for all unobservables at the 4-digit-sector level interacted with labor-market fixed effects. The corresponding results suggest that workers that were employed at an exporting firm in 2014 experienced a change in annual earnings that was about two percentage points lower than that of workers that had not been employed at an exporting firm in the years prior to the shock. Conversely, workers employed at an input-importing firm experienced a change in aggregate earnings that was about 1.3 percentage points higher than that of workers that had not been employed at an importing firm prior to the shock.

Import competition is measured at the 4-digit sector level, and we cannot rely on Column (2) to assess their magnitude as the effects would be absorbed by the fixed effects. Using the results from

[27] For most of the results, we will distinguish sectors at the 4-digit level. When we estimate parameters on sector-level variables such as import competition in the output market, we will use the more granular 2-digit sector level for the sake of parameter identification. However, this will always be explicitly stated. This choice obviously affects the number of fixed effects to be estimated. Regions correspond to 18 labor-market regions as identified by the Swiss Statistical Office.

Table 5: Changes in annual earnings in response to the Swiss franc appreciation by channel of trade exposure

	Δ log(Annual earnings)					
	(1)	(2)	(3)	(4)	(5)	(6)
			firm-weighted		wage-weighted	
Import competition	-0.025***		-0.022***		-0.031***	
	(0.002)		(0.002)		(0.002)	
Exporter	-0.019***	-0.020***	-0.016***	-0.018***	-0.018***	-0.019***
	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)
Importer	0.013***	0.013***	0.012***	0.012***	0.012***	0.012***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Obs.	1,228,446	1,228,446	1,228,446	1,228,446	1,228,446	1,228,446
Fixed effects	2-Digit Ind × Reg	4-Digit Ind × Reg	2-Digit Ind × Reg	4-Digit Ind × Reg	2-Digit Ind × Reg	4-Digit Ind × Reg

Note: Fixed effects correspond to 2- or 4-digit industry level fixed effects interacted with labor-market region level fixed effects. Standard errors are clustered at the sector-region level where the sector aggregation corresponds to the aggregation level used for the fixed effects as reported in the last line of the table. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Column (1), we find that a one-standard-deviation increase in import competition is associated with a change in annual earnings that is 2.5 percentage points lower than without this change.

Overall, this first set of results shows that even within narrowly defined sectors and within regions the effects of a firm's trade exposure on its workers' earnings are economically large under the trade shock analyzed in this paper.

5.3 Scale Versus Substitution Effects of Input Importing

In a setting, where input imports can complement domestic labor or substitute for it, the net effect measured by the coefficient on input importing in Table 5 combines the positive productivity effect and the negative substitution effect. Table 6 reports on results of specifications that differentiate between these two input-market channels by differentiating between the effects of materials versus processed input imports.

In Columns (1), (3), and (5), we use the unweighted share of a firm's imported inputs that is characterized as processed inputs to measure the foreign labor content of these imports. Columns (2), (4), and (6) use a weighted measure. Columns (5) and (6) report on results including a measure of the imported-input intensity at the 4-digit sector level, which may account for differences across sector-specific production technologies in using imported inputs. This measure applies to actual importers as well as non-importers of inputs prior to the trade shock. Columns (1), (2), (5), and (6) control for 2-digit-sector-region fixed effects, while Columns (3) and (4) employ 4-digit-sector-region effects.

We consider Column (3) of Table 6 as the preferred specification, because it identifies both output- and input-market-exposure effects in association with the trade shock from across firms within narrow sectors. Column (3) suggests that the net effect of being employed at an input-importing firm on workers' earnings reported in Table 5 conceals the underlying ambiguity of input importing for workers. For workers in input-importing firms that mainly imported materials without labor substitution, the average annual earnings increased by about 2.1 percentage points more in response to the shock than for the control group. A bigger labor substitution intensity of

Table 6: Changes in annual earnings by type of imports

	Δ log(Annual earnings)					
	(1)	(2)	(3)	(4)	(5)	(6)
Import competition	-0.025***	-0.025***			-0.013***	-0.013***
	(0.002)	(0.002)			(0.003)	(0.003)
Exporter	-0.018***	-0.018***	-0.019***	-0.019***	-0.018***	-0.018***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Importer	0.022***	0.020***	0.021***	0.019***	0.022***	0.020***
	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)
Labor-substitution intensity (unweighted)	-0.012***		-0.012***		-0.013***	
	(0.004)		(0.004)		(0.004)	
Labor-substitution intensity (weighted)		-0.011***		-0.011***		-0.011***
		(0.003)		(0.004)		(0.003)
Imported-input intensity					-0.013***	-0.014***
					(0.003)	(0.003)
Obs.	1,228,446	1,228,446	1,228,446	1,228,446	1,228,446	1,228,446
Fixed effects	2-Digit Ind × Reg	2-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg	2-Digit Ind × Reg	2-Digit Ind × Reg

Note: Fixed effects correspond to 2- or 4-digit industry level fixed effects interacted with labor-market region level fixed effects. Standard errors are clustered at the sector-region level, where the sector aggregation corresponds to the aggregation level used for the fixed effects as reported in the last line of the table. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

these input imports (i.e., a larger share of processed inputs), however, mitigated that positive effect on earnings. The share of processed inputs for the median importing firm amounted to roughly 0.75 prior to the shock. Hence, on average, the positive scale effect of input importing of 2.1 percentage points was reduced by labor substitution by almost one-half. Table 13 in the Appendix presents the same results as in Table 6 when considering input-import and export intensities rather than binary indicators thereof.

Finally, Table 7 presents results that decompose the effect on annual earnings into the intensive margin, measured as monthly wages, and the extensive margin, measured as the share of months an individual is unemployed. The corresponding results suggest that both margins respond and thus contribute to the annual earnings outcome. Roughly one-half of the annual earnings response is due to changes in monthly average wages, while the remaining effect accrues to the (un)employment margin.

5.4 Heterogeneous Effects on Workers Within Firms

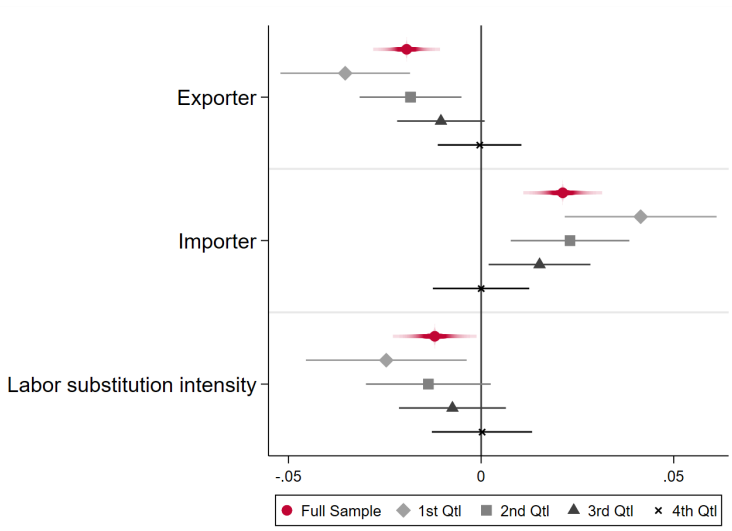
In this subsection, we highlight heterogeneous responses of workers to the trade shock by individual characteristics. We delineate observable differences between workers along three lines: (i) the wage quartile they belong to within a firm wage distribution, which compactly captures numerous observable and unobservable characteristics (ii) observable characteristics such as age, family status, gender, nationality, tenure, and formal education; and (iii) profession or occupation types. Note that all heterogeneity analyses are based on the specification with 4-digit sector fixed effects interacted with labor-market-region fixed effects as presented in Column (3) of Table 6.

Table 7: Extensive (unemployment) and intensive (wage) margins behind annual earnings in response to output- and import-market exposure

	(1)	(2)	(3)	(4)
	Δ log(Wage)		Δ Unemployed	
Import competition	-0.012***		0.003***	
	(0.001)		(0.000)	
Exporter	-0.009***	-0.011***	0.002**	0.002*
	(0.002)	(0.002)	(0.001)	(0.001)
Importer	0.009***	0.009***	-0.003***	-0.003***
	(0.003)	(0.003)	(0.001)	(0.001)
Labor-substitution intensity (unweighted)	-0.005*	-0.005	0.003***	0.003***
	(0.003)	(0.003)	(0.001)	(0.001)
Obs.	1,198,142	1,198,142	1,228,446	1,228,446
Fixed effects	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg

Note: Fixed effects correspond to 4-digit industry level fixed effects interacted with labor-market region level fixed effects. Standard errors are clustered at the sector-region level where the sector aggregation corresponds to the aggregation-level used for the fixed effects as reported in the last line of the table. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure 3: Changes in annual earnings by exposure for different quartiles of the within-firm wage distribution



Note: This figure plots the coefficients and their 95% confidence bands obtained in the main regression in red (corresponding to Column (3) in Table 6) and reports the corresponding coefficients for different sub-samples of workers based on their within-firm wage quartile, ranked such that the first quartile corresponds to the lowest quartile and the fourth quartile to the top quartile.

Table 8: Changes in annual earnings by type of exposure: Heterogeneity across pre-shock characteristics

	Δ log(Annual earnings)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Exporter	-0.000	-0.007*	-0.021***	-0.018***	-0.009**	-0.048***	-0.030***	-0.018*
	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)	(0.007)	(0.010)
Importer	0.018***	0.019***	0.025***	0.016***	0.011**	0.039***	0.021**	0.045***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)	(0.009)	(0.013)
Labor-substitution intensity	-0.008	-0.016***	-0.010**	-0.005	-0.011*	-0.019***	-0.026***	-0.022
	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.005)	(0.010)	(0.014)
Exporter × Lowest quartile	-0.061***							-0.058***
	(0.006)							(0.007)
Importer × Lowest quartile	0.014*							0.010
	(0.008)							(0.008)
Labor-substitution intensity × Lowest quartile	-0.017**							-0.009
	(0.009)							(0.009)
Exporter × ≤ 35 years		-0.024***						-0.022***
		(0.006)						(0.006)
Importer × ≤ 35 years		0.001						-0.009
		(0.007)						(0.008)
Labor-substitution intensity × ≤ 35 years		0.008						0.014
		(0.008)						(0.009)
Exporter × Married			0.005					-0.006
			(0.006)					(0.006)
Importer × Married			-0.010					-0.007
			(0.007)					(0.008)
Labor-substitution intensity × Married			-0.005					0.006
			(0.008)					(0.009)
Exporter × Female				-0.002				0.000
				(0.006)				(0.006)
Importer × Female				0.010				0.004
				(0.007)				(0.007)
Labor-substitution intensity × Female				-0.014*				-0.014*
				(0.008)				(0.008)
Exporter × Swiss					-0.019***			-0.011*
					(0.006)			(0.006)
Importer × Swiss					0.020***			0.015**
					(0.007)			(0.008)
Labor-substitution intensity × Swiss					-0.001			-0.011
					(0.008)			(0.008)
Exporter × Tenure						0.011***		0.009***
						(0.001)		(0.001)
Importer × Tenure						-0.005***		-0.005***
						(0.001)		(0.001)
Labor-substitution intensity × Tenure						0.003***		0.002
						(0.001)		(0.001)
Exporter × Secondary edu.							0.011	0.015*
							(0.008)	(0.008)
Importer × Secondary edu.							0.001	-0.018*
							(0.010)	(0.010)
Labor-substitution intensity × Secondary edu.							0.018*	0.013
							(0.011)	(0.011)
Obs.	1,099,838	1,228,446	1,228,302	1,228,417	1,215,553	1,228,446	1,139,316	1,008,280
Fixed effects	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg

Note: Baseline effects for all interacted variables are included but not reported in this table for readability. They are available on request. Fixed effects correspond to 4-digit industry level fixed effects interacted with labor-market region level fixed effects. Standard errors are clustered at the sector-region level where the sector aggregation corresponds to the aggregation-level used for the fixed effects as reported in the last line of the table. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 9: Changes in annual earnings by type of exposure and worker mobility

	Δ log(Annual earnings)			
	(1)	(2)	(3)	(4)
	Quartile 1 [0-25%]	Quartile 2]25%-50%]	Quartile 3]50%-75%]	Quartile 4]75%-100%]
Exporter	-0.046***	-0.005	-0.006	-0.004
	(0.008)	(0.006)	(0.006)	(0.006)
Importer	0.047***	0.021***	0.003	-0.002
	(0.010)	(0.008)	(0.008)	(0.007)
Labor-substitution intensity	-0.010	-0.020**	0.003	0.004
	(0.010)	(0.008)	(0.008)	(0.008)
Obs.	281,745	281,744	281,744	281,744
Fixed effects	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg
Predicted staying propensity:	Mean (0.43) 25th Percentile (0.32) 75th Percentile (0.55)			

Note: Each quartile corresponds to a quartile of the predicted staying propensity that is based on pre-shock data on age, the relative position within the wage distribution of the firm, the family status, gender, Swiss nationality, tenure at the firm employed at in 2014, and an indicator for secondary education (or higher). The underlying regression is available on request. The distribution of the predicted staying propensity is described in the table. Fixed effects correspond to 4-digit industry level fixed effects interacted with labor-market region level fixed effects. Standard errors are clustered at the sector-region level where the sector aggregation corresponds to the aggregation level used for the fixed effects as reported in the table. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

5.4.1 Heterogeneous effects by income quartile and individual characteristics

In a first step, we consider heterogeneous effects across average workers in different segments of the income distribution within firms. Since the exposure to the trade shock is measured at the firm-level, this heterogeneity is by construction orthogonal to the exposure variables. It turns out to be illustrative to focus on quartiles in this respect. We do so in Figure 3.[28] In the figure, we use lighter gray color for lower annual earnings quartiles and darker color for higher quartiles. For each block of results – pertaining to exporting, input importing and the labor-substitution intensity of imported inputs – the figure draws point estimates of the pre-shock trade-exposure parameters by wage quartile together with 95% confidence bounds. Apart from the wage-quartile-specific effects, we put the average effect of each exposure measure as reported in Column (3) of Table 6 at the top of each block of results.

Figure 3 illustrates that the (negative or positive) effects of each of the three channels tend to be stronger for workers in lower wage quartiles. In particular, none of the trade-exposure effects is different from zero for earners in the highest quartile. On the contrary, workers in the lowest quartile face significant negative effects from export exposure (top panel) and positive ones from input-import exposure (middle panel). The latter positive effects are significantly mitigated for imported inputs with a high foreign labor content (bottom panel).

The results clearly indicate that the identified effects are most pronounced for workers in the lowest quartile of the within-firm wage distribution. This finding is corroborated by Column (1) of Table 8, where we interact the trade-exposure measures with an indicator for workers in the lowest wage quartile of the within-firm wage distribution. The estimates suggest, in particular, that the negative earnings effect resulting from exposure to exporting are concentrated in the lowest quartile of the within-firm wage distribution. The average effect, hence, conceals substantial heterogeneity and amounts to 6 percentage points for workers in the lowest within-firm wage quartile.

Table 8 further reports results that assess the importance of observable individual characteristics, which may also partly explain the position in the within-firm wage distribution of workers. Earlier work demonstrated that earnings responses to trade shocks may differ by age, family status, gender, nationality, tenure, or formal education (see Autor et al., 2014, Hakobyan and McLaren, 2016, Keller and Utar, 2022). While we condition on all of those indicators' main effects in Table 8, we highlight the interactions of these attributes with the trade-exposure variables to see how they mediate the responses to the trade shock.

In the table, we control for the main effect of the three trade-shock exposures and three interaction terms for each observable characteristic one at a time in Columns (1)-(7), and we control for all of them jointly in Column (8). In the block at the top of the table, we report the main effects of the firm-level trade-exposure variables in all columns. In the block underneath, we report the results of all exposure variables interacted with the mentioned characteristics. The results in Columns (1)-(7) suggest that, besides being in the bottom-wage quartile, a younger age, Swiss nationality, and shorter tenure are particularly strong amplifiers of the negative effect of export exposure. Column (8) shows that the export-exposure induces strong effects for workers in the low-wage quartile, even conditional on all other observable characteristics. The positive effect of input-import-exposure is reinforced for Swiss nationals and mitigated for workers with longer tenure.

In sum, while earlier work has identified gender (Keller and Utar, 2022, 2023) and formal education (Autor et al., 2014) as important determinants of the effect of trade shocks on labor-

[28] Note that the underlying data sample is restricted to workers that are employed at firms that have at least four employees in order to construct the quartiles.

market outcomes, these attributes do not have a robust or large differential effect in our data. Instead, the strongest heterogeneity of worker-level earnings responses are due to Swiss nationality, tenure, age, and the position in the within-firm wage distribution. We conjecture that these factors are related to workers' mobility (or the lack thereof), and that worker mobility may be a common underlying factor that matters for workers' earnings responses. We turn to this conjecture in more detail next.

5.4.2 Heterogeneous effects for stayers versus movers

The results reported in Table 8 suggest that effects might be related to workers' mobility. Clearly, worker-level firm switching is an outcome as are annual earnings, and earnings may change in response to the trade shock in association with firm switching, voluntary or involuntary.

To assess the conjecture that firm switching is an important channel behind worker-level earnings changes, we proceed in two steps. First, we assess to which extent the effects on average earnings per worker are due to firm switching versus changes within the firm and on the job. To this end, we construct a binary indicator variable Stay_i which is one whenever the employer of worker i does not change between December 2014 and the end of the sample period in December 2017. We regress this indicator in a linear probability model on pre-shock variables as in Table 8 but also on an exhaustive set of interaction terms between those (conditional on region-sector fixed effects).[29][30] Since these worker-level characteristics are measured prior to the shock, we explain the propensity to stay by workers' pre-shock heterogeneity only.

While we could not use the endogenous realization of staying to shed light on the role of mobility for the findings, we can use the exogenous propensity of staying as predicted by pre-shock factors to do so. This is what we do in the second step, where we relate workers' earnings outcomes to the propensity to stay employed with the pre-shock firm. We summarize the corresponding results in Table 9, where Columns (1)-(4) report results for individuals of four subsamples for each quartile of the distribution of the predicted staying propensities. Throughout the table, we condition on region-sector fixed effects. The propensity of moving is highest in the lowest quartile of the staying propensity reported in Column (1) and lowest in the top one, reported in Column (4). Hence, the results indicate that the average earnings effects from trade exposure are strongest where the propensity of staying is lowest (Column (1)), and they fade as the propensity of staying with the firm increases.

Similarly, the positive earnings response for input-import-exposed workers tends to be stronger, with a lower propensity to stay at the firm. If imports have a high labor content, the positive scale effect is mitigated to some degree, but not fully eliminated. All of these wage effects, positive or negative, tend to be stronger for workers who are more likely to move to other jobs, be it voluntarily

[29] We include age and the relative earnings position prior to the shock as continuous variables in this regression instead of categories as used in Table 8. This is done in order to limit the number of interaction terms only. Earlier work documented that worker characteristics (including their history), firms' production processes, and, in particular, the interplay of the two are relevant predictors of the reallocation of the workforce between the firms and sectors in an economy (Golan et al., 2007). Golan et al. (2007) emphasize the role of tenure in the firm in this regard, Sicherman (1996) reports on the importance of gender as well as of earlier pay (and pay offered elsewhere), and Kurz and Senses (2016) document effects of firms' trade exposure on the firm-level employment volatility, which inevitably translates into individual worker effects.

[30] The respective regressors together explain about as much of the variance in the binary indicator as a corresponding set of fixed effects does. Hence, the predictors are jointly important. The corresponding regression table is available upon request.

or involuntarily.

In sum, the results indicate that export exposure reduces workers' earnings through firm switching, which is consistent with involuntary job losses (displacement). On the contrary, the larger effects of input-import exposure in Column (1) suggest that more mobile workers can capture relatively more earnings increases, which is consistent with voluntary job switching.

Overall, we confirm results of earlier work, which indicate that workers' mobility magnifies the impact of adverse trade shocks on earnings (e.g., Autor et al., 2014). However, our results provide two new insights. First, worker mobility magnifies not only the adverse but also the beneficial effects on earnings. This finding is in line with work in the labor literature showing that voluntary job changes account for an important part of individuals' wage growth (e.g., Pérez and Sanz, 2005, Dustmann and Meghir, 2005, Altonji et al., 2013). Second, we stress that the sharp, unanticipated exchange rate shock enables the measurement of mobility via pre-shock variables and is especially suitable to address the role of mobility for earnings.

5.4.3 Heterogeneous effects across different profession and occupation types

In our task-based conceptual framework of Section 3, workers are hired to complete different types of tasks. In that context, we have argued that the earnings responses to the trade shock may vary across different types of tasks completed by workers. In the next paragraph, we therefore look at the earnings responses for different profession or occupation types which may thus distinguish between workers performing tasks in the manufacturing production process and those who are not.[31]

Table 10 reports the results of our preferred specification separately for broader professional categories. Since we observe (inferred) professional categories only for roughly one-half of the data, and we lose statistical power in subsamples of individual professions, we report separate regression results for the 12 most common professions. We roughly group the professional categories into three groups: those that are linked to manufacturing and are engaged in or close to the production process, such as blue collar production workers, technicians, engineers or scientists (top panel, Columns (1) to (3)), professions that represent generic occupations present in all types of firms (top panel, Columns (4) to (6)) and occupations that are rather linked to services firms (bottom panel, Columns (7) to (12)).

Among the professions associated with manufacturing production processes and among the generic professions, we find the negative effect of exporting in almost all subsamples. This finding suggests that, in line with the prediction of our parsimonious model, output-market driven exposure affects labor-demand responses for all categories roughly proportionally. As firms' output markets shrink, firms reduce their overall size.

The input-market driven exposure, on the other hand – while less precisely measured on average – is slightly more significant and larger for professions that are linked to manufacturing and closer to the production process of the firm. We argue that these findings are in line with our conceptual framework, where tasks are completed by specific occupations and where task-specific labor markets are (partly) segmented. The stronger estimated responses for production-related professions may indeed arise when these professions face improved outside options after the shock. Specifically, the shock may increase the demand for tasks that are complementary to input importing or increase the demand for tasks that are substituted. The equilibrium labor-market outcomes will therefore vary

[31] We stress that our classification of workers into profession and occupation is prone to measurement error, and accordingly should interpret the respective results with caution.

Table 10: Main regression for workers with different previous work experience

	Δ log(Annual earnings)					
	Professions of manufacturing sectors			Generic professions		
	(1)	(2)	(3)	(4)	(5)	(6)
	Engineers & Technicians	Production (blue collar)	Scientists	Management & HR	Office & Administration	Sales
Exporter	-0.060**	-0.038**	-0.034	0.006	-0.029**	-0.056***
	(0.030)	(0.016)	(0.038)	(0.021)	(0.015)	(0.021)
Importer	0.060*	0.043*	0.143***	-0.010	0.012	0.031
	(0.034)	(0.022)	(0.046)	(0.025)	(0.017)	(0.031)
Labor-substitution intensity (unweighted)	-0.061*	-0.020	-0.082*	0.008	-0.001	-0.014
	(0.033)	(0.023)	(0.047)	(0.025)	(0.019)	(0.034)
Obs.	16,979	64,392	16,225	33,005	79,662	54,605
Fixed effects	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg
	Δ log(Annual earnings)					
	Professions of services sectors					
	(7)	(8)	(9)	(10)	(11)	(12)
	Banking & Insurance	Cleaning & pers. services	Construction	Gastronomy	Health	Others (skilled)
Exporter	-0.052*	-0.007	-0.002	0.002	0.050	0.033
	(0.028)	(0.038)	(0.020)	(0.020)	(0.035)	(0.030)
Importer	0.009	-0.020	-0.006	0.048**	0.054**	-0.051
	(0.031)	(0.036)	(0.021)	(0.020)	(0.024)	(0.037)
Labor-substitution intensity (unweighted)	0.043	0.010	0.018	-0.027	-0.069***	0.042
	(0.034)	(0.038)	(0.023)	(0.022)	(0.026)	(0.038)
Obs.	29,746	28,164	45,819	57,512	29,474	22,848
Fixed effects	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg

Note: This table presents the result of the main regression (Column (3) of Table 6) for 12 different subsamples of workers based on the inferred occupation of these workers. We roughly group the categories into occupations that are linked to manufacturing (top panel, Columns (1) to (3)), professions that are generic occupations present in all types of firms (top panel, Columns (4) to (6)) and occupations that are rather linked to services firms (bottom panel, Columns (7) to (12)). Fixed effects correspond to 4-digit industry level fixed effects interacted with labor-market region level fixed effects. Standard errors are clustered at the sector-region level where the sector aggregation corresponds to the aggregation level used for the fixed effects as reported in the last line of the table. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

across task-specific labor markets.[32] In that case, we can expect these professions to obtain larger wage increases in response to the labor-demand shock.[33] Further, the positive effect of general input-import exposure tends to be mitigated if imports embody a large foreign labor content. In line with theory, this mitigating effect surfaces for professions that are close to the production process and whose tasks may thus be substituted by foreign-processed imported inputs. Finally, we expect the effects to be generally weaker for professions that are linked to services sectors, since our exposure measures are entirely based on goods exports and imports. This is indeed the case.

5.5 Firm-level Responses

The empirical analysis of this paper is guided by a conceptual framework, inspired by models of task-based production. According to this framework, an exchange-rate appreciation leads to negative labor-demand responses through the output-market effect (import competition and export exposure) and to positive labor-demand responses through the scale effect of input-import exposure, where the last effect is weaker, the more labor-substituting these imported inputs are. The latter effects suggest, importantly, that firms not only reduce their workforce proportionally to changes in size, but they also reorganize: they adjust their factor mix due to the shock by hiring different labor types and changing their input-importing behavior.

There are important testable predictions regarding the organizational adjustments of firms in response to the trade shock. We expect greater output-market exposure to the shock (import competition and exporting) to reduce overall labor demand of firms and input-market exposure (input importing) to increase labor demand, but less so for labor-intensive imports that substitute domestic labor. Beyond net employment effects, we expect that a greater input-market exposure to induce compositional changes of firms regarding their domestic work force and tasks carried out at home. Finally, the tasks and inputs sourced from abroad are expected to increase. We explore these predictions as a sanity check regarding the suitability of our conceptual framework employed for thinking about the shock at hand.

In order to address firm-level margins of adjustment, we estimate another set of difference-in-differences regressions, similar in spirit to the ones in the main analysis but focusing on various firm-level outcomes. As before, we compare differences of outcomes for firms between the average three-year windows before (2012-14) and after (2015-17) the trade shock, $\Delta\bar{y}_f$, subject to different pre-shock trade exposure:

$$\begin{aligned}\Delta\bar{y}_f =& \text{Import competition}_s\beta_1 + \mathbb{I}\left[\text{Exporter}_f = 1\right]\beta_2 \\ &+ \mathbb{I}\left[\text{Importer}_f = 1\right]\beta_3 + \text{Labor-substitution intensity}_f\beta_4 + \gamma_{s,r} + \Delta e_f, \end{aligned} \tag{8}$$

where $\gamma_{s,r}$ denotes sector-region fixed effects as before.

Table 11 summarizes the results for the different organizational margins of firms. Column (1) of the table confirms the predictions with respect to the number of employees: the headcount shrinks

[32] Indeed, we recall that, while our conceptual framework shows how labor-demand responses depend on the input-import exposure of the firm, the endogenous reactions of labor-market outcomes in response to the shock depend on the labor market firms and workers interact in, including outside options.

[33] Alternative interpretations of these results are the following: (i) task- and occupation-specific returns to scale in the production function and (ii) different labor-market characteristics across tasks and occupations. Specifically, if generic professions exhibit less task-specific knowledge, the increase of a firm's labor demand is more readily met by hiring more workers of these types, which results in a muted response of earnings of the incumbent workers in these labor-market segments.

Table 11: Firm-level regressions

	Extensive hiring margin		**Substitution margin**	
	(1)	(2)	(3)	(4)
	Δlog(No empl)	ΔNew empl share	Δlog(Avg wage$_{2012}$)	ΔNo. imp. product categories
Exporter	-0.014*	0.004	-0.009	0.219***
	(0.008)	(0.004)	(0.005)	(0.017)
Importer	0.062***	0.008*	0.012*	-0.049**
	(0.010)	(0.005)	(0.007)	(0.022)
Labor-substitution intensity	-0.069***	0.024***	-0.019**	0.203***
	(0.012)	(0.005)	(0.008)	(0.024)
Obs.	156,907	156,907	151,210	156,907
Fixed effects	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg

Note: Fixed effects correspond to 4-digit industry level fixed effects interacted with labor-market region level fixed effects. Standard errors are clustered at the sector-region level, where the sector aggregation corresponds to the aggregation level used for the fixed effects as reported in the last line of the table. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

for export-exposed firms and increases for input-import-exposed ones, but less so if input imports are of the labor-substituting type.[34] Column (2) of Table 11 suggests that not only the number of workers and employees changes, but so does the composition of the work force. In particular, a higher labor-substitution intensity of input imports raises the number of new employees hired in response to the shock, which stands in remarkable contrast to the overall reduction in employment in Column (1). In Column (3), the outcome variable is the difference in the average pre-sample-period wage of firms' current employees, which we take as a measure of the *type of workers* employed assuming that different types of workers earn different wages. It shows that, in response to the trade shock, input-import-exposed firms tend to hire workers that were better-paid as of 2012, while the opposite is true for export-exposed firms (statistical significance of the latter effect falls short of conventional levels, though). A higher degree of labor substitution in imported inputs also changes the composition of workers the firm newly employs. In Column (4), the outcome variable is the number of imported product categories, which we take as a proxy for the scope of tasks that a firm outsources. It suggests that export-exposed firms start importing more input-product categories (outsource more tasks). Input-importing firms do so mainly if their previously imported inputs are of the labor-substituting type. Regarding the magnitude of the latter effect, keep in mind that the average labor-substitution intensity among input importing firms is 0.75.

In general, we expect that the labor-demand responses of firms do not only affect extensive employment margins but also intensive margins, i.e., the wage of workers remaining and hired at the firms. With Table 12, we turn to this intensive margin, focusing on the average wage-setting behavior of firms in response to the trade shock. As discussed in Section 3, all effects depend fundamentally on the labor-market environment. Column (1) presents results for the average wages

[34] Table 14 in the Appendix presents the same analysis exploiting variation in the firm-level export and input-import intensity, corroborating qualitatively the findings in the main text.

Table 12: Firm-level regressions: Wage setting along the within-firm wage distribution

	(1)	(2)	(3)	(4)	(5)
	Δlog(Avg wage)	Δlog(Wage at 10th percentile)	Δlog(Wage at median)	Δlog(Wage at 90th percentile)	Δlog(Maximum wage)
Exporter	-0.002	0.002	-0.003	0.002	-0.012*
	(0.006)	(0.010)	(0.006)	(0.007)	(0.007)
Importer	0.016**	0.019	0.015*	0.020**	0.034***
	(0.008)	(0.013)	(0.008)	(0.009)	(0.009)
Labor-substitution intensity	-0.022***	-0.028**	-0.020**	-0.024**	-0.038***
	(0.009)	(0.014)	(0.009)	(0.010)	(0.010)
Obs.	156,907	156,907	156,907	156,907	156,907
Fixed effects	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg

Note: Fixed effects correspond to 4-digit industry level fixed effects interacted with labor-market region level fixed effects. Standard errors are clustered at the sector-region level where the sector aggregation corresponds to the aggregation-level used for fixed effects as reported in the last line of the table. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

paid by firms. Strikingly, a negative output-market exposure does not appear to have any effect on average wages paid by firms. This result is consistent with the earlier worker-level findings that negative wage responses are entirely driven by those workers, who (have to) leave the firms they are employed at in 2014 (see the discussion of Table 9). The findings of Column (1) are confirmed in Columns (2)-(5), where we assess the effects across quantiles of the within-firm wage distribution. Only at the very top, some reduction in earnings is seen among workers that are employed at exporting firms, which might be driven by bonus payments which are sales-dependent and included in the wages reported in the social security data.

Finally, the positive labor-demand exposure of firms through access to cheaper foreign inputs tends to have positive effects on average wages paid by these firms. The more this scale effect of importing is counteracted by the labor-substitution effect of imported inputs, however, the smaller is the overall positive effect on average wages. Columns (2)-(5) of Table 12 suggest that the positive effect is slightly skewed towards higher wages.

6 Discussion

In the previous section, we exploited a sharp and clean trade shock to identify its effects on worker-level outcomes. We provided evidence that the effects vary strongly by firm-level export- and input-import-exposure and that the effect of input-import exposure varies by the type of inputs, in particular, the (foreign) labor content of imported inputs. On the broad scale, the results suggest that the reaction of worker outcomes to trade shocks are very heterogeneous across worker groups. Specifically, aggregate labor-market responses from reduced-form analyses run the risk to neglect important distributional consequences due to both, heterogeneity in trade exposure across firms even within narrowly defined industries and heterogeneous responses across workers for a given firm-level exposure. This observation is important for the interpretation of work that relies on less detailed data and focuses on aggregate outcomes and/or sector-level variation.

Instead of reviewing the entity of the previous results, the current section returns to the parsimonious conceptual framework laid out in Section 3, which informed our reduced-form empirical

analysis. Specifically, we offer a structured and concise interpretation of the central results through the lens of this framework. In this framework, we derived channel-specific changes of firm-level labor demand in response to a trade shock. Clearly, in the data the effects on earnings, wages and employment status all depend on factors that are specific to the labor-market environment and are not specified in the model. In the current section, we therefore discuss a set of standard labor-market features, which appear helpful in interpreting the empirical findings.

We will argue that firm-specific wage premia, search and matching frictions and wage rigidities in combination with segmented labor markets along broader task dimensions are the natural ingredients that explain the overall picture emerging from our empirical analysis.

A first important dimension of our results is the difference in earnings responses to price changes of material and of processed inputs (Table 6). Our conceptual framework predicts that the exchange-rate shock induces different shifts of demand for the labor types L_1 and L_2. The resulting differences in wage and earnings responses, in turn, suggest that both types of labor must be genuinely distinct and operate in labor markets that are segmented along the dimension of different tasks (see Acemoglu and Restrepo, 2022). This interpretation of task-based segmentation of labor markets is further corroborated by the corresponding regressions for different professions (Table 10). In those professions, where the two channels of input-import-exposure on earnings are expected to be more prevalent (professions close to manufacturing production workers), the estimated effects are indeed particularly pronounced. Together, these observations suggest that labor-market segmentation along the dimension of tasks is a suitable modeling feature to interpret our results.

The second important dimension of the results relates to worker mobility and, in particular, the observations that earnings losses and gains are more pronounced for workers who change their employer (Tables 8 and 9). For exporting firms, we see that workers who stay with their export-exposed employer do not suffer earnings losses, while earnings losses are large for workers who leave these firms. We argue that the distinct outcomes for a priori equally treated workers hint at downward wage rigidities (e.g., as modeled in Rodríguez-Clare et al., 2022). These rigidities protect the stayers from earnings losses at the expense of workers who suffer (presumably involuntary) job separation and corresponding earnings losses. In combination with search frictions, they are also consistent with the interpretation that involuntary job separation leads to unemployment and makes workers ultimately accept lower wages at their new employers. Furthermore, the observed wage cuts for workers of export-exposed firms are consistent with the view that pre-shock matches of these workers were particularly good, in line with exporter wage premia (Table 3), e.g., due to efficiency wages. Turning to the input-market channels, we see that workers who stay with their input-import-exposed employer do enjoy some rent-sharing, due to the productivity effect of cheaper inputs (if the negative substitution effect does not dominate) and also experience lower unemployment risk. Yet, earnings gains are much larger for workers who move to other firms, pointing at a voluntary job separation and a positive selection of movers. Both results are also compatible with the view that firm-level and aggregate demand rises in the labor-market segment for tasks that complement the use of imported inputs, leading to higher wages in these segments. Moreover, the asymmetry between stayers at exporting and stayers at input-importing firms is consistent with the view that wage rigidities are indeed one-sided, preventing cuts of staying workers' wages while allowing upward adjustments.

Finally, the labor-market segmentation discussed above also explains salient features of the firm-level analysis (Table 11). Specifically, while labor-substituting imports tend to reduce a firm's

worker headcount (Table 11, Column (1)), the share of newly hired labor actually increases (Table 11, Column (2)). Again, this finding is in line with task-based production and segmented labor markets: while an input-importing firm's demand for some tasks drops due to substitution, demand for other tasks increases and so does the hiring of complementary labor. Together, the two effects induce a restructuring of the workforce in input-import-exposed firms (as, e.g., in Helpman et al., 2010, Sampson, 2014), compatible with segmented labor markets. This interpretation is corroborated by the observation that such firms raise the scope of imported inputs in the aftermath of the shock (Table 11, Column (4)).

Overall, we have seen that many of the salient results of our analysis naturally emerge in models of task-based production, when combined with segmented labor markets, firm-specific wage premia, search costs and downward wage rigidities. We thus argue that models featuring these characteristics seem promising to capture the full combination of the results presented in this paper. These labor-market features also imply that the distributional consequences of trade shocks can be substantially larger than average effects might suggest.

7 Conclusion

This paper exploits the unique setting of a large, unanticipated, and persistent appreciation of the Swiss franc to identify causal effects of a trade shock on labor markets. Based on a conceptual framework of task-based production, we characterize four channels through which the trade shock impacts firms' labor demand and worker outcomes. The first two channels relate to the impact on firms' *output markets*, as firms experience increased competition on (i) domestic markets and (ii) export markets. The two other channels relate to firms' *input markets*, where firms experience (iii) a positive productivity effect due to cheaper imported intermediate inputs, which increases the demand for workers that are complementary to these inputs, but which can also have (iv) a negative substitution effect on labor demand if workers are replaced by imported inputs.

The data permit analyzing worker-level responses as well as firm-level ones. The results show that the Swiss trade shock does affect workers through all four output- and input-market channels in the expected ways. We document the well-known effects of import competition: employment in a sector with a one standard deviation higher import competition involves a decline in earnings growth of 2.5 percentage points. But even within narrowly defined sectors and within labor-market regions, workers' earnings responses strongly depend on their firm's trade exposures. Pre-shock employment at exporting firms induces earnings losses of 1.9 percentage points for the average worker, employment at input-importing firms induces relative earnings gains of 2.1 percentage points if imports only consist of materials (complementing labor), but the latter effect declines to 0.9 percentage points if importing consists of processed inputs (substituting labor). We also provide strong evidence that the bulk of these effects are brought about by workers who – voluntarily or involuntarily – leave their employer.

Considering effects at the level of firms, we document that output-exposed firms shrink and input-import-exposed firms tend to grow in terms of their labor force. Additionally, we see that firms tend to restructure their work force.

Overall, the paper demonstrates that worker-level outcomes of trade shocks vary across many dimensions, suggesting that average labor-market effects hide important heterogeneities and distributional implications of trade shocks. The heterogeneity emerges through heterogeneous exposure of individual firms but also through heterogeneous worker responses at the same firm. In particular,

our findings indicate that the worker-level responses are concentrated on workers in the lower tail of the wage distribution and, in particular, on workers who change their employer (voluntarily or involuntarily). Our results point at characteristics of the labor market that reinforce adverse outcomes for certain segments of the workers while shielding others, and inform modeling assumptions for future work.

References

Acemoglu, D., D. Autor, D. Dorn, G. H. Hanson, and B. Price (2016). Import Competition and the Great US Employment Sag of the 2000s. *Journal of Labor Economics 34*(S1), S141–S198.

Acemoglu, D. and P. Restrepo (2022). Tasks, Automation, and the Rise in U.S. Wage Inequality. *Econometrica 90*(5), 1973–2016.

Adão, R., C. Arkolakis, and F. Esposito (2020). Spatial Linkages, Global Shocks, and Local Labor Markets: Theory and Evidence. Working Paper 25544, National Bureau of Economic Research.

Aghion, P., A. Bergeaud, M. Lequien, M. Melitz, and T. Zuber (2022). Opposing Firm-Level Responses to the China Shock: Horizontal Competition versus Vertical Relationships? Working Paper 29196, National Bureau of Economic Research.

Alfaro, L., A. Cunat, H. Fadinger, and Y. Liu (2023). The Real Exchange Rate, Innovation, and Productivity. *Journal of the European Economic Association 21*(2), 637–689.

Altonji, J. G., A. A. Smith Jr, and I. Vidangos (2013). Modeling Earnings Dynamics. *Econometrica 81*(4), 1395–1454.

Antràs, P., T. C. Fort, and F. Tintelnot (2017). The Margins of Global Sourcing: Theory and Evidence from US Firms. *American Economic Review 107*(9), 2514–2564.

Antràs, P. and E. Helpman (2004). Global Sourcing. *Journal of Political Economy 112*(3), 552–580.

Arni, P., R. Lalive, and J. C. van Ours (2013). How Effective Are Unemployment Benefit Sanctions? Looking Beyond Unemployment Exit. *Journal of Applied Econometrics 28*, 1153–1178.

Arni, P., G. J. van den Berg, and R. Lalive (2022). Treatment Versus Regime Effects of Carrots and Sticks. *Journal of Business & Economic Statistics 40*(1), 111–127.

Artuç, E., S. Chaudhuri, and J. McLaren (2010). Trade Shocks and Labor Adjustment: A Structural Empirical Approach. *American Economic Review 100*(3), 1008–45.

Artuç, E. and J. McLaren (2015). Trade Policy and Wage Inequality: A Structural Analysis with Occupational and Sectoral Mobility. *Journal of International Economics 97*(2), 278–294.

Auer, R., A. Burstein, K. Erhardt, and S. M. Lein (2019). Exports and Invoicing: Evidence from the 2015 Swiss Franc Appreciation. *AEA Papers and Proceedings 109*, 533–38.

Auer, R., A. Burstein, and S. M. Lein (2021). Exchange Rates and Prices: Evidence from the 2015 Swiss Franc Appreciation. *American Economic Review 111*(2), 652–86.

Auer, R., A. Burstein, S. M. Lein, and J. Vogel (2023). Unequal Expenditure Switching: Evidence from Switzerland. *The Review of Economic Studies*, rdad098.

Auer, R. A., T. Chaney, and P. Sauré (2018). Quality Pricing-to-Market. *Journal of International Economics 110*, 87–102.

Autor, D., D. Dorn, and G. H. Hanson (2013). The China Syndrome: Local Labor Market Effects of Import Competition in the United States. *The American Economic Review 103*(6), 2121–2168.

Autor, D., D. Dorn, and G. H. Hanson (2015). Untangling Trade and Technology: Evidence from Local Labour Markets. *Economic Journal 125*(584), 621–46.

Autor, D., D. Dorn, and G. H. Hanson (2016). The China Shock: Learning from Labor-Market Adjustment to Large Changes in Trade. *Annual Review of Economics 8*, 205–240.

Autor, D., D. Dorn, and G. H. Hanson (2021). On the Persistence of the China Shock. *Brookings Papers on Economic Activity Fall 2021*, 381–447.

Autor, D., D. Dorn, G. H. Hanson, and J. Song (2014). Trade Adjustment: Worker-Level Evidence. *The Quarterly Journal of Economics 129*(4), 1799–1860.

Aw, B. Y., M. J. Roberts, and D. Y. Xu (2011). R&D Investment, Exporting, and Productivity Dynamics. *American Economic Review 101*(4), 1312–1344.

Balsvik, R., S. Jensen, and K. G. Salvanes (2015). Made in China, Sold in Norway: Local Labor Market Effects of an Import Shock. *Journal of Public Economics 127*, 137 – 144.

Bernard, A. B. and J. B. Jensen (1999). Exceptional Exporter Performance: Cause, Effect, or Both? *Journal of International Economics 47*(1), 1–25.

Blaum, J. (2023). Global Firms in Large Devaluations. *Quarterly Journal of Economics forthcoming*.

Boehm, C. E., A. Flaaen, and N. Pandalai-Nayar (2020). Multinationals, Offshoring, and the Decline of US Manufacturing. *Journal of International Economics 127*, 103391.

Boeri, T. and U. Cramer (1992). Employment Growth, Incumbents and Entrants: Evidence from Germany. *International Journal of Industrial Organization 10*(4), 545–565.

Bonadio, B., A. M. Fischer, and P. Sauré (2020). The Speed of Exchange Rate Pass-Through. *Journal of the European Economic Association 18*(1), 506–538.

Borcherding, T. E. and E. Silberberg (1978). Shipping the Good Apples Out: the Alchian and Allen Theorem Reconsidered. *Journal of Political Economy 86*(1), 131–138.

Caliendo, L., M. Dvorkin, and F. Parro (2019). Trade and Labor Market Dynamics: General Equilibrium Analysis of the China Trade Shock. *Econometrica 87*(3), 741–835.

Caliendo, L., L. D. Opromolla, F. Parro, and A. Sforza (2021). Goods and Factor Market Integration: a Quantitative Assessment of the EU Enlargement. *Journal of Political Economy 129*(12), 3491–3545.

Caliendo, L., L. D. Opromolla, F. Parro, and A. Sforza (2023). Labor Supply Shocks and Capital Accumulation: The Short and Long Run Effects of the Refugee Crisis in Europe. In *AEA Papers and Proceedings*, Volume 113, pp. 577–584. American Economic Association.

Caliendo, L., F. Parro, E. Rossi-Hansberg, and P.-D. Sarte (2018). The Impact of Regional and Sectoral Productivity Changes on the US Economy. *The Review of Economic Studies 85*(4), 2042–2096.

Caliendo, L. and E. Rossi-Hansberg (2012). The Impact of Trade on Organization and Productivity. *The Quarterly Journal of Economics 127*(3), 1393–1467.

Cardoza, M., F. Grigoli, N. Pierri, and C. Ruane (2023). Worker Mobility in Production Networks. Working paper, STEG Working Paper Series.

Cavallo, A., F. Lippi, and K. Miyahara (2023). Large Shocks Travel Fast. Working Paper 31659, National Bureau of Economic Research.

Colella, F. (2022). The Effect of Trade on Skill Requirements: Evidence from Job Postings. Mimeo.

Costa, R., S. Dhingra, and S. Machin (2019). Trade and Worker Deskilling. Working Paper 25919, National Bureau of Economic Research.

Costinot, A., M. Sarvimäki, and J. Vogel (2022). Exposure(s) to Trade and Earnings Dynamics: Evidence From the Collapse of Finnish-Soviet Trade. Working paper, MIT Working Paper.

Dauth, W., S. Findeisen, and J. Suedekum (2014). The Rise of the East and the Far East: German Labor Markets and Trade Integration. *Journal of the European Economic Association 12*(6), 1643–1675.

Dauth, W., S. Findeisen, J. Suedekum, and N. Woessner (2021). The Adjustment of Labor Markets to Robots. *Journal of the European Economic Association 19*(6), 3104–3153.

Davis, S. J., J. C. Haltiwanger, and S. Schuh (1998). *Job Creation and Destruction*. The MIT Press.

Department of Economic and Social Affairs Statistics Division (2016). Classification by Broad Economic Categories Rev.5. M 53, Department of Economic and Social Affairs Statistics Division. Revision 5.

Dix-Carneiro, R. and B. K. Kovak (2017). Trade Liberalization and Regional Dynamics. *American Economic Review 107*(10), 2908–46.

Dix-Carneiro, R. and B. K. Kovak (2019). Margins of Labor Market Adjustment to Trade. *Journal of International Economics 117*, 125–142.

Dustmann, C. and C. Meghir (2005). Wages, Experience and Seniority. *The Review of Economic Studies 72*(1), 77–108.

Ebenstein, A., A. Harrison, M. McMillan, and S. Phillips (2014). Estimating the Impact of Trade and Offshoring on American Workers Using the Current Population Surveys. *Review of Economics and Statistics 96*(4), 581–595.

Efing, M., R. Fahlenbrach, C. Herpfer, and P. Krueger (2023). How Do Investors and Firms React to a Large, Unexpected Currency Appreciation Shock? *The Review of Corporate Finance Studies 12*(3), 488–538.

Egger, D., D. Auer, and J. Kunz (2022). Effects of Migrant Networks on Labor Market Integration, Local Firms and Employees. Mimeo.

Egger, H., U. Kreickemeier, C. Moser, and J. Wrona (2022). Exporting and Offshoring with Monopsonistic Competition. *The Economic Journal 132*(644), 1449–1488.

Egger, P., M. Pfaffermayr, and A. Weber (2007). Sectoral Adjustment of Employment to Shifts in Outsourcing and Trade: Evidence from a Dynamic Fixed Effects Multinomial Logit Model. *Journal of Applied Econometrics 22*(3), 559–580.

Ekholm, K., A. Moxnes, and K. H. Ulltveit-Moe (2012). Manufacturing Restructuring and the Role of Real Exchange Rate Shocks. *Journal of International Economics 86*(1), 101–117.

Fadinger, H., P. Herkenhoff, and J. Schymik (2024). Quantifying the Germany Shock: Structural Labor-Market Reforms and Spillovers in a Currency Union. *Journal of International Economics*, 103905.

Feenstra, R. C. and G. H. Hanson (1996). Globalization, Outsourcing, and Wage Inequality. *The American Economic Review 86*(2), 240–245.

Feenstra, R. C. and G. H. Hanson (1997). Foreign Direct Investment and Relative Wages: Evidence from Mexico's Maquiladoras. *Journal of International Economics 42*(3), 371–393.

Feenstra, R. C. and A. Sasahara (2018). The 'China Shock', Exports and US Employment: A Global Input–Output Analysis. *Review of International Economics 26*(5), 1053–1083.

Fischer, A. M., P. Herkenhoff, and P. Sauré (2023). Identifying Chinese Supply Shocks: Effects of Trade on Labor Markets. *Review of International Economics 31*(4), 1476–1507.

Funk, A. K. and D. Kaufmann (2022). Do Sticky Wages Matter? New Evidence from Matched Firm Survey and Register Data. *Economica 89*(355), 689–712.

Galle, S., A. Rodríguez-Clare, and M. Yi (2023). Slicing the Pie: Quantifying the Aggregate and Distributional Effects of Trade. *The Review of Economic Studies 90*(1), 331–375.

Gimenez-Perales, V. (2024). The Dynamics of Importer–Exporter Connections. *European Economic Review 161*, 104638.

Golan, A., J. Lane, and E. McEntarfer (2007). The Dynamics of Worker Reallocation within and across Industries. *Economica 74*(293), 1–20.

Goldberg, P. K. and M. M. Knetter (1999). Measuring the Intensity of Competition in Export Markets. *Journal of International Economics 47*(1), 27–60.

Gourinchas, P.-O. (1998). Exchange Rates and Jobs: What Do We Learn From Job Flows? *NBER Macroeconomics Annual 13*, 153–208.

Grossman, G. M. (1986). Imports as a Cause of Injury: The Case of the U.S. Steel Industry. *Journal of International Economics 20*(3), 201–223.

Grossman, G. M. and E. Rossi-Hansberg (2008). Trading Tasks: A Simple Theory of Offshoring. *The American Economic Review 98*(5), 1978–1997.

Gulyas, A., M. Meier, and M. Ryzhenkov (2023). Labor Market Effects of Monetary Policy Across Workers and Firms. Technical report, University of Bonn and University of Mannheim, Germany.

Hakobyan, S. and J. McLaren (2016). Looking for Local Labor Market Effects of NAFTA. *Review of Economics and Statistics 98*(4), 728–741.

Halpern, L., M. Koren, and A. Szeidl (2015). Imported Inputs and Productivity. *American Economic Review 105*(12), 3660–3703.

Harrison, A. and M. McMillan (2011). Offshoring Jobs? Multinationals and US Manufacturing Employment. *Review of Economics and Statistics 93*(3), 857–875.

Helpman, E., O. Itskhoki, M.-A. Muendler, and S. J. Redding (2016). Trade and Inequality: From Theory to Estimation. *The Review of Economic Studies 84*(1), 357–405.

Helpman, E., O. Itskhoki, and S. Redding (2010). Inequality and Unemployment in a Global Economy. *Econometrica 78*(4), 1239–1283.

Hummels, D., R. Jørgensen, J. Munch, and C. Xiang (2014). The Wage Effects of Offshoring: Evidence from Danish Matched Worker-Firm Data. *American Economic Review 104*(6), 1597–1629.

Hummels, D., R. Jørgensen, J. Munch, and C. Xiang (2014, June). The Wage Effects of Offshoring: Evidence from Danish Matched Worker-Firm Data. *American Economic Review 104*(6), 1597–1629.

Irarrazabal, A., A. Moxnes, and K. H. Ulltveit-Moe (2013). Heterogeneous Firms or Heterogeneous Workers? Implications for Exporter Premiums and the Gains from Trade. *Review of Economics and Statistics 95*(3), 839–849.

Jordan, T. (2015). The Impact of International Spillovers on Inflation Dynamics and Independent Monetary Policy: the Swiss Experience. In *Background paper for presentation at the 39th Economic Symposium on "Inflation Dynamics and Monetary Policy" hosted by the Federal Reserve Bank of Kansas City: Technical Report, (pp. 171-200). Jackson Hole, WY.*

Jordan, T. J. (2016). The Impact of International Spillovers on Swiss Inflation and the Exchange Rate. *Journal of International Money and Finance 68*, 262–265.

Kahn, L. B. (2010). The Long-Term Labor Market Consequences of Graduating from College in a Bad Economy. *Labour Economics 17*(2), 303–316.

Kasahara, H. and B. Lapham (2013). Productivity and the Decision to Import and Export: Theory and Evidence. *Journal of international Economics 89*(2), 297–316.

Keller, W. and H. Utar (2022). Globalization, Gender, and the Family. *The Review of Economic Studies 89*(6), 3381–3409.

Keller, W. and H. Utar (2023). International Trade and Job Polarization: Evidence at the Worker Level. *Journal of International Economics 145*, 103810.

Klein, M. W., S. Schuh, and R. K. Triest (2003). Job Creation, Job Destruction, and the Real Exchange Rate. *Journal of International Economics 59*(2), 239–265.

Kletzer, L. G. (2000). Trade and Job Loss in U.S. Manufacturing, 1979-1994. In *The Impact of International Trade on Wages*, pp. 349–396. University of Chicago Press.

Kletzer, L. G. (2002). *Imports, Exports, and Jobs: What Does Trade Mean for Employment and Job Loss?* WE Upjohn Institute.

Kohler, W. (2004). International Outsourcing and Factor Prices with Multistage Production. *The Economic Journal 114*(494), C166–C185.

Kropf, A. and P. Sauré (2014). Fixed costs per shipment. *Journal of International Economics 92*(1), 166–184.

Kurz, C. and M. Z. Senses (2016). Importing, Exporting, and Firm-Level Employment Volatility. *Journal of International Economics 98*, 160–175.

Magyari, I. (2017). Firm reorganization, Chinese imports, and US manufacturing employment. Working Paper CES-17-58, Center for Economic Studies.

McLaren, J. (2022). *Trade Shocks and Labor-Market Adjustment*, Volume forthcoming. Oxford Research Encyclopedia of Economics and Finance.

McLaren, J. and D. Parks (2022). Family and Demographic Effects in Worker Response to Trade Shocks: Results from the Matched CPS. Mimeo.

Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica 71*(6), 1695–1725.

Oberfield, E. (2018). A Theory of Input–Output Architecture. *Econometrica 86*(2), 559–589.

Pavcnik, N. (2002). Trade Liberalization, Exit, and Productivity Improvements: Evidence from Chilean Plants. *The Review of Economic Studies 69*(1), 245–276.

Pérez, J. I. G. and Y. R. Sanz (2005). Wage Changes Through Job Mobility in Europe: A Multinomial Endogenous Switching Approach. *Labour Economics 12*(4), 531–555.

Pierce, J. R. and P. K. Schott (2016). The Surprisingly Swift Decline of US Manufacturing Employment. *The American Economic Review 106*(7), 1632–1662.

Pytka, K. and A. Gulyas (2021). Understanding the Sources of Earnings Losses After Job Displacement: A Machine-Learning Approach. Technical report, mimeo.

Restrepo, P. (2023). Automation: Theory, Evidence, and Outlook. Working Paper 31910, National Bureau of Economic Research.

Revenga, A. L. (1992). Exporting Jobs? The Impact of Import Competition on Employment and Wages in US Manufacturing. *Quarterly Journal of Economics 107*(1), 255–284.

Rodríguez-Clare, A., M. Ulate, and J. P. Vásquez (2022). Trade with Nominal Rigidities: Understanding the Unemployment and Welfare Effects of the China Shock. Working Paper 27905, National Bureau of Economic Research.

Sampson, T. (2014). Selection Into Trade and Wage Inequality. *American Economic Journal: Microeconomics 6*(3), 157–202.

Schmieder, J. F., T. von Wachter, and J. Heining (2023). The Costs of Job Displacement over the Business Cycle and Its Sources: Evidence from Germany. *American Economic Review 113*(5), 1208–54.

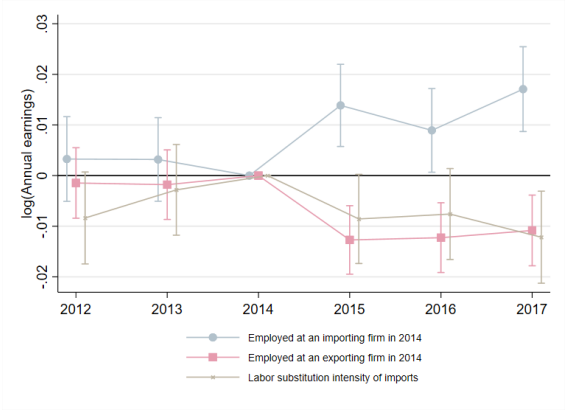
Sicherman, N. (1996). Gender Differences in Departures from a Large Firm. *ILR Review 49*(3), 484–505.

Utar, H. (2018). Workers Beneath the Floodgates: Low-Wage Import Competition and Workers' Adjustment. *Review of Economics and Statistics 100*(4), 631–647.

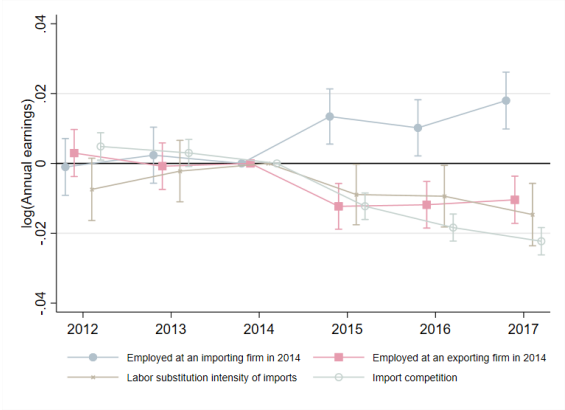
Wachter, T. V. (2020). The Persistent Effects of Initial Labor Market Conditions for Young Adults and Their Sources. *Journal of Economic Perspectives 34*(4), 168–194.

A. Further results

Figure 4: Event study: Annual earnings by all exposure variables



All firm-level exposure variables



All firm- and sector-level exposure variables

Note: These graphs plot the coefficients obtained in a worker-level regression of log(annual earnings) absorbing worker fixed effects and sector × year fixed effects. The coefficients are year-specific coefficients on the firm- and sector-level exposure dimensions of the firm a worker is employed at in 2014. The level of aggregation for sectors is at the 4-digit level in the left panel and 2-digit level in the right panel to allow for the identification of import competition as this exposure variable varies at the 4-digit level. The regression equation is based on Equation (6).

Table 13: Changes in annual earnings by type of imports: Variation in export and import intensity

	Δ log(Annual earnings)					
	(1)	(2)	(3)	(4)	(5)	(6)
Import competition	-0.025***	-0.025***			-0.013***	-0.013***
	(0.002)	(0.002)			(0.003)	(0.003)
Low export intensity	-0.017***	-0.017***	-0.017***	-0.017***	-0.017***	-0.017***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Medium export intensity	-0.025***	-0.025***	-0.028***	-0.028***	-0.025***	-0.026***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
High export intensity	-0.018***	-0.018***	-0.023***	-0.023***	-0.019***	-0.019***
	(0.005)	(0.005)	(0.006)	(0.006)	(0.005)	(0.005)
Low import intensity	0.020***	0.018***	0.020***	0.018***	0.021***	0.018***
	(0.004)	(0.003)	(0.004)	(0.004)	(0.004)	(0.003)
Medium import intensity	0.028***	0.026***	0.027***	0.025***	0.029***	0.027***
	(0.005)	(0.004)	(0.005)	(0.005)	(0.005)	(0.004)
High import intensity	0.022***	0.020***	0.024***	0.022***	0.023***	0.022***
	(0.006)	(0.005)	(0.006)	(0.006)	(0.006)	(0.005)
Labor substitution intensity (unweighted)	-0.012***		-0.012***		-0.013***	
	(0.004)		(0.004)		(0.004)	
Labor substitution intensity (weighted)		-0.011***		-0.011***		-0.011***
		(0.003)		(0.004)		(0.003)
Imported input intensity					-0.013***	-0.014***
					(0.003)	(0.003)
Obs.	1,228,446	1,228,446	1,228,446	1,228,446	1,228,446	1,228,446
Fixed effects	2-Digit Ind × Reg	2-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg	2-Digit Ind × Reg	2-Digit Ind × Reg

Note: Export and import intensities are constructed based on export and import values over the wage bill of firms, respectively. The bins reflect three different levels of these intensities based on the distribution of the variables for exporters and importers, respectively. Non-importers and non-exporters are assigned a value of zero and are the baseline category. Fixed effects correspond to 2- or 4-digit industry level fixed effects interacted with labor-market region level fixed effects. Standard errors are clustered at the sector-region level where the sector aggregation coincides with the aggregation-level used for fixed effects as reported in the last line of the table. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 14: Firm-level regressions: Variation in export and import intensity

	Extensive hiring margin		**Substitution margin**		**Wage setting**
	(1)	(2)	(3)	(4)	(5)
	Δlog(No empl)	ΔNew empl share	Δlog(Avg wage$_{2012}$)	ΔNo. imp. product categories	Δlog(Avg wage)
Low export intensity	-0.036***	0.014***	-0.021***	0.251***	-0.008
	(0.011)	(0.005)	(0.007)	(0.023)	(0.008)
Medium export intensity	-0.052***	0.004	-0.014*	0.260***	-0.011
	(0.012)	(0.006)	(0.008)	(0.025)	(0.009)
High export intensity	-0.026*	0.004	-0.006	0.354***	0.001
	(0.014)	(0.006)	(0.009)	(0.028)	(0.010)
Low import intensity	0.038***	0.013**	0.008	-0.019	0.014*
	(0.011)	(0.005)	(0.007)	(0.023)	(0.008)
Medium import intensity	0.080***	0.005	0.013*	-0.035	0.014
	(0.012)	(0.006)	(0.008)	(0.025)	(0.009)
High import intensity	0.114***	0.000	0.026***	-0.217***	0.027***
	(0.014)	(0.006)	(0.009)	(0.029)	(0.010)
Labor substitution intensity	-0.070***	0.024***	-0.019**	0.207***	-0.022***
	(0.012)	(0.005)	(0.008)	(0.024)	(0.009)
Obs.	156,907	156,907	151,210	156,907	156,907
Fixed effects	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg	4-Digit Ind × Reg

Note: Export and import intensities are constructed based on export and import values over the wage bill of firms, respectively. The bins reflect three different levels of this intensities based on the distribution of the variables for exporters and importers, respectively. Non-importers and non-exporters are assigned a value of zero and are the baseline category. Fixed effects correspond to 2- or 4-digit industry level fixed effects interacted with labor-market region level fixed effects. Standard errors are clustered at the sector-region level where the sector aggregation coincides with the aggregation-level used for fixed effects as reported in the last line of the table. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

B. Descriptives

Table 15: Summary statistics on worker characteristics.

Variable	Mean	Std. Dev.	Min.	Max.	N
Age	38.464	10.40	20	59	1,228,446
Married	0.410	0.492	0	1	1,228,302
Tenure (in years) at employer in Dec. 2014	2.528	3.044	0	14	1,228,446
Secondary education (or higher)	0.814	0.389	0	1	1,139,316
Female	0.476	0.499	0	1	1,228,417
Swiss	0.541	0.498	0	1	1,215,553

Note: This information is taken from unemployment insurance register data and calculated from social security data. All data refer to information as of Dec. 2014. Since we have social security data from 2000 onwards only, any tenure above 14 years is coded as 14 years.

Table 16: Inferred occupations of workers

Previous work experience	**Number of observations**
Banking, trust, insurance	29,746
Chemistry	2,948
Cleaning & personal services	28,164
Construction	45,819
Education	12,610
Electronics and watches	4,910
Engineers & technicians	16,979
Food and agriculture	11,798
Gastronomy	57,512
Health	29,474
Informatics	14,877
Management & HR	33,005
Marketing, PR, print	11,381
Office & administration	79,662
Others (skilled)	22,848
Production (blue collar)	64,392
Raw material preparation	5,804
Sales	54,605
Scientists	16,225
Security and law	8,473
Social occupations	13,062
Tourism, transport, communication	1,051
Total	565,345

Note: This information is based on unemployment insurance register data where individuals' occupations in their former and newly found job in each spell with the unemployment agency are recorded. For a person employed at a firm in 2014, we can get an idea of their profession in this job by using (i) the information about their indicated occupation in their next job as recorded at the unemployment agency at the spell before the person has taken up a job at their current employer, or by using (ii) the information about their last occupation as indicated in the next unemployment spell after their employment in 2014. We observe at least one of these two pieces of information for roughly one half of our sample. If we have information for both variables, we choose the information that is recorded closer to December 2014. Since we do not have information regarding occupation switching at the same firm, this occupation does not necessarily match the occupation of the individual in December 2014. For the remaining 663,101 individuals that are not covered here, no information is recorded.