

Dreger, Christian; Fourné, Marius; Holtemöller, Oliver

**Working Paper**

## Globalization, productivity growth, and labor compensation

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# Discussion Papers

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## Globalization, Productivity Growth, and Labor Compensation

Christian Dreger, Marius Fourné, Oliver Holtemöller

## Authors

### Christian Dreger

#### Marius Fourné

*Corresponding author*

Halle Institute for Economic Research (IWH) –  
Member of the Leibniz Association,  
Department of Macroeconomics, and  
Martin Luther University Halle-Wittenberg  
E-mail: [marius.fourne@iwh-halle.de](mailto:marius.fourne@iwh-halle.de)  
Tel +49 345 7753 860

#### Oliver Holtemöller

Halle Institute for Economic Research (IWH) –  
Member of the Leibniz Association,  
Department of Macroeconomics, and  
Martin Luther University Halle-Wittenberg  
E-mail: [oliver.holtemoeller@iwh-halle.de](mailto:oliver.holtemoeller@iwh-halle.de)  
Tel +49 345 7753 800

## Editor

Halle Institute for Economic Research (IWH) –  
Member of the Leibniz Association

Address: Kleine Maerkerstrasse 8  
D-06108 Halle (Saale), Germany  
Postal Address: P.O. Box 11 03 61  
D-06017 Halle (Saale), Germany

Tel +49 345 7753 60  
Fax +49 345 7753 820

[www.iwh-halle.de](http://www.iwh-halle.de)

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# Globalization, Productivity Growth, and Labor Compensation\*

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## Abstract

Since the onset of globalization, production activities have become increasingly fragmented and organized in global value chains, facilitating the trade of intermediaries across industries and countries. In this paper, we analyze the dynamic effect of increasing participation in global value chains on both productivity growth and the functional income distribution. To account for potential endogeneity, we construct a granular instrumental variable for international trade integration using detailed international input-output tables. Our findings show on the country-industry level, that both trade in intermediate inputs and trade in value-added significantly raise productivity in advanced countries, at the expense of the labor share of income. Moreover, labor shares decline more sharply in both manufacturing and services sectors, as well as in industries positioned closer to the final stages of the global value chain. Finally, our results show that a decline in international trade integration would have substantial negative effects on long-term productivity growth.

*Keywords:* *global value chains, globalization, income distribution, labor share, productivity*

*JEL classification:* *F4, F6, J3*

\* We mourn the passing of our coauthor Christian Dreger, who passed away in 2024.

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Statements and Declarations: The authors report there are no competing interests to declare.

# 1 Introduction

That international trade has positive effects on welfare has been a core element of economic wisdom for a long time. Already Adam Smith has identified the main mechanism through which international trade reduces the costs of production and therefore contributes to welfare: “It is the maxim of every prudent master of a family, never to attempt to make at home what it will cost him more to make than to buy ... What is prudence in the conduct of every private family, can scarce be folly in that of a great kingdom.” (Smith, 1776, Book IV, Chapter II, pp. 456-457). Empirical evidence supports the hypothesis that international trade has positive effects on overall macroeconomic performance (Frankel and Romer, 1999; Dollar and Kraay, 2004; de Loecker, 2013).

The distributional effects of the gains from international trade, however, are less clear. Although there is a great amount of literature on the wage inequality of workers, little is known about how international trade integration affects the division of gains between labor and capital. Moreover, although the labor shares around the world are declining since the early eighties, only few researchers examine the role of international trade integration for the decline. Elsby et al. (2013), for example, show for the US that industries which are exposed to a higher degree of import competition experience larger decreases in the labor share. Similarly, Abdih and Danninger (2018) show that there is a negative relationship between labor share and both import competition and the foreign input intensity in US industries. However, with the US being the largest importer of goods, a generalization of findings to other countries is misleading. More recently, Reshef and Santoni (2023) examine forward linkages in global value chains and document a contemporaneous negative effect on the labor share of exporting industries. Riccio et al. (2025) introduce the concept of vertical labor share to trace labor income along global value chains and examine its determinants using an input-output decomposition. Taken together, these contributions provide valuable insights into the role of trade integration for labor income, but they either focus on short-run contemporaneous effects or remain descriptive in nature.

In our paper, we address this gap by identifying the causal and dynamic effects of trade integration on productivity and the functional income distribution. Our analysis accounts for both advanced and emerging countries as well as for different sectors, and we apply a unique instrumental variable approach. We focus on the trade aspects of globalization and do not consider international capital flows or international migration which do also contribute to the globalization of markets. Therefore, we use the terms *globalization* and *international trade integration* interchangeably. We examine the hypotheses that a higher degree in trade integration leads to productivity gains and that these gains are distributed unequally to the detriment of employees. Our contribution to the literature is twofold. First, we provide empirical evidence that the formation of global value chains contributed to the acceleration in productivity, in particular in advanced countries. Second, and per-

haps even more important, the response of the labor share to increasing trade integration is heterogeneous both across sectors and country groups.

As indicators for international trade integration we use the foreign share in intermediate inputs and the foreign share in value added, extracted from international input-output tables. Our empirical analysis, based on local projections, addresses the endogenous nature of international trade variables by applying the granular instrumental variable approach from Gabaix and Koijen (2024). Accordingly, we extract idiosyncratic shocks from bilateral intermediate input and value added flows to construct instruments for the aggregate foreign intermediate input share and foreign value added share, respectively.

Our major findings underpin a positive relationship between the degree of international trade integration and productivity, driven by advanced countries and service industries. Regarding our second hypothesis, which explores the unequal distribution of productivity gains between labor income and capital income or profits, results vary across country groups and sectors. While it appears that trade in intermediate inputs slightly raises the labor share of income in emerging countries, there is a strong negative response to both trade integration variables in advanced countries. Importantly, this negative response accelerates over time. On the sectoral level, we find that manufacturing as well as service industries experience both declines in the labor share. Moreover, we find that industries whose positions are closer to the end of the global value chain experience stronger declines in the labor share in response to increasing their trade integration.

The paper is structured as follows. In Section 2, we explain our main hypotheses and the conceptual framework from which we derive these hypotheses. In Section 3, the data that we use are introduced and described. The empirical analysis of our hypotheses is presented and discussed in Section 4. Finally, Section 5 offers conclusions.

## 2 Conceptual framework and hypotheses

### 2.1 Main hypotheses

We understand international trade integration as the increase in foreign contributions (foreign intermediate inputs or foreign value added) to domestic total output or value added. Driven by lower trade and investment barriers and advances in information and communication technologies, production and trade have become increasingly fragmented and organized in global value chains (GVC). GVC include firms from different countries and the full range of activities that producers undertake to bring a product from its conception to its final use by consumers. Firms can enter these networks by focusing on specialized tasks, without the need of developing a complete product from scratch. Due to the finer division of tasks, productivity gains should be expected. Moreover, the

changing production pattern alters the impact of policies conducted at the national level. For instance, restrictions on imports of foreign intermediaries can have adverse effects on domestic exports and final products.<sup>1</sup> The formation of GVC is behind the spectacular increase in international trade in the early 2000. At the current edge, more than one half of global trade in manufacturing and services are based on intermediate inputs (De Backer and Miroudot, 2013).

We test two hypotheses:

1. Globalization (international trade integration) is associated with productivity gains.
2. Productivity gains are distributed unequally to labor and capital or profits: the labor share decreases in the degree of international trade integration.

Both hypotheses are analyzed empirically for advanced and emerging economies.

## 2.2 Globalization and productivity

International trade is positively related to aggregate productivity. Alcalá and Ciccone (2004) report a positive and robust impact of trade on productivity for a huge set of countries, even after controlling for institutional quality and geographic conditions. They employ a measure for real openness as a proxy for trade and control for potential endogeneity of trade and institutional quality. According to Melitz (2003) and Bernard et al. (2006) falling transportation costs and tariffs lead to a reallocation of activities from less to high-productive firms. The larger the decline in trade costs, the stronger the productivity gains in manufacturing industries.

The effect of trade in intermediate inputs has been studied theoretically in Gibson and Graciano (2018) and Grossman and Helpman (2018). Both studies show that trade in intermediate inputs raises productivity. Halpern et al. (2015) show empirically that trade in intermediate inputs boosts firm-level productivity in Hungary. Ahn et al. (2019) show that reducing tariffs has positive effects on productivity via both an output and an intermediate input channel. Following Coe and Helpman (1995) and Coe et al. (2009) the foreign R&D stock embodied in exports can exert positive technology spillovers to the importing country, with subsequent positive effects on productivity, see also Lind and Ramondo (2018). Using Norwegian data, Bøler et al. (2015) show that improved access to imported inputs promotes R&D investments and technological change. Formai and Caffarelli (2015) found a positive impact of participation in GVC on total factor productivity. Similarly, Thomson and Athukorala (2020) show that GVC participation accelerates industrial upgrading at a faster pace compared to trade in products that have

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<sup>1</sup>Baldwin and Lopez-Gonzalez (2015) and Johnson and Noguera (2012) provide evidence on the evolution of the production networks.

been exclusively produced within a single country. For middle and high income countries, Kummritz (2015) argues that participation in GVC is positively related to domestic value added and Ignatenko et al. (2019) found beneficial effects on productivity and investment. The established explanation is that productivity gains arise due to lower costs, since richer countries outsource activities to low-wage countries.

The situation may be different in emerging economies. On the one hand, the inclusion in GVC provides opportunities for fast-track development and economic upgrading, as positive spillovers to the domestic economy are generated (Kowalski et al., 2015). Bos and Vannoorenberghe (2019) report a positive impact of access to intermediate inputs on firm-level product innovation in developing countries. Pahl and Timmer (2020) show that GVC participation benefits productivity in manufacturing industries of developing countries. Similarly, using data of Chinese manufacturing firms, Ding et al. (2016) show that intra-industry trade in intermediate inputs reduces the dispersion of productivity by pushing the least productive firms out of the market. On the other hand, these benefits cannot be exploited on a broader level, if the countries lack sufficient absorptive capacities. Moreover, the remuneration of firms specialized in standardized tasks is usually low, implying that productivity gains are rather limited. Hence, GVC participation may not work as a catching-up strategy for emerging economies (Rodrik, 2018).

### 2.3 Globalization and labor compensation

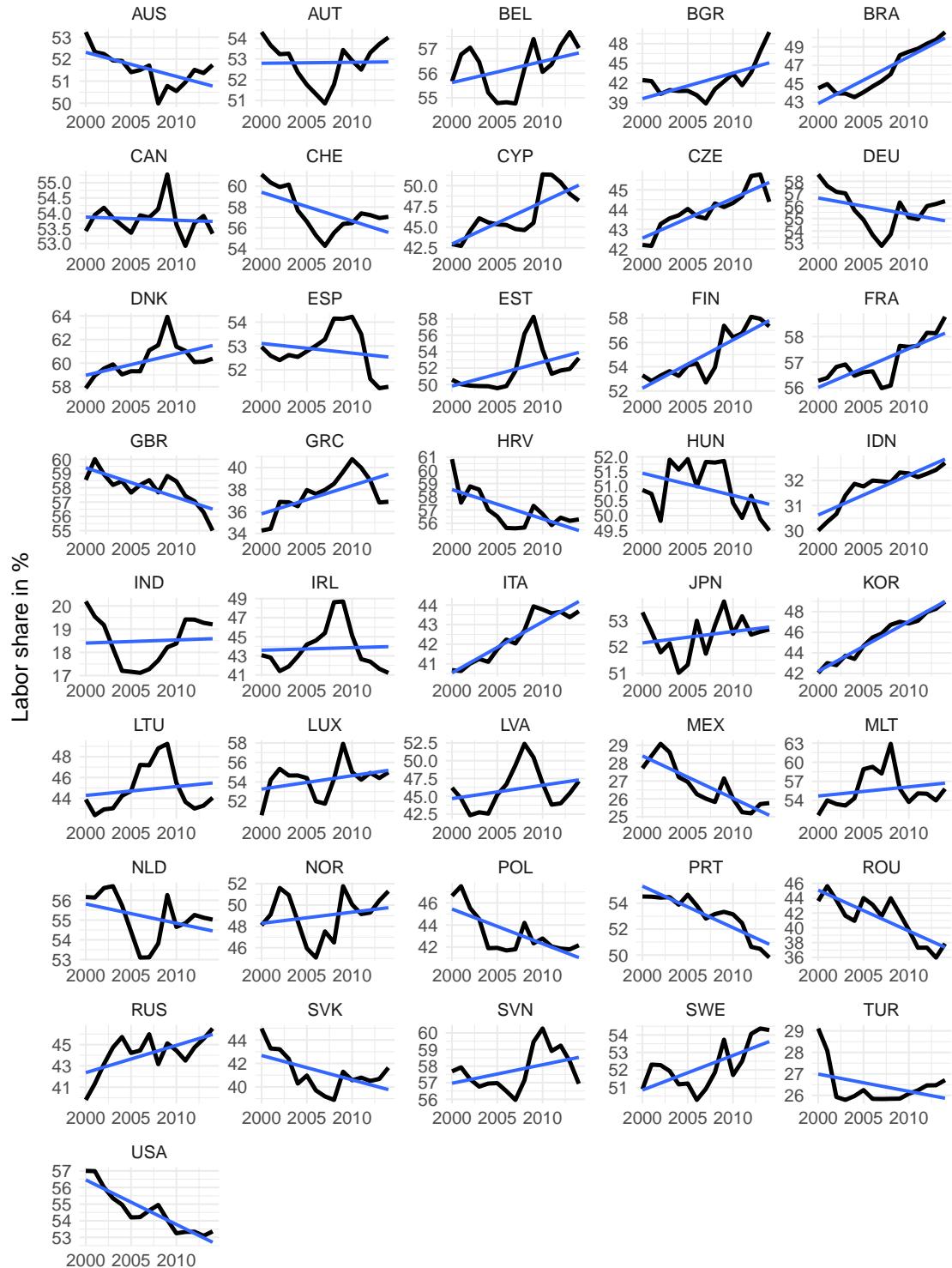
The international phenomenon of declining labor shares aroused in the early eighties (IMF, 2007; ILO, 2012; Karabarbounis and Neiman, 2014). For some advanced countries, in particular the US and the UK, the downward trend is also persistent for the two recent decades (Fig. 1). The decrease is even more pronounced in the manufacturing sector: For the period from 2000 to 2014 the labor share in this sector decreased from 59% to 47% in the US and from 68% to 64% in the UK. (Fig. 13 in the Appendix). Accordingly, there is a growing body of literature on the determinants of functional income distribution. For the US, Elsby et al. (2013) found that offshoring of labor-intensive activities is a potential explanation for the decline. Dao et al. (2020) argue that global integration chiefly explains the decrease in labor share for emerging countries and identify technological change as the predominant driver for the decline in advanced countries.<sup>2</sup> According to the ILO and the OECD (2015) and Bourguignon (2015) the decrease in labor share is accompanied by eroding support for market-oriented policies and globalization.

Another cause for diminishing labor shares may be increasing market power of firms

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<sup>2</sup>Capital-labor substitution triggered by automation is also seen by other researchers as a substantial cause for the fall in the labor share (Karabarbounis, 2023; Autor and Salomons, 2018; Ray and Mookherjee, 2022; Peralta Alva and Roitman, 2018). Abdih and Danninger (2018), for example, show for the US that there is downward pressure on wages for individuals with occupations that are exposed to automation and offshoring, and in industries with a higher concentration of large firms.

Fig. 1: Labor share of income (total economy, in percent)



Source: World Input Output Database (WIOD), own calculations.

(Barkai, 2020; Díez et al., 2018; Eggertsson et al., 2021; Naidu et al., 2018; Young and Tackett, 2018). The relationship between the labor share and market power can formally

be described as follows. Suppose production is determined by the following production function:

$$Y = K^\alpha (AN)^{1-\alpha}, \quad (1)$$

where  $Y$  denotes output,  $K$  capital and  $N$  labor. Changes in  $A$  capture technological progress and  $\alpha$  is a constant parameter. Marginal productivity of labor is then given by:

$$MPL = K^\alpha A^{1-\alpha} (1-\alpha) N^{-\alpha} = (1-\alpha) \frac{Y}{N}. \quad (2)$$

Furthermore, suppose that firms set prices according to markup-pricing:

$$P = (1+\mu)MC = (1+\mu) \frac{W}{MPL} = \frac{1+\mu}{1-\alpha} \frac{WN}{Y}, \quad (3)$$

where  $MC$  denotes marginal cost,  $W$  nominal wage and  $\mu$  markup. The markup drives a wedge both between prices and marginal cost as well as real wage and labor productivity. In this simple setting, it therefore reflects market power on both goods and labor markets. The labor share is then given by:<sup>3</sup>

$$\frac{WN}{PY} = \frac{1-\alpha}{1+\mu}. \quad (4)$$

Hence, a rise in market power of firms, given by an increase in  $\mu$ , may partially explain declining labor shares. Autor et al. (2017) and Autor et al. (2020) argue that globalization is in particular beneficial to the most productive firms and contributes to increasing product market concentration and market power. Böckerman and Maliranta (2012), for example, found that globalization in Finnish manufacturing plants negatively affects the aggregated industry labor shares by shifting value-added to plants with high capital shares and forcing plants with high labor shares to exit. Eggertsson et al. (2021) argue that globalization leads to higher concentration of market shares and rising markups of superstar firms. Using data on over 70,000 firms in 134 countries de Loecker and Eeckhout (2018) show that markups have risen substantially between 1980 and 2016. Basu (2019) provides a critical review of the approaches to estimate markups.

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<sup>3</sup>In case of a constant-elasticity-of-substitution (CES) production function with labor and capital as production factors,

$$Y = \left[ (1-\alpha)^{\frac{1}{\eta}} N^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} K^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}},$$

the labor share also depends on the output-labor ratio (Clette et al., 2019):

$$\frac{WN}{PY} = \frac{(1-\alpha)^{\frac{1}{\eta}}}{1+\mu} \left( \frac{Y}{N} \right)^{\frac{1-\eta}{\eta}}.$$

Similarly, a rise in the mark up could be motivated by a decline in the power of trade unions to negotiate wages, see Arpaia et al. (2009), among others, or by employment protection deregulation (Ciminelli et al., 2022). Dimova (2019) argue that globalization and the erosion of labor market safety nets have contributed to the decline in the labor share in many advanced countries. A decreasing labor share is in general associated with increasing income inequality because capital income is distributed more unequally than labor income (ILO and OECD, 2015; Doan and Wan, 2017; Nolan et al., 2019).<sup>4</sup>

## 3 Data description

### 3.1 Coverage and data cleaning

Our main data source for the empirical analysis is the World Input Output Database (WIOD), where the 2016 edition is used.<sup>5</sup> It covers data from 2000 to 2014 for 43 countries and 56 industries (Timmer et al., 2015; Timmer et al., 2016).<sup>6</sup> The countries and the industries are listed in the Appendix. As we show in the following section, global trade integration has slowed down considerably after the financial crisis. Including periods of both strong and weak changes in the degree of trade intensity, the sample thus carries information on productivity and labor share's response to globalization shocks. We clean the data in the following way:

- For  $K = 43$  countries,  $T = 15$  years, and  $L = 56$  industries, we have in total  $N = K \times T \times L = 36.120$  observations.
- We exclude China and Taiwan due to data problems (missing data on hours worked).<sup>7</sup>
- We exclude the industry 55 and 56 (activities of households as employers and of extraterritorial organizations and bodies).

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<sup>4</sup>There are also other explanations for the decline in the labor share. Karabarbounis and Neiman (2014), for example, attribute a substantial part of the decline to an increase in capital intensity due to lower investment prices, see also Río and Lores (2019). Another driver may be the reallocation to highly productive low-labor share firms (Kehrig and Vincent, 2021). The statistically increasing capital share could also be a consequence of increasing income for intangibles (Chen et al., 2021). Doan and Wan (2017) show that trade affects the labor compensation. Specifically, exports depress and imports tend to increase labor share. For a more general overview on the various explanations for the decrease in the labor share, see Karabarbounis (2023) and Grossman and Oberfield (2022).

<sup>5</sup><http://www.wiod.org/home>

<sup>6</sup>The previous release of WIOD contained labor compensation for skilled and unskilled workers. However, the current release 2016 does not provide this information.

<sup>7</sup>Accounting for the increasingly important role of these countries in globalization, they are included in the construction of the indicators for international trade integration in other country-industry pairs. However, industries in China and Taiwan are excluded from the analysis of the effects of international trade integration on productivity and labor share.

- We exclude country-industry pairs with incomplete information (MLT 43, IND 51, MEX 54) or with unreasonable data (employment  $\leq 0$ , value added  $\leq 0$ , or capital  $\leq 0$ ).
- Remaining observations:  $N = 30.840$ .

## 3.2 Measuring international trade integration

We use the following indicators for international trade integration:

- The share of foreign (imported) intermediate inputs in all intermediate inputs used in an industry ( $FIIS$ ),
- The foreign value added share ( $FVAS$ , Timmer et al., 2015).

### 3.2.1 Foreign intermediate input share

Denote intermediate inputs used in industry  $j$  and country  $i$  from industry  $\ell$  in country  $k$  by  $ii_{ij}^{k\ell}$ . Then total intermediate inputs  $ii_{ij}$  of industry  $j$  of country  $i$  are given by

$$ii_{ij} = \sum_k \sum_{\ell} ii_{ij}^{k\ell} \quad (5)$$

and the share of foreign (imported) intermediate inputs  $FIIS$  in total intermediate inputs is

$$FIIS_{ij} = \frac{\sum_{k \neq i} \sum_{\ell} ii_{ij}^{k\ell}}{ii_{ij}} = \frac{fii_{ij}}{ii_{ij}} = 1 - \frac{dii_{ij}}{ii_{ij}} = 1 - DIIS_{ij}, \quad (6)$$

where  $fii$  denotes foreign (imported) intermediate inputs and  $dii$  denotes domestic intermediate inputs. The extent to which foreign intermediate inputs contribute to gross output ( $go$ ) in a specific industry is  $\frac{fii_{ij}}{go_{ij}}$ . Gross output is the sum of intermediate inputs and value added ( $va$ ):

$$go_{ij} = ii_{ij} + va_{ij} = fii_{ij} + dii_{ij} + va_{ij}. \quad (7)$$

### 3.2.2 Foreign value added share

The calculation of the foreign share in value added ( $FVAS$ ) is based on the global value chain (GVC) of a final good which is “the set of all value-adding activities needed in its production” (Timmer et al., 2015, p. 582). A GVC includes the value added in the industry where the last stage of production takes place, as well as in all other industries in the same country or abroad where previous stages of production take place.

$FVAS$  can be calculated from the input-output tables using Leontief's decomposition method. Define  $\mathbf{Q}$  as a vector with total output levels across all countries and industries,  $\mathbf{B}$  as the matrix of technical coefficients and  $\mathbf{F}$  as a diagonal matrix with the ratios of value added to total output. Let  $\mathbf{D}$  be a column vector which includes the value for the final demand in the country and industry of interest, and zeroes elsewhere. The final output for that country and industry is therefore equal to  $\mathbf{D}$ . The vector  $\mathbf{BD}$  contains the values of the first-stage number of intermediates necessary to produce the output of the selected country and industry. The second stage intermediates need to be produced as well. Adding over every stage of production results in a geometric sequence:

$$\mathbf{D} + \mathbf{BD} + \mathbf{B}^2\mathbf{D} + \mathbf{B}^3\mathbf{D} + \dots = (\mathbf{I} - \mathbf{B})^{-1}\mathbf{D}, \quad (8)$$

with  $\mathbf{I}$  being an identity matrix. Multiplying the above sequence with the value added vector  $\mathbf{F}$  indicates the total value added involved in every stage of production for the specific country and industry. Setting the values of the resulting vector to zero for domestic sectors for each individual country and summing up by industry yields the foreign value added included in domestic industries. Relating the foreign value added to total value added of a country-industry combination gives the share of foreign value added in total value ( $FVAS$ ) added by country and industry.

### 3.2.3 Stylized facts

Import shares and the foreign share in value added have on average increased in the period from 2000 to 2014, see Fig. 2. Both measures  $FIIS$  and  $FVAS$  are positively correlated with a coefficient of 0.62. According to both measures, international trade integration has been most pronounced in manufacturing. Within manufacturing, all industries exhibit an increase in the share of foreign intermediate inputs and in the foreign value added share. Fig. 3 shows time series for selected industries in Germany and in the US. Both measures  $FIIS$  and  $FVAS$  pick up the same underlying trend, but there are differences in detail. For example,  $FVAS$  has been stagnating in German motor vehicle production recently, while  $FIIS$  has been increasing until the end of the sample.

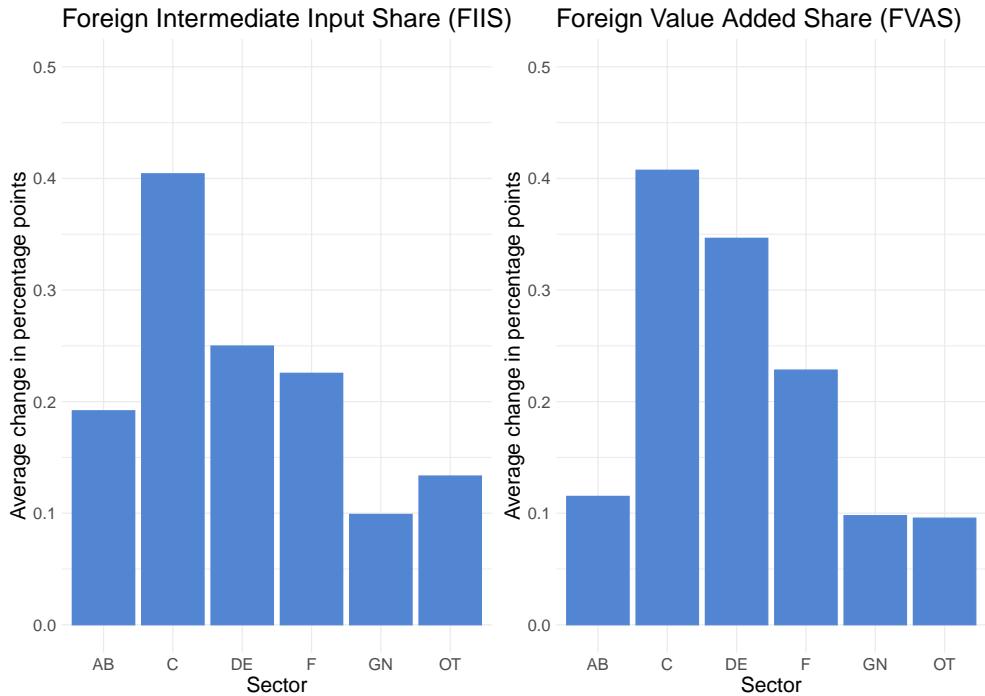
## 3.3 Productivity growth

Productivity in country  $i$  and industry  $j$  is measured in terms of value added per employed person ( $prod_n$ ) and value added per hour worked ( $prod_h$ ), respectively:

$$prod_{nij} = \frac{va_{qi,ij}}{empe_{ij}} \quad \text{and} \quad prod_{hij} = \frac{va_{qi,ij}}{h_{empe,ij}}, \quad (9)$$

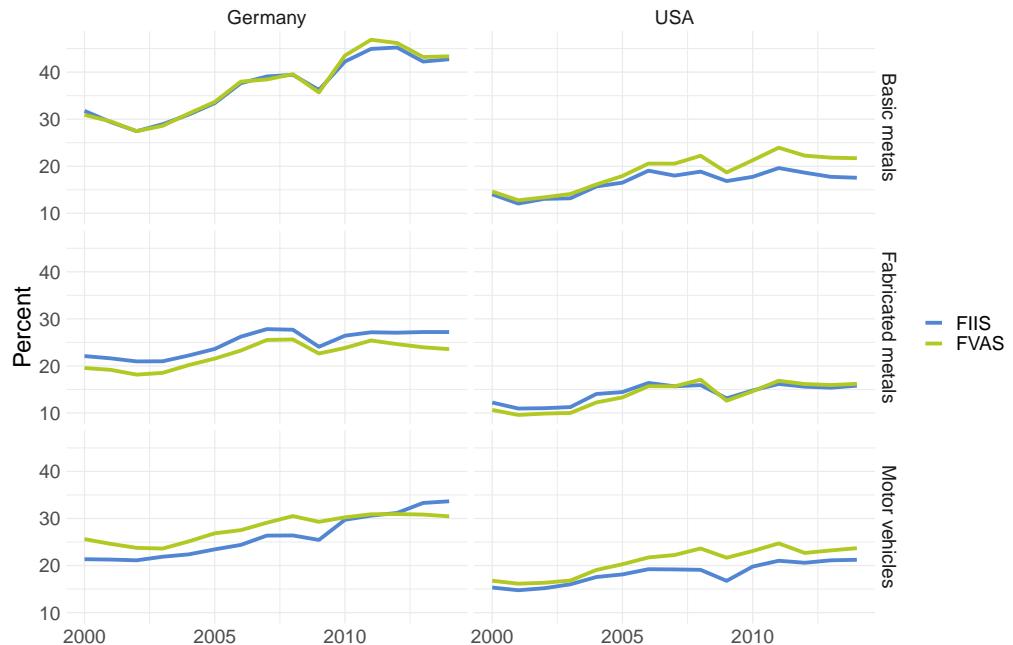
where  $va_{qi}$  denotes gross value added in volume indices with 2010=100.  $empe$  and  $h_{empe}$

Fig. 2: Average annual change of FIIS and FVAS, full sample 2000-2014, by sector



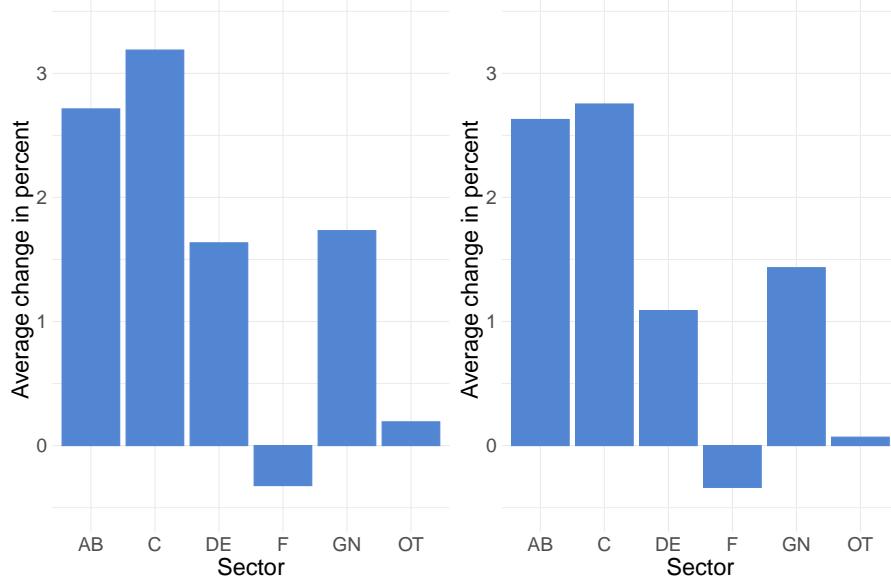
Notes: AB: agriculture, forestry and fishing, mining and quarrying, C: manufacturing, DE: utilities, F: construction, GN: trade and market services, OT: other services. Source: WIOD and own calculations.

Fig. 3: Globalization in selected manufacturing industries in Germany and in the USA



Source: WIOD and own calculations.

Fig. 4: Change in labor productivity 2000-2014  
 Labor productivity (by hour)      Labor productivity (by person)



Source: WIOD and own calculations. Weighted by employed persons and by hours worked, respectively.

denote the number of employees and the total hours worked by employees, respectively. Both  $prodn$  and  $prodh$  are normalized to 100 in 2000. Fig. 4 shows the development of productivity by sector. Productivity growth has been highest in the manufacturing sector. Within this sector, the production of computers, electronic and optical products has exhibited the highest growth rates. However, in some countries like for example Brazil or Greece, average productivity growth has been negative between 2000 and 2014. Productivity growth was also particularly low in Italy, while central and eastern European countries which joined the European Union have realized relatively large productivity gains.

### 3.4 Change in labor compensation

The distribution of income to production factors is measured by the labor share ( $labs$ ):

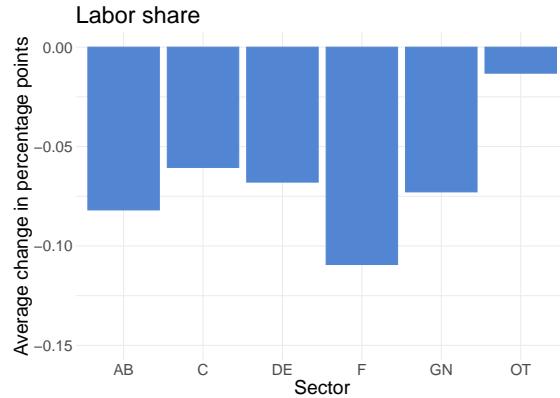
$$labs_{ij} = \frac{comp_{ij}}{va_{ij}}, \quad (10)$$

where  $comp$  denotes the compensation of employees and  $va$  value added in current prices.<sup>8</sup> The changes in the labor share by sector are exhibited in Fig. 5. Averaged over all countries, the labor share has decreased in all sectors during the observation period. However, there is a substantial degree of variation between countries and industries (see

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<sup>8</sup>Various possibilities to define and to measure the labor share are discussed in Mućk et al. (2018).

Fig. 5: Change in labor share 2000-2014



Source: WIOD and own calculations. Weighted by value added in USD.

Fig. 13 in the Appendix). In the US and in Germany, for example, overall labor shares in manufacturing are on a declining trend, but the evidence is heterogeneous across sectors. Specifically, the labor share decreased in the wood, paper and paper products industry, but increased in the manufacturing of food, basic pharmaceutical products and pharmaceutical preparations.

To get some insights into the components of a changing labor share, we conduct a shift-share analysis. It decomposes the country-specific labor shares into changes linked to within-industry developments and changes linked to changing weights of specific industries. The latter can be seen as a proxy for structural change. The labor share in country  $i$  is given by:

$$labs_{i,t} = \sum_j w_{ij,t} \times labs_{ij,t}, \quad w_{ij,t} = \frac{va_{ij,t}}{\sum_j va_{ij,t}}. \quad (11)$$

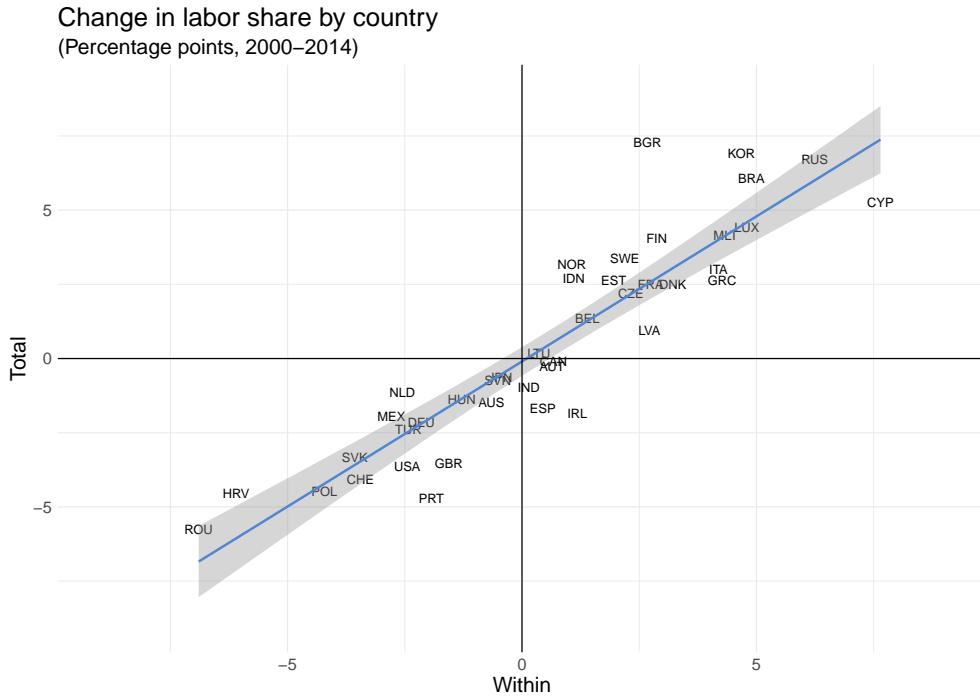
The shift-share analysis decomposes the change of the labor share into the two components:

$$\Delta labs_{i,t} = \underbrace{\sum_j \frac{w_{ij,t} + w_{ij,t-1}}{2} \times \Delta labs_{ij,t}}_{\text{within}} + \underbrace{\sum_j \Delta w_{ij,t} \times \frac{labs_{ij,t} + labs_{ij,t-1}}{2}}_{\text{between}}. \quad (12)$$

The total change in the labor shares is depicted on the horizontal axis of Fig. 6, while the part of the change in the labor share that is explained by within-industry variation is exhibited on the vertical axis. The fitted line almost resembles a 45-degree-line. While structural change, i.e. changes in the relative weights of the industries, dominates in some countries the change of the labor share can be mainly attributed to changes within industries.<sup>9</sup>

<sup>9</sup>For the period before our sample (1979 to 2001), Lawless and Whelan (2011) report for European countries that most of the variation in aggregate labor shares is also explained by within sector developments while composition effects played a minor role.

Fig. 6: Shift-share analysis of country-specific labor shares (2000-2014)



*Notes:* Labor shares weighted by value added in USD. The shaded area represents the 95% confidence level interval. *Source:* WIOD and own calculations.

## 4 Empirical analysis

### 4.1 Estimation approach: Endogeneity and timing

In order to explore the dynamic relationship between international trade integration, productivity, and labor compensation, we employ the local projections approach pioneered by Jordà (2005). This approach directly estimates impulse responses at each horizon and thus allows for more flexibility than a parametric model. However, estimating the effects of internationalization on productivity and labor share introduces potential biases due to endogeneity issues. Specifically, the internationalization variables may be correlated with the error term, as the outcome variables and internationalization variables in a given industry of a country might be influenced by the same supply and demand shocks. To address this concern, we augment the local projection approach with an instrumental variable strategy, as done by Jordà and Taylor (2016), Jordà et al. (2022), and Ramey and Zubairy (2018), among others. Specifically, we follow the approach from Gabaix and Koijen (2024) by extracting the idiosyncratic component of an industry's trade integration shock to construct a granular instrument variable.

First, we explain the granular instrumental variable approach in a simplified setting, where we regress the change in labor share in a country-industry on the industry's change in its foreign intermediate input share:

$$\Delta \ln LABS_{ij,t} = \alpha \Delta \ln FIIS_{ij,t} + \epsilon_{ij,t}, \quad (13)$$

with  $\epsilon_{ij,t}$  being an aggregate shock to industry  $j$  in country  $i$ . Recalling formula (6), one can also express a country-industry's change in foreign intermediate input share as a weighted average of changes in individual foreign intermediate input shares. The latter can be thought of as the individual foreign supplier's share to a country-industry under consideration, originating from industry  $\ell$  in foreign country  $k(\neq i)$ :

$$FIIS_{ij,t}^{k \neq i, \ell} = \frac{ii_{ij,t}^{k \neq i, \ell}}{\sum_k \sum_{\ell} ii_{ij,t}^{k \ell}} \quad (14)$$

$$\Delta \ln FIIS_{ij,t} = \sum_{k \neq i} \sum_{\ell} w_{ij,t-1}^{k \neq i, \ell} \Delta \ln FIIS_{ij,t}^{k \neq i, \ell} \quad (15)$$

where the weights  $w_{ij,t-1}^{k \neq i, \ell}$  are the lagged share of a specific foreign supplier of intermediates in total intermediates from foreign suppliers. Central to this approach is the idea that changes in individual foreign supplier shares themselves can be decomposed into a common shock component  $\eta_{ij,t}$  (with uniform factor loading  $\lambda$ ), which possibly affects the labor share of income as well, and an idiosyncratic shock component:

$$\Delta \ln FIIS_{ij,t}^{k \neq i, \ell} = \lambda \eta_{ij,t} + u_{ij,t}^{k \neq i, \ell} \quad (16)$$

In this setting,  $u_{ij,t}^{k \neq i, \ell}$  is the idiosyncratic shock to an industry  $j$  in country  $i$  that affects its share of imported inputs coming from industry  $\ell$  in country  $k(\neq i)$ . This shock can either stem from a unique relationship between a specific supplier and demand industry, but it could also stem from the specific supplier, thereby affecting multiple importing industries. For the idiosyncratic shock, we assume that it is orthogonal to the common shock  $\eta_{ij,t}$  and the aggregated shock  $\epsilon_{ij,t}$ , respectively. The granular instrumental variable is then the difference between the size-weighted average of the changes in individual foreign supplier shares and its equal-weighted counterpart:

$$\begin{aligned}
z_{ij,t}^{FIIS} &= \Delta \ln FIIS_{ij,t} - \overline{\Delta \ln FIIS_{ij,t}} \\
&= \sum_{k \neq i} \sum_{\ell} \left( w_{ij,t-1}^{k \neq i, \ell} \Delta \ln FIIS_{ij,t}^{k \neq i, \ell} - \frac{1}{N} \Delta \ln FIIS_{ij,t}^{k \neq i, \ell} \right) \\
&= \sum_{k \neq i} \sum_{\ell} \left( w_{ij,t-1}^{k \neq i, \ell} (\lambda \eta_{ij,t} + u_{ij,t}^{k \neq i, \ell}) - \frac{1}{N} (\lambda \eta_{ij,t} + u_{ij,t}^{k \neq i, \ell}) \right) \\
&= \sum_{k \neq i} \sum_{\ell} u_{ij,t}^{k \neq i, \ell} \left( w_{ij,t-1}^{k \neq i, \ell} - \frac{1}{N} \right) \\
&= \tilde{u}_{ij,t} - \bar{u}_{ij,t}
\end{aligned} \tag{17}$$

where  $\tilde{u}_{ij,t}$  and  $\bar{u}_{ij,t}$  are the size-weighted and equal-weighted aggregated idiosyncratic shocks, respectively. Accordingly, this approach exploits the heterogeneity in individual foreign supplier shares of the aggregate foreign intermediate input share. Additionally, it also shows that the instrument would equal zero and be invalid if a country-industry sources its intermediate inputs equally from foreign producers. A key feature of this approach is that the common shock  $\eta_{ij,t}$  is purged and we can thus identify the causal effect as long as supplier-specific shocks are uncorrelated with common shocks.

To obtain idiosyncratic shocks which are isolated from common shocks, we regress the individual foreign supplier shares on a set of fixed effects tailored to address different endogeneity channels. We include importing country-industry-year fixed effects ( $\alpha_{ij,t}$ ) to help address omitted variables, for example when domestic technological improvements in a specific industry lead to both changes in productivity and changes in import patterns. Additionally, they also mitigate reverse causality, such as when rising domestic labor costs encourage firm to shift towards cheaper foreign input suppliers. Same industry-year fixed effects ( $\alpha_{j=\ell,t}$ ) control for global industry-specific shocks affecting both exporters and importers simultaneously. Finally, time-invariant bilateral country-industry pair fixed effects ( $\alpha_{ij}^{k\ell}$ ) account for persistent characteristics across trading partners, including historical and cultural ties, transport costs, or stable contractual agreements:

$$\Delta \ln FIIS_{ij,t}^{k \neq i, \ell} = \alpha_{ij,t} + \alpha_{j=l,t} + \alpha_{ij}^{k\ell} + u_{ij,t}^{k \neq i, \ell} \tag{18}$$

The residual variation used for the construction of the instrument thus originates from supplier-specific shocks such as natural disasters or labor strikes affecting a particular foreign industry, as well as from bilateral pair-specific shocks such as targeted trade restrictions. Finally, we calculate the difference in size-weighted and equal-weighted averages of the obtained residuals  $u_{ij,t}^{k \neq i, \ell}$  to use this variable as instrument for the aggregated foreign intermediate share in a 2SLS estimation. The second stage takes the following form:

$$\begin{aligned}
y_{ij,t+h} - y_{ij,t} = & \beta_0^h + \beta_1^h \widehat{\Delta \ln FIIS}_{ij,t+1} \\
& + \beta_2^h \Delta y_{ij,t} + \beta_3^h \Delta y_{ij,t-1} \\
& + \alpha_i^h + \alpha_j^h + \alpha_t^h + \varepsilon_{ij,t}^h,
\end{aligned} \tag{19}$$

where  $y$  stands for log productivity, log real wage, log employment, log value added or log labor share, respectively, in country  $i$  and industry  $j$  at time  $t$ . The coefficient we are interested in is  $\beta_1^h$ . It measures the percentage change in the respective outcome variable's response from time  $t$  to  $t+h$ , caused by the impulse variable  $\widehat{\Delta \ln FIIS}_{ij,t+1}$ . The simulated shock is a one percent increase in foreign intermediate input shares. To allow for feedback effects within the model, we control for lagged values of the outcome variable,  $\Delta y_{ij,t}$  and  $\Delta y_{ij,t-1}$ . Country, industry, and time fixed effects are denoted by  $\alpha_i^h$ ,  $\alpha_j^h$ , and  $\alpha_t^h$ , respectively. The model specification remains the same when we substitute the impulse variable for the change in foreign value added share ( $\widehat{\Delta \ln FVAS}_{ij,t+1}$ ). Accordingly, the instrument for the aggregated foreign value added share is constructed analogously to the procedure that we described, by using the bilateral data for value added instead of intermediate inputs. Overall, the two instruments have a good predictive power, as presented in Table 1.

Table 1: Predictive relationship between instruments and international trade integration

$h$	Sample for local projection for horizon $h$							
	1	2	3	4	5	6	7	8
<b>Panel A</b>								
$z_{ij,t}^{FIIS}$	0.185 [7.218]	0.193 [7.068]	0.197 [6.249]	0.194 [5.941]	0.188 [5.356]	0.194 [5.461]	0.206 [5.994]	0.216 [7.583]
Observations	24683	22626	20569	18512	16455	14398	12341	10284
Effective F-Statistic	51.977	291.414	245.861	252.544	205.423	196.876	206.971	224.798
Adj. $R^2$	0.241	0.251	0.254	0.261	0.263	0.264	0.198	0.225
<b>Panel B</b>								
$z_{ij,t}^{FVAS}$	0.244 [7.165]	0.264 [8.004]	0.292 [7.802]	0.295 [7.643]	0.302 [6.765]	0.298 [6.745]	0.231 [5.122]	0.236 [6.579]
Observations	24683	22626	20569	18512	16455	14398	12341	10284
Effective F-Statistic	51.085	147.822	124.969	128.700	131.041	95.230	35.750	98.654
Adj. $R^2$	0.161	0.166	0.179	0.195	0.203	0.219	0.106	0.127

*Notes:*  $t$ -statistics are reported in brackets. Standard errors are clustered on the country and industry level. In Panel A (B), the dependent variable is the log difference in foreign intermediate input share (foreign value added share). The instrument is the difference in size-weighted and equal-weighted averages of idiosyncratic shocks, extracted from bilateral intermediate input and value added flows, respectively. We used the effective F-Statistic from Olea and Pflueger (2013).

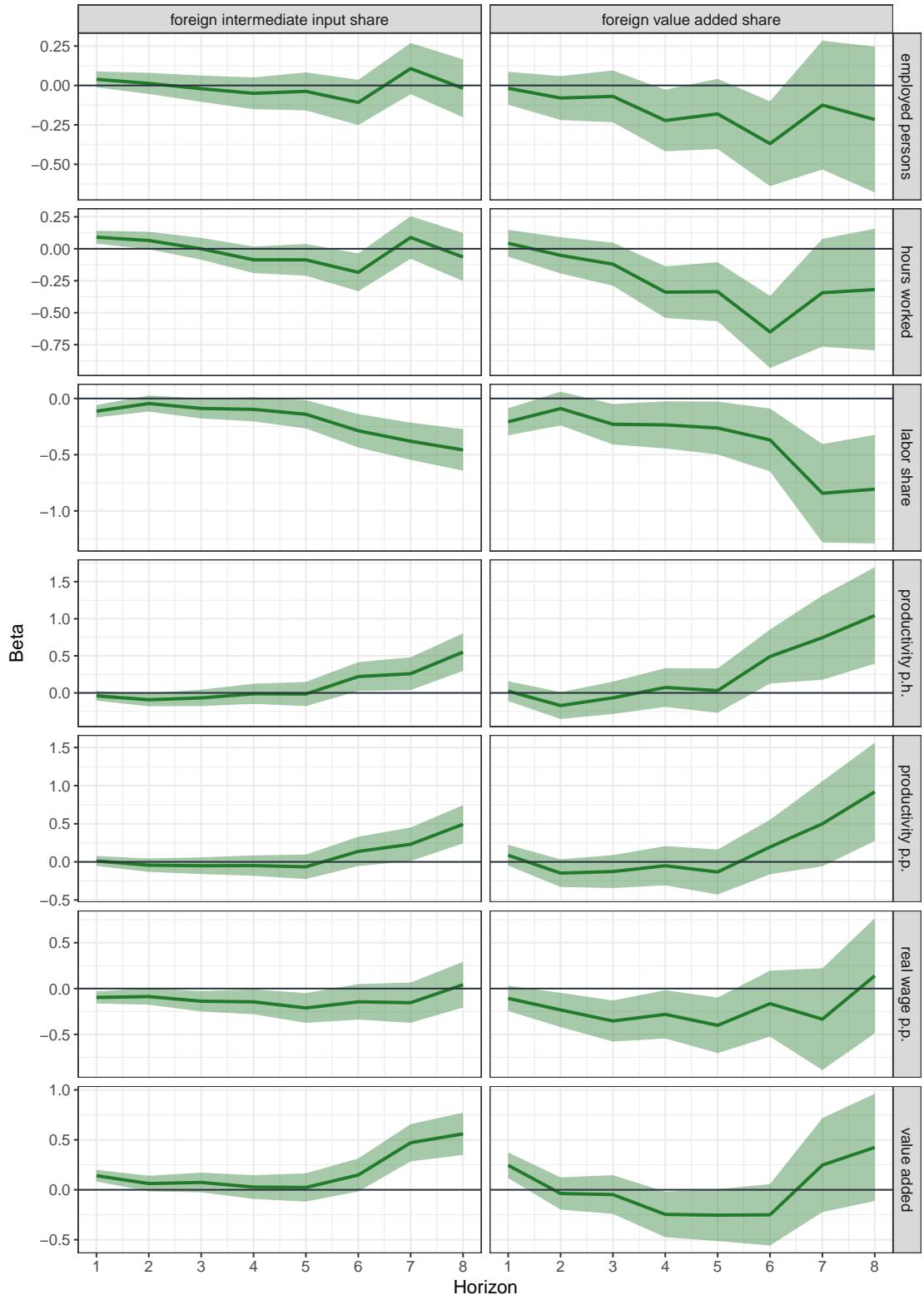
## 4.2 Baseline results

In this section, we present the estimated impulse response functions obtained from the local projection framework. First, we report the results for the full sample consisting of 41 countries and 54 industries for the period from 2000 to 2014. Subsequently, we further disentangle the effects of globalization on productivity and labor share by splitting the sample into advanced and emerging countries. Finally, we present estimates for different economic sectors.

**Full sample.** Averaged over all countries, our hypothesis that international trade integration is associated with productivity gains is compatible with the data (Fig. 7). An impulse caused by an increase in the foreign intermediate input share (*FIIS*) leads to increase in both productivity per person and per hours in the long run of around 0.5 percent. Similarly, increasing the foreign value added share (*FVAS*) by one percent increases productivity per person and per hour, respectively, by around 1 percent, eight years after the shock. Interestingly, the impact on value added differs: an increase in *FIIS* leads to a positive effect over time, while for *FVAS*, the response is shifted downwards and turns negative three years after the shock. Additionally, increasing both trade integration measures lowers the real wage per person, whereas the effect is more pronounced for increasing *FVAS*. Regarding the employment measures, we document a negative response to increasing trade integration except for the effect of *FIIS* on employed person, which is insignificant for all periods. In terms of the labor share of income, a one percent increase in *FIIS* (*FVAS*) corresponds to a roughly 0.5 (0.8) percent decrease over the eight year horizon. Accordingly, considering the full sample encompassing all countries and industries, our second hypothesis positing a decline in labor share with increasing GVC participation is supported by the data.

**Advanced vs. emerging countries.** In the definition of advanced and emerging economies we follow the IMF classification; eleven of 41 countries in our sample are classified as emerging economies, see Table 2 in the Appendix. Fig. 8 illustrates the estimated impulse response functions for both advanced and emerging countries. For advanced countries, the results indicate that an increase in *FIIS* and *FVAS* leads to heightened productivity per person and per hour worked. The effect is insignificant for most of the horizons in emerging countries. Regarding the labor share of income's response in advanced countries, there is negative effect over the long run which builds up to a 1 and 1.5 percent decrease in response to increasing *FIIS* and *FVAS*, respectively. For emerging countries, the effect of increasing *FVAS* on labor share is insignificant whereas there is a slight positive effect in the long run for *FIIS*. Considering employed persons and hours worked, there is a negative effect for emerging countries when trade integration increases. For advanced countries, on the other hand, increasing *FIIS* leads to a small increase in both employment measures. Real wage per person is negatively affected in

Fig. 7: Impulse responses - full sample



Notes: Responses to a one percent increase in the foreign intermediate input share or foreign value added share. P.p. and p.h. denote per person and per hour worked, respectively. Standard errors are clustered on the country and industry level. The shaded areas on the graphs represent 95% confidence bands.

advanced countries, whereas the effect is statistically insignificant for emerging countries for most of the periods. Regarding the response of value added, there is a positive effect of increasing *FIIS* for advanced countries, while the effect of increasing *FVAS* is slightly negative around four years after the shock and it turns positive towards the end of the sample.

**Sectoral Analysis.** We group the 54 industries into 6 broad sectors: AB (agriculture, forestry and fishing, mining and quarrying), C (manufacturing), DE (utilities), F (construction), GN (trade and market services), and OT (other services), see Tables 3 and 4 in the Appendix. Fig. 9 displays the estimated impulse responses for each of these sectors, with a focus on labor share and productivity per hour for clarity. For the sectors DE, F, and OT, the effect of increasing trade integration on the productivity and labor share is mostly insignificant for all years after the shock.<sup>10</sup> The agricultural sector AB experiences a decrease in labor share in response to increasing *FVAS*. Regarding the manufacturing sector C, both productivity and labor share react negatively to increasing both trade integration measures. Lastly, increasing trade integration leads to a substantial increase in productivity in the service sector GN, accompanied by a decrease in the labor share of income. Similar to sector C, the magnitude is more pronounced when *FVAS* increases.

### 4.3 Discussion

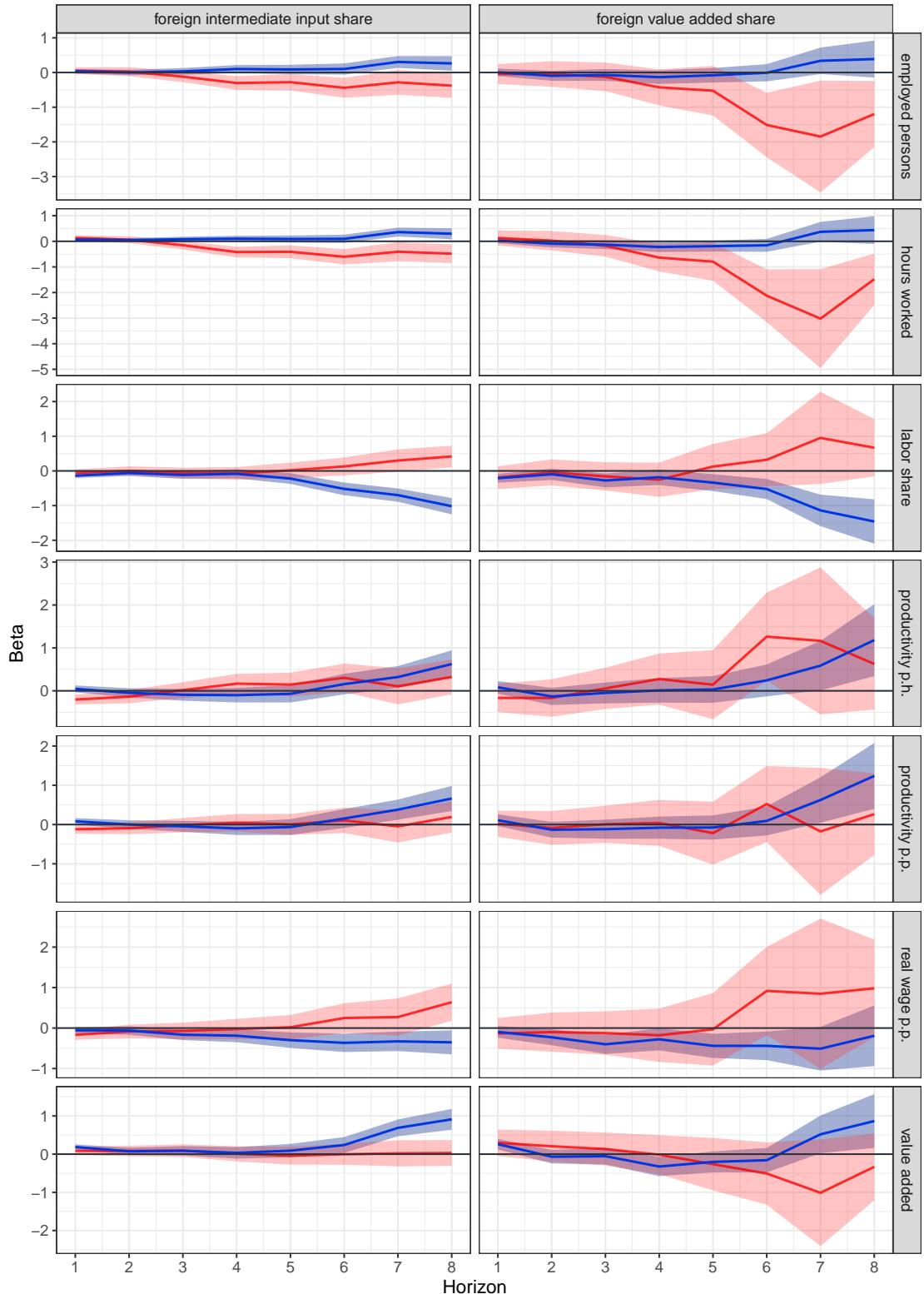
Both the productivity gains and the decline in the labor share of income appear to be driven by the group of advanced countries whereas the magnitude is slightly more pronounced for increases in the foreign value added share. Overall, decreases in both real wages and employment contribute to the fall in the labor share of income in this country group and it also highlights that the productivity growth is decoupled from real wage growth. Notably, the negative effect on hours worked is slightly larger than the estimated reduction in employment, indicating an extension of working hours for the remaining workforce. Further examining possible channels, we regress capital intensity per hour worked and per person, respectively, on the trade integration measures. Fig. 10 depicts the estimated impulse response functions. While there is a slight positive effect of increasing trade integration on capital intensity per hour in emerging countries, advanced countries' capital intensity is affected negatively for most of the years after the shock. Accordingly, as trade integration raises productivity in advanced countries but lowers capital intensity and labor share of income, this suggests that capital-intensive activities are increasingly relocated to emerging countries, while at the same time, advanced countries shift toward less capital-intensive service activities.

Due to the smaller number of emerging countries in our sample, the estimated coefficients

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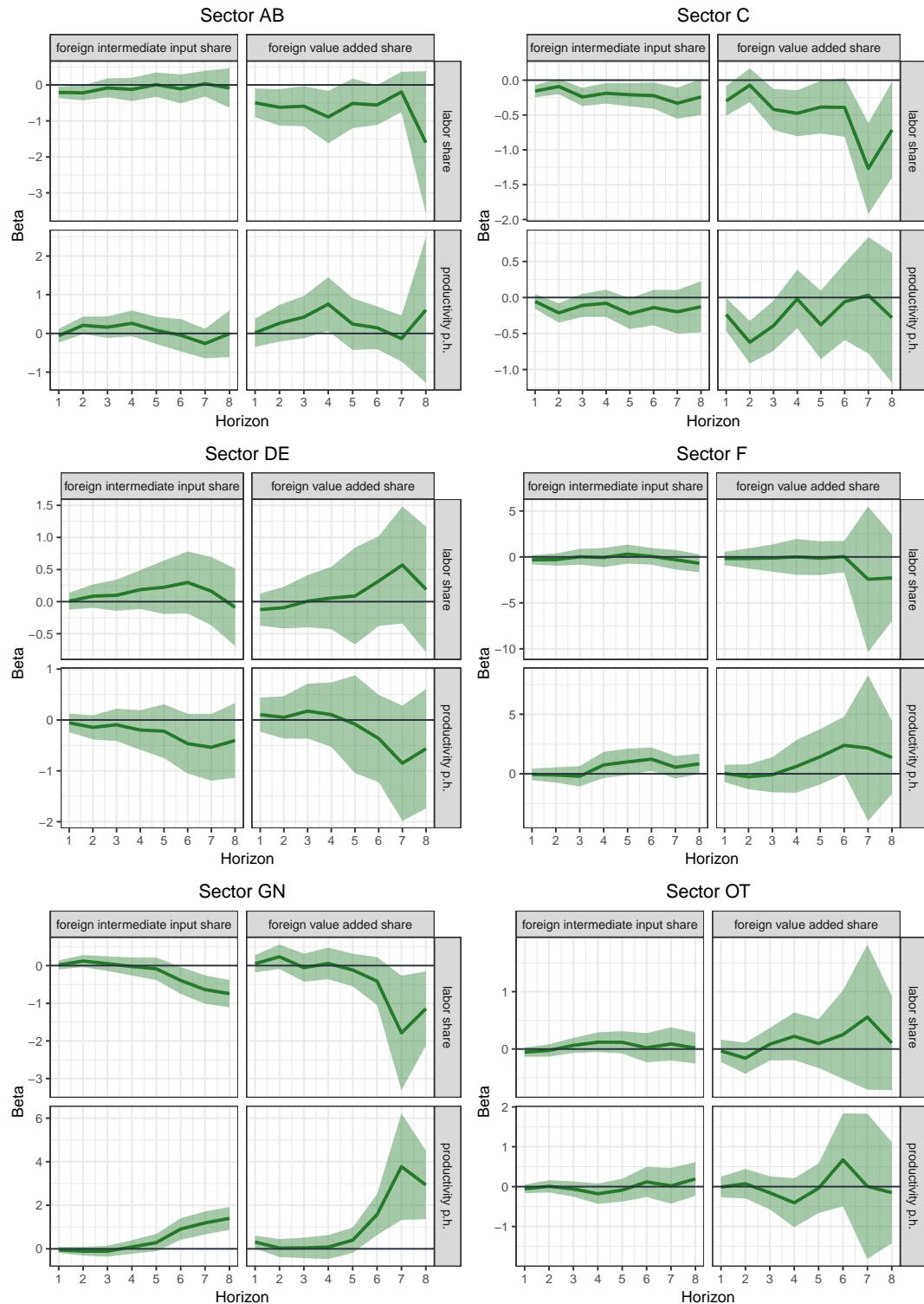
<sup>10</sup>For the sector F, we excluded country fixed effects from the specification as this sector consists of only one industry.

Fig. 8: Impulse responses - advanced countries (blue) vs. emerging countries (red)



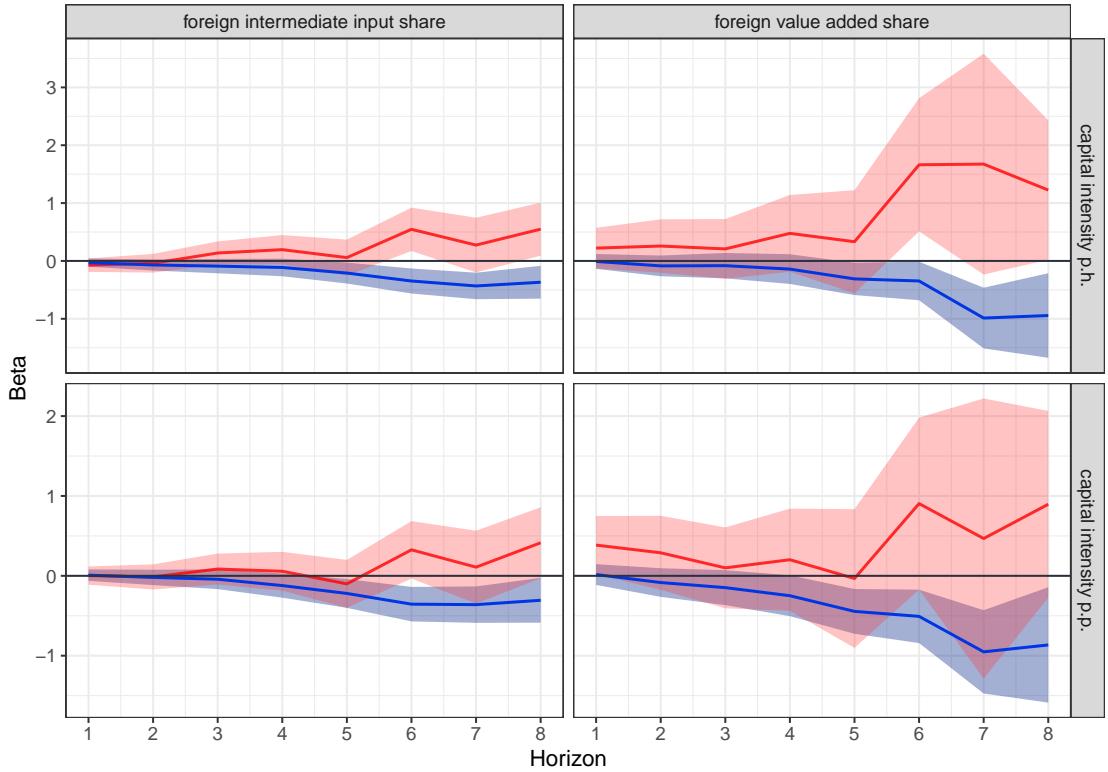
Notes: Responses to a one percent increase in the foreign intermediate input share or foreign value added share. P.p. and p.h. denote per person and per hour worked, respectively. Standard errors are clustered on the country and industry level. The shaded areas on the graphs represent 95% confidence bands.

Fig. 9: Impulse responses - sectoral analysis



*Notes:* Responses to a one percent increase in the foreign intermediate input share (FIIS) or foreign value added share (FVAS). P.h. denotes per hour worked. Standard errors are clustered on the country and industry level. The shaded areas on the graphs represent 95% confidence bands. AB: agriculture, forestry and fishing, mining and quarrying, C: manufacturing, DE: utilities, F: construction, GN: trade and market services, OT: other services.

Fig. 10: Impulse responses - capital intensity - advanced countries (blue) vs. emerging countries (red)



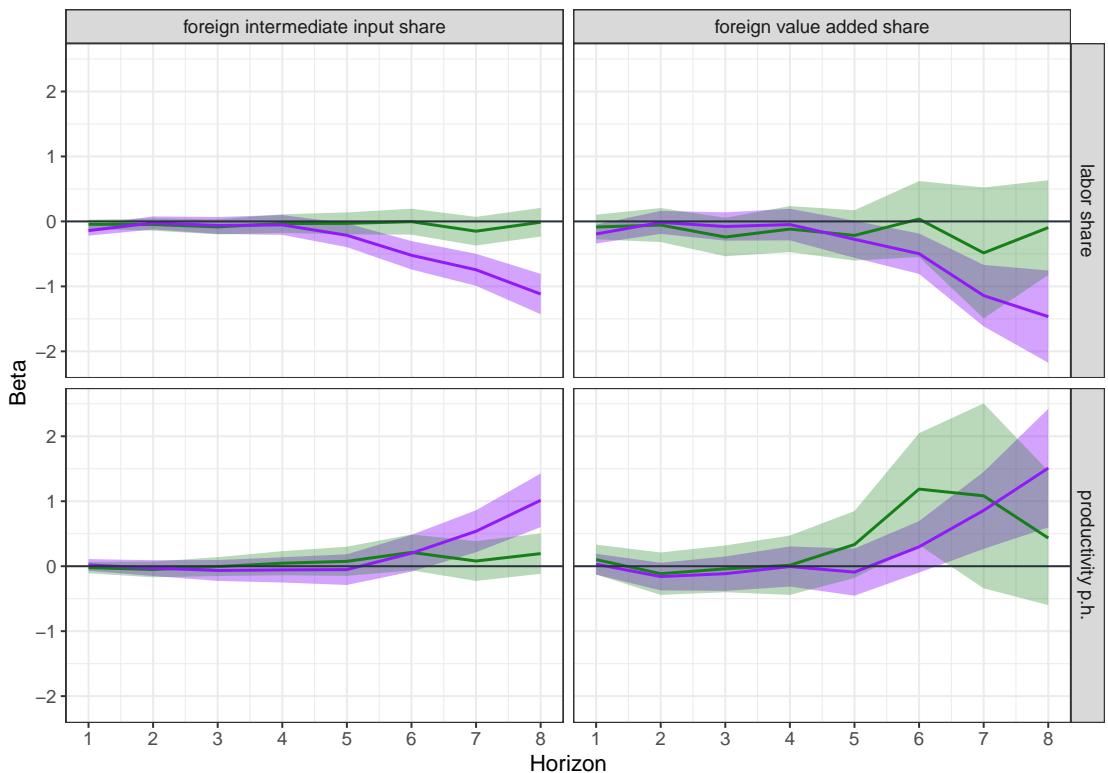
Notes: Responses to one percent increase in the foreign intermediate input share or foreign value added share. Standard errors are clustered on the country and industry level. The shaded areas on the graphs represent 95% confidence bands.

from the sectoral analysis are driven by the group of advanced countries. Overall, the sectoral analysis supports the view that there is a shift of capital intensive tasks away from advanced countries as we find that manufacturing industries (sector C) experience decreases in productivity while service industries (sector GN) are able to increase their productivity in response to increasing trade integration. Meanwhile, trade integration lowers the labor share of income in both these sectors, highlighting that workers in manufacturing industries are disproportionately affected by the absence of productivity gains and providing additional support for the notion of deindustrialization in advanced countries.

Further examining the role of capital intensity, we group industries into either high or low capital intensity industries based on their median value. Then, we estimate the impulse response functions separately for the two groups. The results are depicted in Fig. 11. For the low capital intensity group, there is a positive and significant effect of foreign value added share around six years after the shock, while no significant effect appears for the foreign intermediate input share. For the high capital intensity group, productivity gains are much more pronounced, with both measures turning significant after six years and remaining so until the end of the period. With respect to the labor share of income, we find that only industries with high capital intensity respond negatively to an increase in in-

ternational trade integration. At the aggregate level, however, measured capital intensity declines, which partly reflects the relative decline of manufacturing compared to services, to which trade integration appears to contribute. At the same time, the industries that are capital-intensive show the largest decline in the labor share. Two mechanisms may therefore operate simultaneously: a compositional shift away from capital-intensive industries, and within those industries, stronger international competition and rising markups that put additional pressure on the labor share. This helps explain why the negative effect of trade integration on the labor share is concentrated in advanced countries, which are more specialized in capital-intensive sectors.

Fig. 11: Impulse responses - low capital intensity (green) vs. high capital intensity (violet)



*Notes:* Responses to one percent increase in the foreign intermediate input share or foreign value added share. Standard errors are clustered on the country and industry level. The shaded areas on the graphs represent 95% confidence bands.

Abstracting from these direct observable channels and referring to formula (4) in Section 2.3, we derived the labor share of income as  $(1 - \alpha)$  relative to  $(1 + \mu)$  with  $\alpha$  denoting output elasticity of capital and  $\mu$  denoting markup. One possibility is that internationalization raises capital's contribution, increasing  $\alpha$  and lowering the labor share. Our results, however, point in a different direction: trade integration is associated with declining capital intensity in advanced countries, reflecting a shift away from capital-intensive manufacturing towards services. At the same time, productivity gains are stronger in high capital-intensity industries but not in manufacturing, while labor shares fall across both. This suggests that capital intensity alone cannot account for the observed decline.

A more consistent interpretation is that internationalization raises firms' market power in advanced countries, allowing markups to increase and reducing the share of income going to labor.

Another interesting finding is that both productivity and the labor share of income react, on average, more sensitive to changes in the foreign value added share compared to the foreign intermediate input share. We explore this further by examining the influence of an industry's position in the global value chain on our results. Being located at the more upstream or downstream end of the global value chain can have different effects on firms who expand their international activity. This is because they are equipped with a unique set of characteristics which shapes their competitive advantage in the global market. Accordingly, an assembly line close to the final usage of a product, considered to be a more downstream industry, may be characterized by more labor-intensive tasks in contrast to a more upstream industry extracting raw materials. While our two measures *FIIS* and *FVAS* are able to depict the degree of trade integration for an industry, they do not give sufficient information about an industry's position in a global value chain as they do not distinct between the domestic consumption and global export of output or value added, respectively.

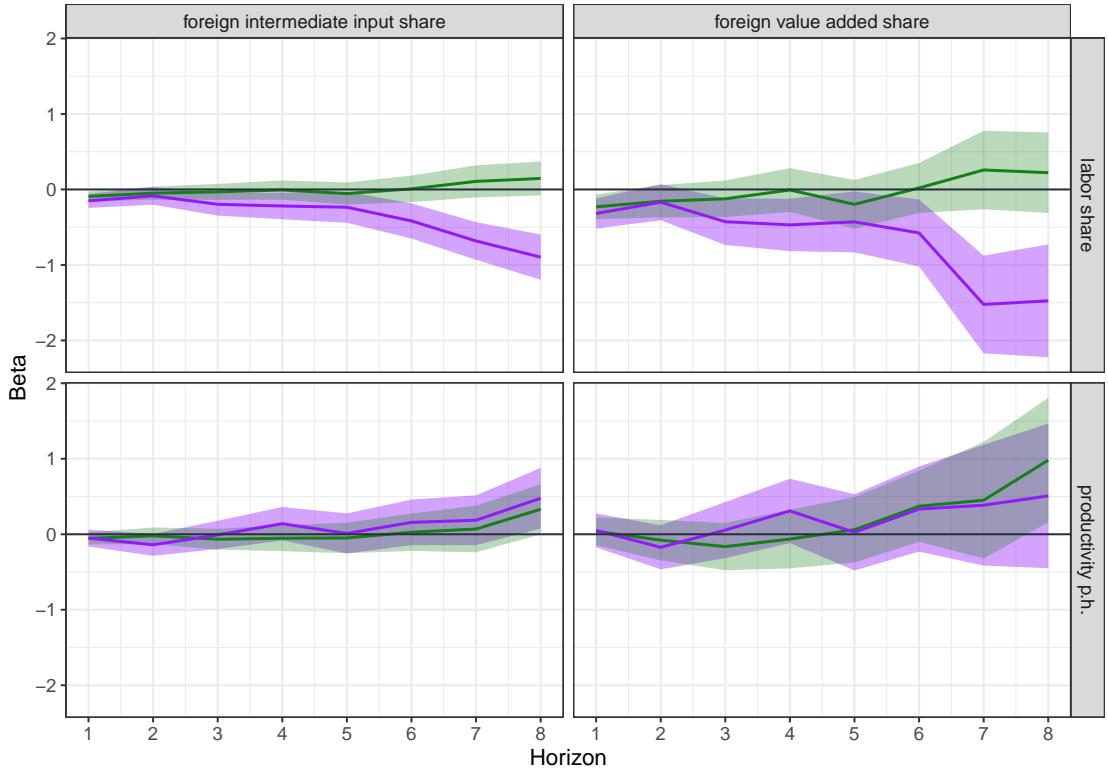
Locating an industry's position in an international context, we follow Wang et al. (2013) and calculate the share of foreign value added contained in an industry's exports relative to its gross exports.<sup>11</sup> The idea is that higher values for this measure capture a higher degree of downstreamness because the higher the foreign content of value added is an exported product, the more production stages it went through and is thereby closer to its final use. For each year, we group industries into a group of either a low and high degree of downstreamness based on the median value. Subsequently, we regress productivity and labor share, respectively, on the trade integration variables for each group separately. The estimated impulse responses are depicted in Fig. 12. We find that the negative effect on the labor share of income which we find in our baseline results appears to be driven by industries which are closer to the end of the global value chain. Furthermore, it appears that more upstream industries experience a slightly stronger increases in productivity.

Lastly, it is worth mentioning that the negative relationship between trade integration and the labor share also holds for major economies such as the US. Estimating impulse responses for the US separately, we find that there is a significant negative effect of increasing *FIIS* or *FVAS* on labor share (Fig. 13 in the Appendix). This is in line with the findings of Elsby et al. (2013), who argue that offshoring is one of the determinants responsible for the decline in labor share in the US. Similarly, Dorn and Levell (2021) show that US industries which are strongly exposed to increasing net imports from China

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<sup>11</sup>Originally, the accounting framework to decompose exports on the country level into different value added components was provided by Koopman et al. (2014). However, Wang et al. (2013) extended this approach to the bilateral sectoral level.

Fig. 12: Impulse responses - low downstreamness (green) vs. high downstreamness (violet)



Notes: Responses to one percent increase in the foreign intermediate input share or foreign value added share. Standard errors are clustered on the country and industry level. The shaded areas on the graphs represent 95% confidence bands.

experience a larger decrease in wages and employment.

#### 4.4 Robustness

So far, our identification strategy relies on regressing the individual foreign supplier shares on a set of fixed effects to obtain the idiosyncratic shocks. However, a possible threat to identification is that the part of residual variation originating from bilateral-specific shocks may also affect outcomes through channels other than changes in the share of foreign intermediate inputs or foreign value added share. For example, disruptions in major trade corridors, such as port closures or shipping route interruptions, can delay deliveries or increase transport costs across multiple bilateral links. These effects can influence productivity, wages, or output through channels unrelated to the sourcing composition (*FIIS* and *FVAS*). Such events therefore risk creating a direct path from the underlying disruption to the outcome variable, which would violate the exclusion restriction. To mitigate this concern, we follow Gabaix and Koijen (2024) and augment the specification with principal components extracted from the bilateral residuals to capture latent common factors. While this strengthens the plausibility of the exclusion restriction, it may also remove some variation that is plausibly exogenous, highlighting a trade-off between strict

exclusion and preserving identifying variation. As a robustness check, we thus include the first three principal components as control variables in the first and second stage of the regressions.<sup>12</sup> The estimated impulse response functions are presented in the Figures 15-17 in the Appendix. Overall, the estimated magnitudes are slightly more pronounced, but the direction of the effects is unchanged.

In another robustness check, we further include an interaction of country and year fixed effects in the first and second stage of the model. The benefit of this approach is that it adds another layer of robustness to country-specific shocks which interfere with both the trade integration variables and the labor share of income. However, the downside is that there may be countries in which the trade integration of the industries predominantly follows countrywide patterns, which inevitably leads us to sweep away this variation. The estimated impulse responses for this specification are presented in the Figures 18-20 in the Appendix. While the impact of increasing *FVAS* on value added now turns positive for advanced countries, both the estimated effects on productivity and the labor share of income remain as in our baseline results.

As proposed by Gabaix and Koijen (2024), a possible way to validate the granular instrumental variable is by conducting a narrative analysis. Their idea is to identify large idiosyncratic shocks in the data and link them to historic events. For a small amount of shocks, their exogenous nature could be verified this way and accordingly, one could construct a granular instrumental variable based on these few shocks. However, while this is a reasonable approach for higher frequency data, as for example daily data, it is important to note that it is almost impossible to verify such events based on yearly data.

Up to this point we considered labor share as the compensation paid to employees relative to value added in current prices. Intuitively, this measure ensures that the labor share accounts for the share of income that is distributed to workers, but as pointed out by Gollin (2002), leaving out the compensation of the self-employed undervalues labor share and affects the variation over time. An accompanying feature is that the underestimation is dependent on the level of development of a country as shares of self-employed workers are higher in emerging countries. By including this group of workers in the measurement of labor share, we can thus account for a larger part of workforce in emerging countries. The estimated impulse responses for both country groups and both measures of labor share are shown in Fig. 21 in the Appendix. Despite a slight downward shift in the impulse response functions for emerging countries, the previous results remain robust to the inclusion of self-employed workers.

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<sup>12</sup>We also estimated specifications with either less or more principal components and the results are qualitatively the same.

## 5 Conclusions

Using data from input-output tables for 41 countries we shed light on the relationship between international trade integration, productivity growth and the functional income distribution. Our first hypothesis that international trade integration leads to higher productivity does hold for the group of advanced countries, while there is almost no effect in emerging countries. For advanced countries, the results for our second hypothesis that productivity gains are unequally distributed to labor income and capital income or profits is compatible with the data. For emerging economies, however, there is no evidence of a negative effect of international trade integration on the labor share. Furthermore, we show that industries which are closer to the final use of a product, oftentimes adding less value added to the product, experience more substantial losses in labor shares. Additionally, we show that these effects build up over time. Moreover, a notion of deindustralization as a result of trade integration evolves as productivity in service industries benefits more than in manufacturing. Importantly, as trade integration lowers the labor share in both these sectors, it shows that workers are mostly not only unable to benefit proportionally from productivity gains, but they are also faced with a disproportional loss of income in times of cost cutting. Lastly, our research will be beneficial in assessing the economic consequences of geopolitical fragmentation. Global trade integration has slowed down immediately after the financial crisis. Recent crises such as the pandemic and the US-China trade conflict can be supposed to have a similar effect. Due to the regionalization of international supply chains and the subsequent reduction in the dependency on these, the share of productivity growth that can be attributed to GVC participation will likely decrease and the effects on the labor share will be suppressed.

A weakness of our findings is that we are not able to distinguish between skilled and unskilled workers in our sample.<sup>13</sup> Since efficiency gains might not be equally distributed across different groups of workers, the rewards of factor inputs are potentially affected; moreover individual effects interact with general equilibrium effects (Hornbeck and Moretti, 2018). In contrast to the Kuznets hypothesis, income inequality did not fall with rising per capita income. It increased in many advanced economies over the recent decades, most notably in the US and the UK. While owners of capital and high-skilled labor benefited from the evolution, income shares for the medium and low skilled workers declined (Timmer et al., 2014). The role of GVC in explaining these shifts is still unclear. Helpman (2017) concluded that international trade integration has an impact on inequality only over long periods, but the effects are minor compared to other drivers like skill-biased technological progress. Autor et al. (2003) and Autor et al. (2008) argued that increased

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<sup>13</sup>International trade integration does not only affect skilled and unskilled workers but also other groups of workers in different ways. Galle et al. (2022) set-up a model in which workers in export-oriented and import-oriented industries are affected differently by international integration. Luck (2019) shows that the effects of outsourcing and offshoring depend on labor market frictions.

computerization crowded out jobs for routinized tasks and contributed to relative income losses of the medium skilled. According to Lopez-Gonzalez et al. (2015) GVC can reduce inequality in industrial countries, if production is close to final demand. Outsourcing of low skilled tasks leads to productivity gains of the remaining low-skilled workers in the home country and rising wages, i.e. wage differentials between high and low skilled decline. In principle, this response could outweigh the initial downward pressure on wages of the low skilled (Grossman and Rossi-Hansberg, 2008). However, international trade integration can also increase skill premiums (Lee and Yi, 2018). Therefore, in future research we will extend our analysis to the relationship between international trade integration and inequality.

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## Appendix

Table 2: Countries

Acronym	Country	Acronym	Country	Acronym	Country
AUS	Australia	GBR	United Kingdom	NLD	Netherlands
AUT	Austria	GRC	Greece	NOR	Norway
BEL	Belgium	HRV	Croatia (e)	POL	Poland (e)
BGR	Bulgaria (e)	HUN	Hungary (e)	PRT	Portugal
BRA	Brazil (e)	IND	India (e)	ROU	Romania (e)
CAN	Canada	IDN	Indonesia (e)	RUS	Russian Federation (e)
CHE	Switzerland	IRL	Ireland	SVK	Slovakia
CYP	Cyprus	ITA	Italy	SVN	Slovenia
CZE	Czech Republic	JPN	Japan	SWE	Sweden
DEU	Germany	KOR	South Korea	TUR	Turkey (e)
DNK	Denmark	LTU	Lithuania	USA	United States
ESP	Spain	LUX	Luxembourg		
EST	Estonia	LVA	Latvia		
FIN	Finland	MEX	Mexico (e)		
FRA	France	MLT	Malta		

Notes: Emerging economies are marked by (e). Classification of emerging economies from IMF (<https://www.imf.org/external/pubs/ft/weo/2018/01/weodata/groups.htm#ae>).

Table 3: Industry classification (A-F)

No.	NACE Code	Description
	<i>A</i>	<i>Agriculture, forestry and fishing</i>
1	A01	Crop and animal production, hunting and related service activities
2	A02	Forestry and logging
3	A03	Fishing and aquaculture
	<i>B, C, D, E</i>	<i>Manufacturing, mining and quarrying and other industry</i>
4	B	Mining and quarrying
5	C10-C12	Manufacture of food products, beverages and tobacco products
6	C13-C15	Manufacture of textiles, wearing apparel and leather products
7	C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
8	C17	Manufacture of paper and paper products
9	C18	Printing and reproduction of recorded media
10	C19	Manufacture of coke and refined petroleum products
11	C20	Manufacture of chemicals and chemical products
12	C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
13	C22	Manufacture of rubber and plastic products
14	C23	Manufacture of other non-metallic mineral products
15	C24	Manufacture of basic metals
16	C25	Manufacture of fabricated metal products, except machinery and equipment
17	C26	Manufacture of computer, electronic and optical products
18	C27	Manufacture of electrical equipment
19	C28	Manufacture of machinery and equipment n.e.c.
20	C29	Manufacture of motor vehicles, trailers and semi-trailers
21	C30	Manufacture of other transport equipment
22	C31_C32	Manufacture of furniture; other manufacturing
23	C33	Repair and installation of machinery and equipment
24	D35	Electricity, gas, steam and air conditioning supply
25	E36	Water collection, treatment and supply
26	E37-E39	Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services
	<i>F</i>	<i>Construction</i>
27	F	Construction

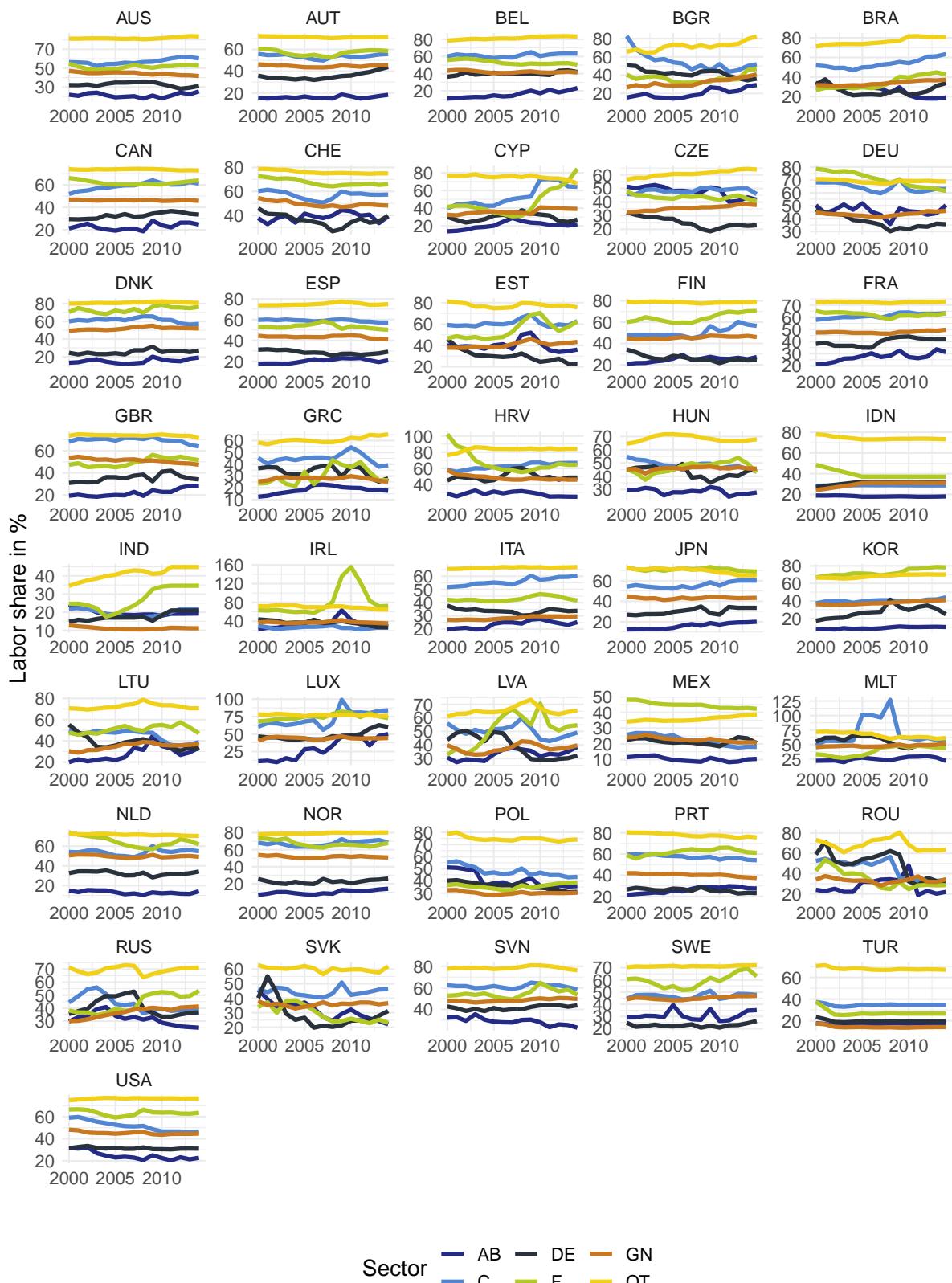
Source: European Commission (2008).

Table 4: Industry classification (G-U)

No.	NACE Code	Description
	<i>G-T</i>	<i>Trade and Services</i>
28	G45	Wholesale and retail trade and repair of motor vehicles and motorcycles
29	G46	Wholesale trade, except of motor vehicles and motorcycles
30	G47	Retail trade, except of motor vehicles and motorcycles
31	H49	Land transport and transport via pipelines
32	H50	Water transport
33	H51	Air transport
34	H52	Warehousing and support activities for transportation
35	H53	Postal and courier activities
36	I	Accommodation and food service activities
37	J58	Publishing activities
38	J59_J60	Motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activities
39	J61	Telecommunications
40	J62_J63	Computer programming, consultancy and related activities; information service activities
41	K64	Financial service activities, except insurance and pension funding
42	K65	Insurance, reinsurance and pension funding, except compulsory social security
43	K66	Activities auxiliary to financial services and insurance activities
44	L68	Real estate activities
45	M69_M70	Legal and accounting activities; activities of head offices; management consultancy activities
46	M71	Architectural and engineering activities; technical testing and analysis
47	M72	Scientific research and development
48	M73	Advertising and market research
49	M74_M75	Other professional, scientific and technical activities; veterinary activities
50	N	Administrative and support service activities
51	O84	Public administration and defense; compulsory social security
52	P85	Education
53	Q	Human health and social work activities
54	R_S	Other service activities
55	T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
56	U	Activities of extraterritorial organizations and bodies

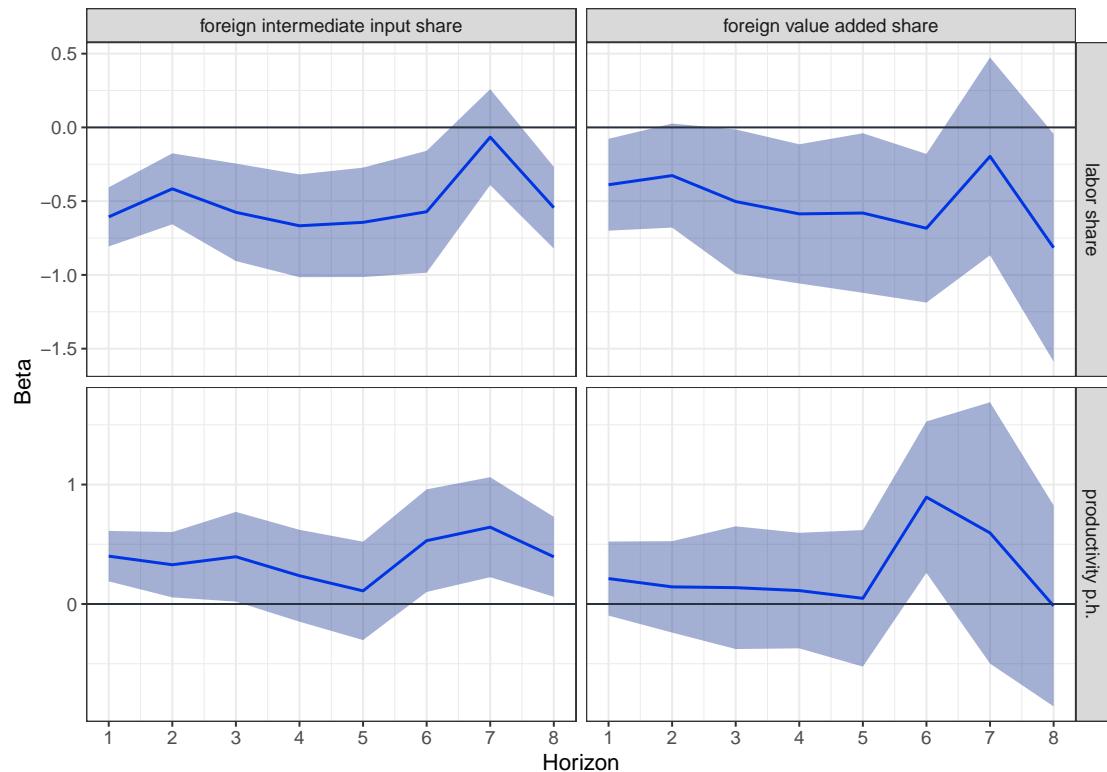
Source: European Commission (2008).

Fig. 13: Labor shares by country and sector



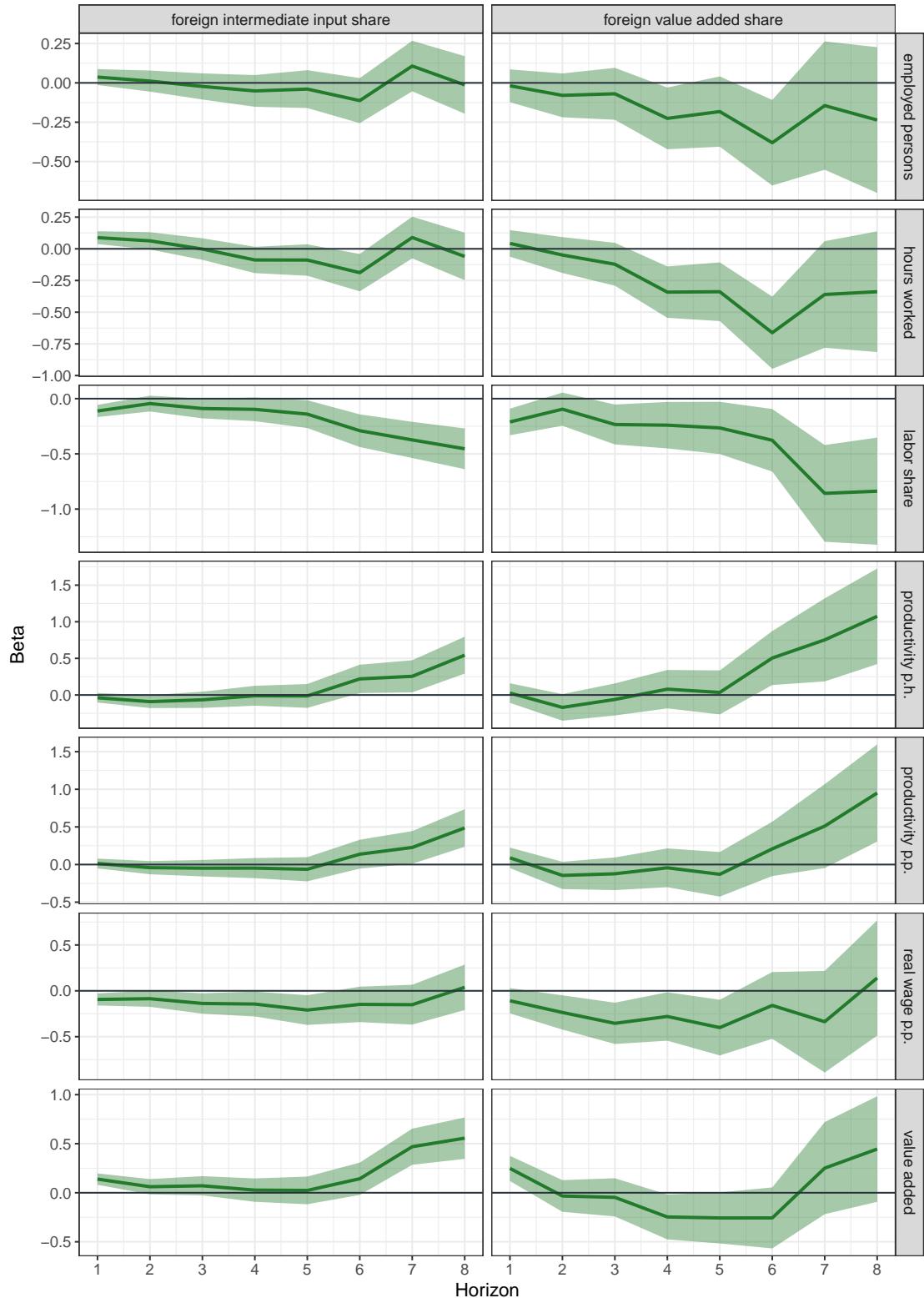
Source: World Input-Output Database, own calculations.

Fig. 14: Impulse responses - USA



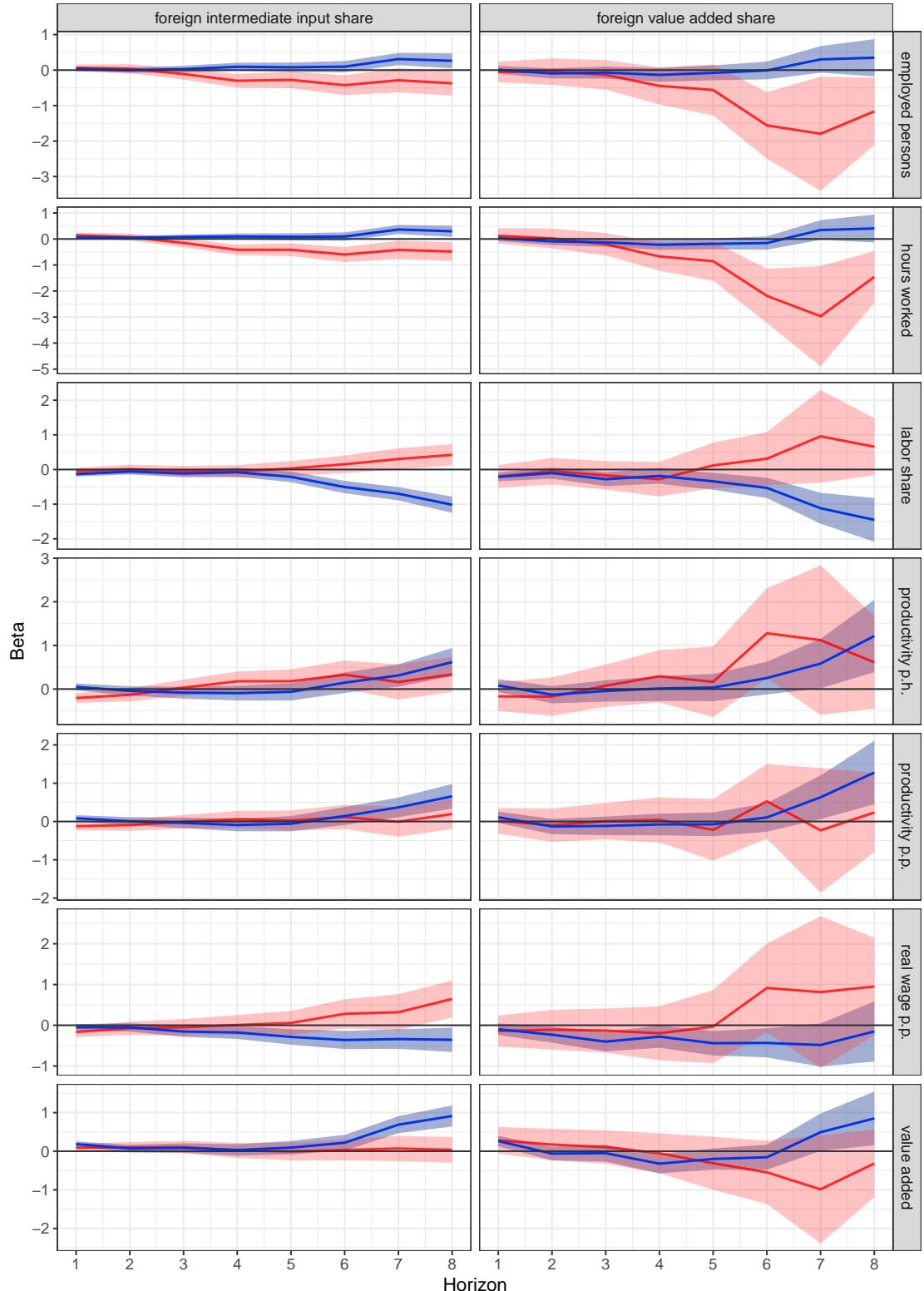
*Notes:* Responses to a one percent increase in the foreign intermediate input share or foreign value added share. P.p. and p.h. denote per person and per hour worked, respectively. Standard errors are clustered on the country and industry level. The shaded areas on the graphs represent 95% confidence bands.

Fig. 15: Impulse responses including principal components as controls - full sample



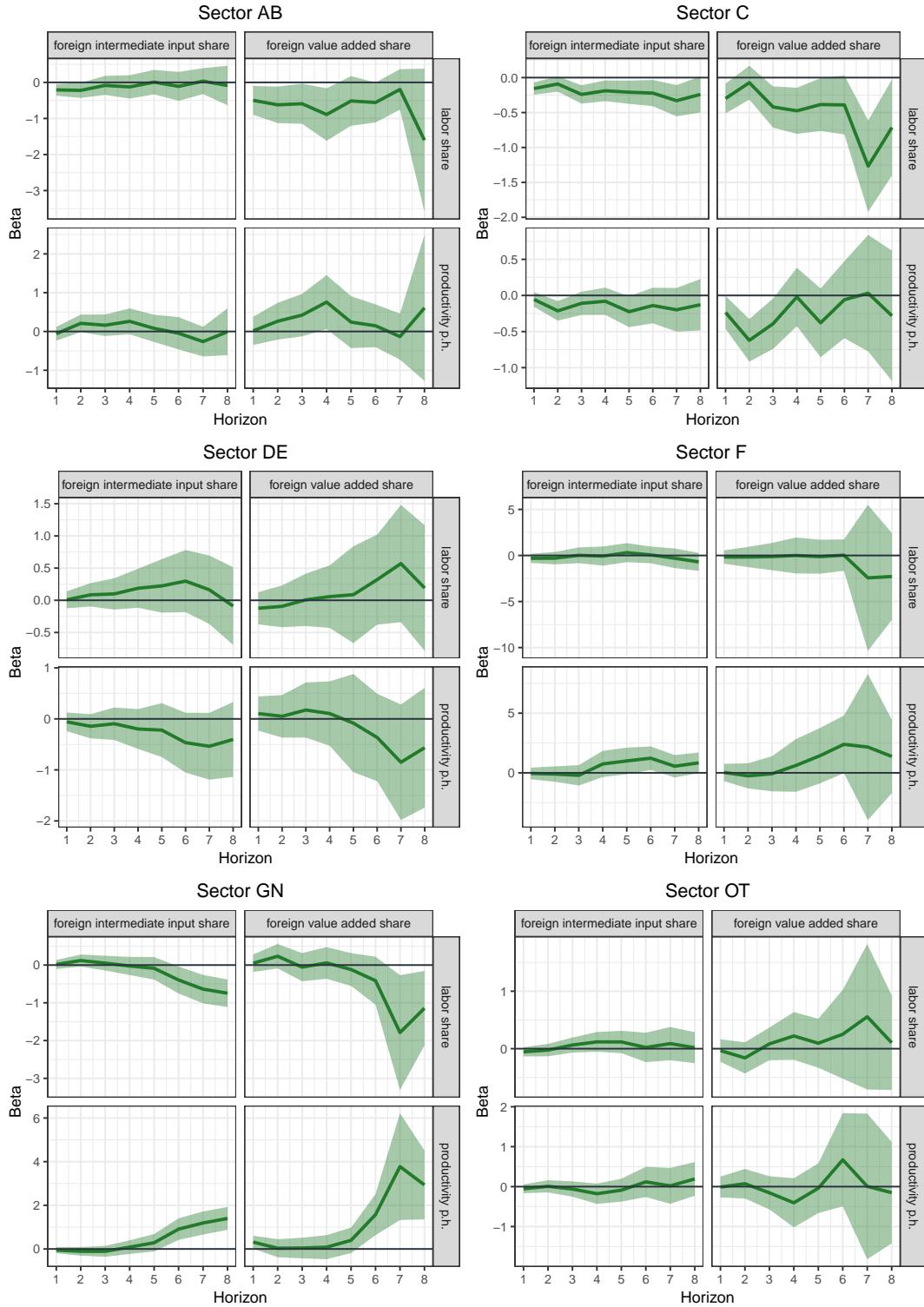
Notes: Responses to a one percent increase in the foreign intermediate input share or foreign value added share. P.p. and p.h. denote per person and per hour worked, respectively. Standard errors are clustered on the country and industry level. The shaded areas on the graphs represent 95% confidence bands.

Fig. 16: Impulse responses including principal components as controls - advanced countries (blue) vs. emerging countries (red)



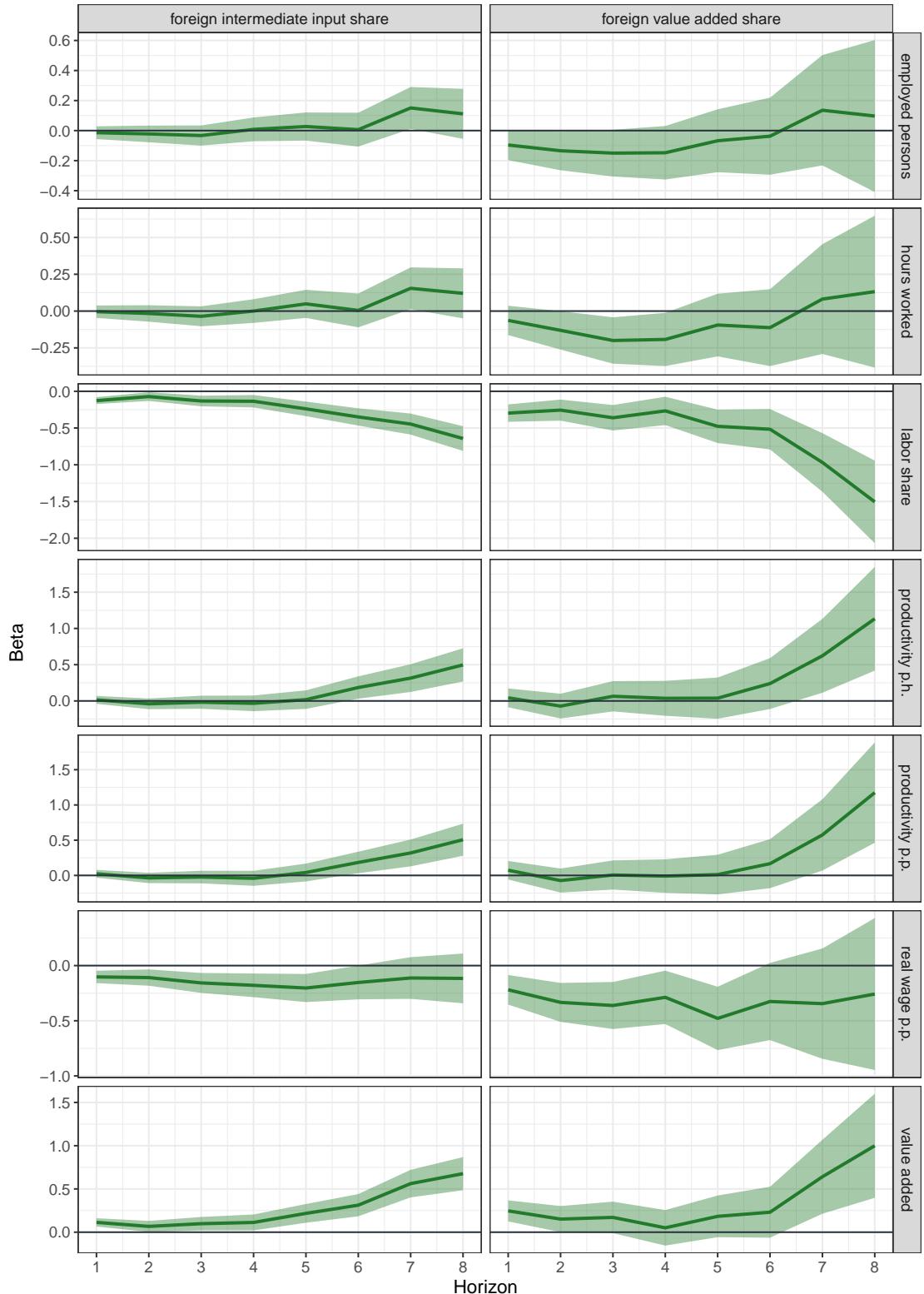
Notes: Responses to a one percent increase in the foreign intermediate input share or foreign value added share. P.p. and p.h. denote per person and per hour worked, respectively. Standard errors are clustered on the country and industry level. The shaded areas on the graphs represent 95% confidence bands.

Fig. 17: Impulse responses including principal components as controls - sectoral analysis



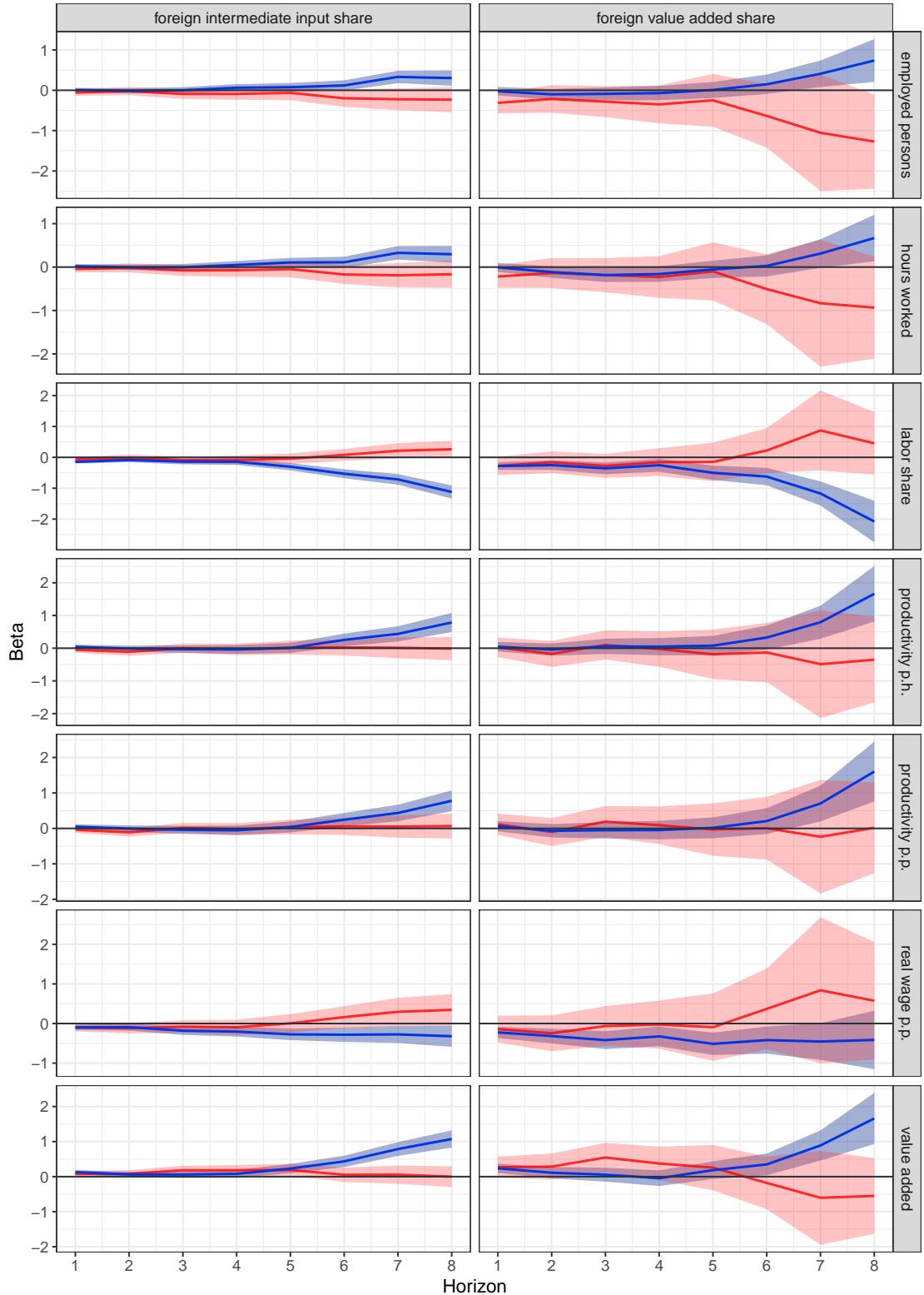
Notes: Responses to a one percent increase in the foreign intermediate input share (*FIIS*) or foreign value added share (*FVAS*). P.h. denotes per hour worked. Standard errors are clustered on the country and industry level. The shaded areas on the graphs represent 95% confidence bands. AB: agriculture, forestry and fishing, mining and quarrying, C: manufacturing, DE: utilities, F: construction, GN: trade and market services, OT: other services. For the sector F, we excluded country fixed effects from the specification as this sector consists of only one industry.

Fig. 18: Impulse responses including principal components and country-year fixed effects as controls - full sample



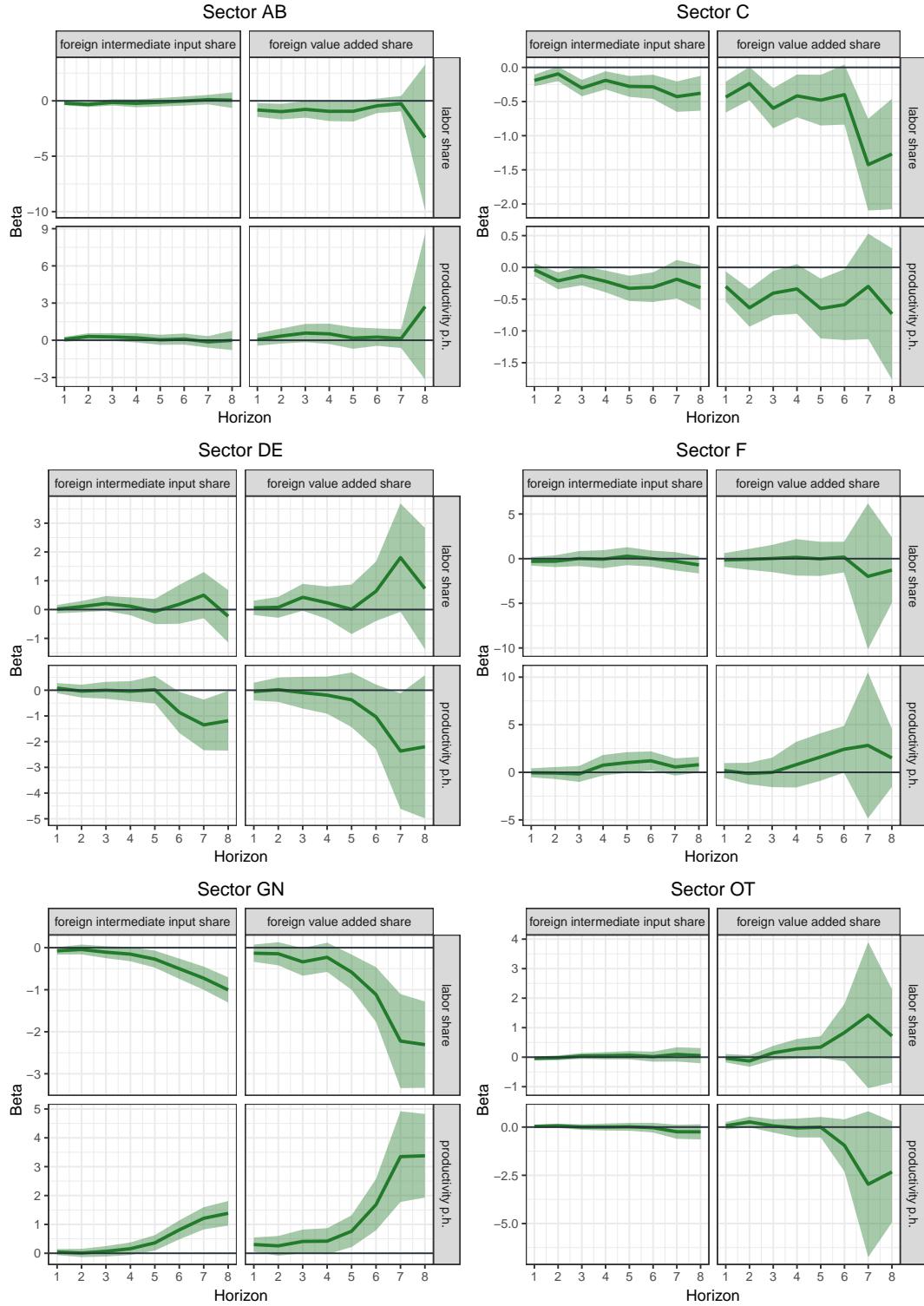
Notes: Responses to a one percent increase in the foreign intermediate input share or foreign value added share. P.p. and p.h. denote per person and per hour worked, respectively. Standard errors are clustered on the country and industry level. The shaded areas on the graphs represent 95% confidence bands.

Fig. 19: Impulse responses including principal components and country-year fixed effects as controls - advanced countries (blue) vs. emerging countries (red)



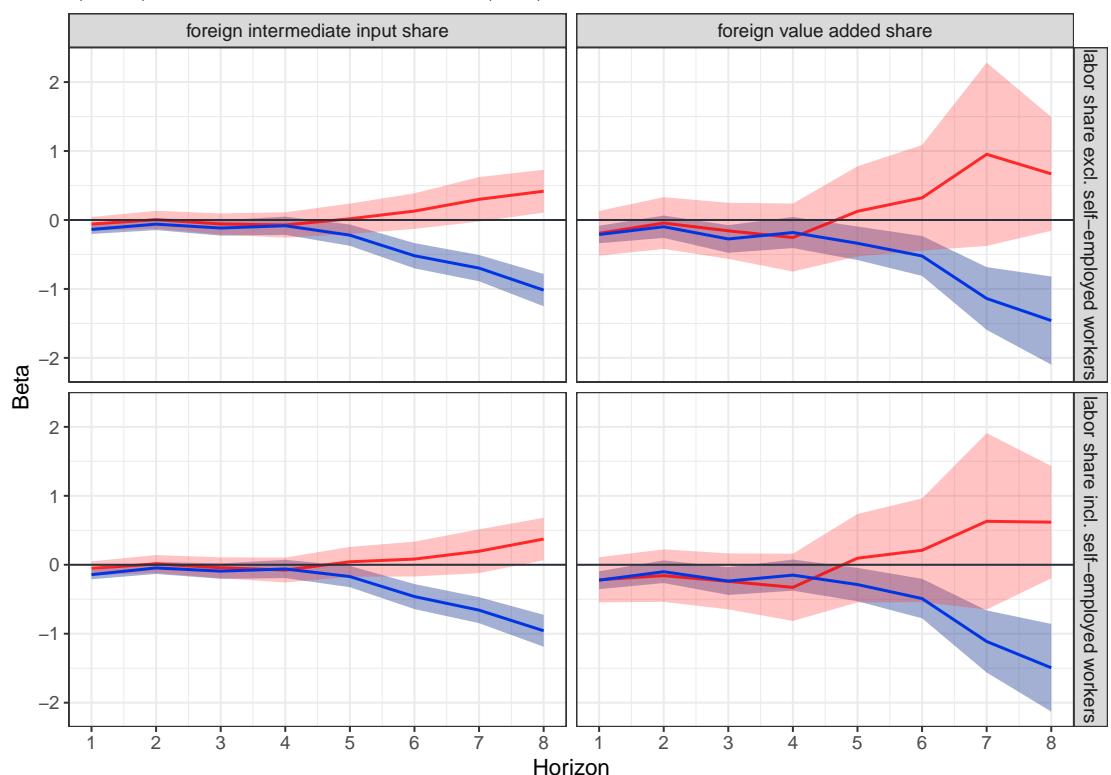
Notes: Responses to a one percent increase in the foreign intermediate input share or foreign value added share. P.p. and p.h. denote per person and per hour worked, respectively. Standard errors are clustered on the country and industry level. The shaded areas on the graphs represent 95% confidence bands.

Fig. 20: Impulse responses including principal components and country-year fixed effects as controls - sectoral analysis



Notes: Responses to a one percent increase in the foreign intermediate input share (FIIS) or foreign value added share (FVAS). P.h. denotes per hour worked. Standard errors are clustered on the country and industry level. The shaded areas on the graphs represent 95% confidence bands. AB: agriculture, forestry and fishing, mining and quarrying, C: manufacturing, DE: utilities, F: construction, GN: trade and market services, OT: other services. For the sector F, we excluded country fixed effects from the specification as this sector consists of only one industry.

Fig. 21: Impulse responses - labor share including self-employed workers - advanced countries (blue) vs. emerging countries (red)



*Notes:* Responses to one percent increase in the foreign intermediate input share or foreign value added share. Standard errors are clustered on the country and industry level. The shaded areas on the graphs represent 95% confidence bands.

Halle Institute for Economic Research –  
Member of the Leibniz Association

Kleine Maerkerstrasse 8  
D-06108 Halle (Saale), Germany

Postal Adress: P.O. Box 11 03 61  
D-06017 Halle (Saale), Germany

Tel +49 345 7753 60  
Fax +49 345 7753 820

[www.iwh-halle.de](http://www.iwh-halle.de)

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