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# Structural transformation and international trade

Evidence from the China shock

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**Abstract:** How does international trade affect structural transformation in developing countries? We use data on sectoral allocation of labour and value-added in 46 developing economies over the period 1995–2017 and exploit for identification plausibly exogenous variation in manufacturing imports from China. We find that the so-called 'China shock' largely slows down the transformation of low- and middle-income economies out of agriculture. In our main specification industrialization decreases by 0.49 per cent on average for each additional per cent of manufacturing imports from China. It highlights a competition effect where exposure to Chinese imports is largely detrimental to structural transformation. These results hold across geographical regions, with a difference in Sub-Saharan Africa, where international trade causes an increase in the size of the services sector.

**Key words:** developing economies, industrialization, structural transformation, trade

**JEL classification:** F14, F63, O11

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# 1 Introduction

The question of how international trade affects economic development is a long-standing debate in economics.[1] In this paper, we provide new evidence on this topic by studying how international competition from China has impacted structural transformation in low- and middle-income economies.

Structural transformation, which can be defined as the reallocation of economic activity across the broad sectors of agriculture, industry, and services, has been at the centre of macro-development theories for several decades (e.g. Clark 1967; Kuznets 1973, 1966; Lewis 1954; Syrquin 1988). A key insight emerging from those theories is that releasing resources from low-productive sectors, often considered as agriculture, towards those with higher potentials (e.g. industry) allows significant economic growth simply by correcting misallocations (e.g. Adamopoulos and Restuccia 2014; Gollin et al. 2002, 2013; Lagakos and Waugh 2013). Hence, understanding the economic mechanisms and policy measures that lead to the growth of the non-agricultural sector in poor countries is a subject of utmost importance.

How international trade alters this process remains unclear. On the one hand, when a country has a comparative advantage in the agricultural sector, opening to trade could hinder the transformation of the economy out of agriculture. Theoretically, since the economy is able to supply the world market with lower prices, it could specialize in the production of agricultural goods (Matsuyama 1992, 2009). As a consequence, the reallocation of resources (e.g., workers, capital flows) towards the non-agricultural sector would be delayed by trade openness. On the other hand, opening to trade could instead accelerate the movement of factors out of agriculture through an increase in imports of food products (Betts et al. 2017; Teignier 2018; Uy et al. 2013). Following this possibility, international trade could provide a solution to the so-called *food problem*. This view posits that increased trade can hasten the process of structural transformation. Another possibility is that, by allowing the imports of modern inputs that are not produced domestically (e.g. fertilizers), trade also benefits the economy. In this case, the import of intermediate inputs could help to modernize the traditional sector and lead to a faster transition out of agriculture (McArthur and McCord 2017). In summary, the impact of international trade on structural transformation is not straightforward and can possibly have mixed effects.

To bring new evidence on this topic, we exploit the ‘China shock’—that is, the fact that China became a global manufacturing supplier quickly after joining the World Trade Organization in 2001. China’s experience provides arguably a relevant and exogenous instrument to study trade shocks as it was both an unexpected and a sizeable shock (Autor et al. 2013, 2016). This is true both for developed and developing countries. For instance, according to the World Bank, in 1990 only 2 per cent of total imported products in Sub-Saharan Africa were coming from China. By 2018 this number had increased to almost 15 percentage points, thus showing a large shift, including in poor economies.

To estimate the causal impact of the China shock on structural transformation in developing countries, we rely on the yearly variation in the share of labour allocation (percentage of total employment) and value-added (percentage of GDP) per sector in each country of our sample. This information is obtained from the Economic Transformation Database (ETD), provided by the Groningen Growth and Development Centre and UNU-WIDER (De Vries et al. 2021; Kruse et al. 2022). It provides measures of economic growth and labour inputs for 51 economies in Africa, Asia, and Latin America in 12 sectors of the economy between 1990 and 2018. To measure trade shocks, we build a variable of exposure to Chinese imports by exploiting the BACI dataset (Gaulier and Zignago 2010). The variable is computed as the yearly manufacturing imports from China relative to the initial size of the manufacturing sector in each developing economy of our sample. Adding controls on the level of economic development

[1] See, for instance, Atkin and Donaldson (2022) for a recent review.

and demographic pressure, as well as time and individual fixed effects, we then regress this variable of interest on our measures of structural transformation.

A potential concern in our identification strategy is that exposure to Chinese competition could be correlated to unobserved demand shocks in recipient economies. If this was the case, the causal identification of the shock would be threatened. To address this concern, we use an instrumental variable in a two-stage least squares estimation (IV-2SLS). More precisely, we instrument a country's manufacturing imports from China by those realized by its direct geographic neighbours. By doing so, we relate to the well-known strategy proposed by Autor et al. (2013). In all, our identification relies on a shift-share setting with an instrumental variable as well as a set of country and year fixed effects.

We highlight four main findings. First, the rise of China as a global supplier has been largely and significantly detrimental to industrialization in the developing economies of our sample. For all the measures of structural transformation used, we systematically find that being more exposed to imports of manufacturing goods from China causes a decline in the size of the industrial sector. The effect is quite large and mainly driven by the manufacturing sector (i.e. not by construction or mining, both part of the industrial sector). For example, in our baseline specification, we find that a 1 per cent increase in manufacturing imports from China causes industrial employment to shrink by 0.49 per cent. This highlights the importance of a competition effect: the industrial sector in the developing economies of our sample compete against Chinese production. While it can lead either to decrease or increase in its size, our results suggest that on average the outcome is largely negative. Competition from China did not help low- and middle-income economies to further industrialize. On that matter, our results are related to the paper of Rodrik (2016) on premature deindustrialization.

Second, and perhaps more preoccupying, we find that the shrinking of the industrial sector caused by the China shock is largely redirected towards agriculture. In our baseline specification we find that a 1 per cent increase in manufacturing imports from China causes agricultural employment to increase by 0.44 per cent. This result implies that, on average in our sample, trade openness as measured by exposure to Chinese imports slows down the process of transformation out of agriculture. This is important since the agricultural sector is not traditionally viewed as the sector providing long-term growth benefits in poor countries.

Our third important result is related to geographical heterogeneities. While the negative impact of exposure to Chinese imports on the size of the industrial sector holds for every region, we find that the consequences of this negative effect are slightly different for Sub-Saharan Africa. In this region, the shock has largely pushed workers towards services. Our results show that increasing exposure to manufacturing imports from China by 1 per cent causes a rise of 0.28 per cent of employment in services there. In agriculture, we find a positive coefficient but not significantly different from zero. Overall, this suggests that international trade, measured by competition from China, has promoted a structural transformation away from industry and towards services in Sub-Saharan Africa. This is not the case of Latin America or East and South Asia.

Our last key result concerns the value of output per worker, an index of labour productivity. Our findings show that an increase in manufacturing imports from China raises industrial labour productivity on average in our sample. This could suggest the presence of an input effect, where countries are able to import intermediate inputs to boost output per worker thanks to the China shock. However, our regressions reveal a very small effect: a 0.015 per cent increase in the value of industrial value-added per worker for each additional percent of imports from China. In all, it suggests that the negative competition effect described earlier largely offsets this positive input effect.

This paper contributes to several strands of the literature, as we detail in Section 2. Our main contribution is to provide a causal inference of the impact of international trade on structural transformation. We do so at the macro-level by using the most recent cross-country database available on sectoral employment and value-added: the ETD (De Vries et al. 2021). Another key contribution of this paper is to provide evidence of how the rise of China affects economic development elsewhere, which is again an open debate in the field of economic development. Finally, our value-added is also to document the impacts of the China shock in low- and middle-income countries, thus contributing to a literature that has mostly focused on high-income countries so far (Autor et al. 2016).

The rest of the paper is organized as follows. Section 2 extensively discusses the literature and highlights our contribution in more details. Section 3 presents our data and our identification strategy using shift-shares combined with an instrumental variable. Section 4 shows the results and Section 5 concludes.

## 2 Related literature

Our work is related to the long-lasting literature on structural transformation that has been at the centre of interest of many economists for several decades (Clark 1967; Kuznets 1973, 1966; Lewis 1954; Syrquin 1988). While Herrendorf et al. (2014) review existing evidence and channels of structural transformation in developing economies, a central idea is that the reallocation of factors from low- to high-productivity sectors is absolutely critical in order to foster economic development.[2]

Directly related to that fact, a large body of literature has identified, using different data sources, substantial differences in labour productivity between the agricultural sector and the rest of the economy, particularly in developing countries. This stylized fact is known as the agricultural productivity gap (Adamopoulos and Restuccia 2014; Gollin et al. 2002, 2013; Lagakos and Waugh 2013).

On the contrary, it is common to historically associate the most productive sectors to industrial activities in general and manufacturing in particular. This is the reason why some authors, such as Rodrik (2016), argue that the patterns of 'premature deindustrialization' observed in many developing countries could undermine long-term growth. Yet, using the ETD, Herrendorf et al. (2022) provide recent evidence from 64 poor countries over 1990–2018 showing that labour productivity gaps in manufacturing are actually larger than in the aggregate.

Our contribution to this first part of the literature is to analyse how international trade affects this process of structural transformation, out of agriculture and towards what has been called modern sectors. We do so by examining the causal impact of exposure to Chinese imports on the reallocation of resources (labour and value-added) across sectors.

The effect of trade is ambiguous. On the one hand, it could slow down transition out of agriculture. Related to this possibility, Matsuyama (1992, 2009) develops a model and shows how trade openness combined with high agricultural productivity could lead to specialization in the primary sector, at the expense of the manufacturing one. Another deindustrialization channel could be that opening to trade exposes countries to international competition at the expense of domestic manufacturing firms if these are not competitive.

Trade could also accelerate transitions. Teignier (2018) proposes a quantitative model to measure how important trade was to structural transformation in Great Britain and then in South Korea. The main insight is that by importing food, developing countries may not need to reach high agricultural produc-

[2] Theoretical works in a closed-economy setting show that the transformation channels usually rely either on income effects, as in Kongsamut et al. (2001), or relative price effects, as in Ngai and Pissarides (2007).

tivity levels and may release labour towards non-agricultural sectors faster. Uy et al. (2013) and Betts et al. (2017) study South Korea and find similar results. Finally, international trade could also benefit a developing economy by increasing the ability to access intermediate inputs that would raise productivity. Amiti and Konings (2007) and Topalova and Khandelwal (2011) find evidence of this channel for Indonesia and India, respectively.

Overall, the relationship between trade and structural transformation may be ambiguous, as the exchange of goods with the rest of the world can either facilitate or hinder the reallocation of resources under certain conditions. As a result, determining the exact nature of this relationship is an empirical question that requires careful analysis, and which we tackle using the newly released ETD from De Vries et al. (2021).

This work also relates to a broader literature examining how openness to trade affects a country's economic growth. A strand of the literature has focused specifically on what has been called the 'China shock' (Autor et al. 2016) and how it has affected labour market and other outcomes. Our paper is linked to their work as we use the rise of China as an economic partner to developing economies to instrument countries' openness. Our contribution here is to document outcomes in low- and middle-income countries, contrary to most previous studies using this strategy.

Some authors have also accounted for trade in cross-country studies of structural transformation, as we do here. This is the case of McMillan et al. (2014), Rodrik (2016), and Kruse et al. (2022), who distinguish between manufacturing exporters and non-exporters. However, since the share of resources allocated to a given sector is also likely to determine whether a country can export goods produced in this sector, those studies may suffer from endogeneity due to simultaneity bias. Our contribution is thus to work on causal effects and by precisely tracing the effect of Chinese competition.

## 3 Empirical strategy

This section first presents our data sources and then details our strategy to identify the causal impacts of trade on structural transformation.

### 3.1 Data

Our primary source of data is the newly released ETD (De Vries et al. 2021; Kruse et al. 2022). It provides comprehensive, long-term, and internationally comparable sectoral data on both output (value-added at constant and current prices) and employment (persons employed) in Africa, Asia, and Latin America. It covers the period 1990–2018 and 12 sectors: agriculture, mining, manufacturing, utilities, construction, trade services, transport services, business services, financial services, real estate, government services, and other services.

We build two key indicators to measure structural transformation: (1) sectoral employment (percentage of total persons employed) and (2) sectoral value-added (percentage of GDP). Those sector-specific outcomes are built following the 12 sectors' decomposition in the ETD. In some parts of the analysis we aggregate them into the three broad sectors of agriculture, industry, and services. To do this, we follow Herrendorf et al. (2014): while *agriculture* corresponds to the original category of the ETD, *industry* encompasses manufacturing, mining, and construction. services contain the following International Standard Industrial Classification (ISIC-4) categories: utilities, trade, transport, business, finance, real estate, government, and other.

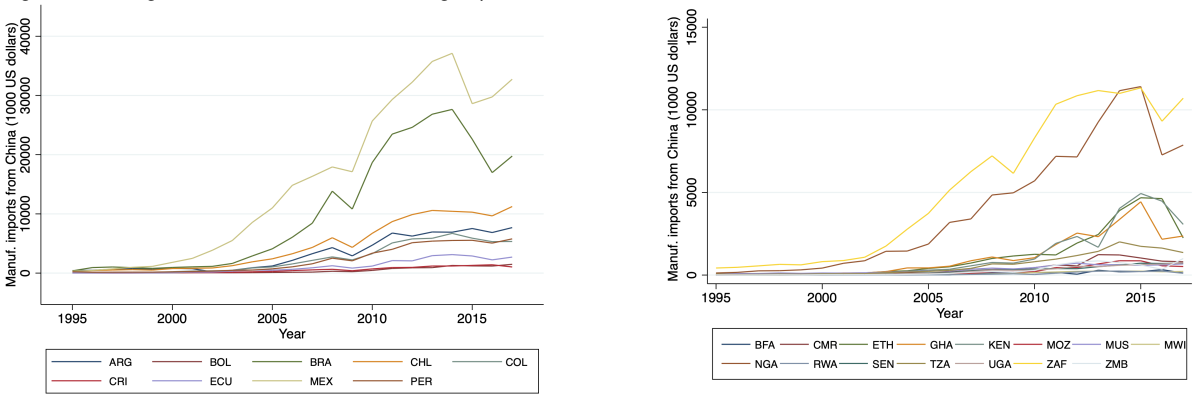
The ETD is then combined with data on international trade taken from the BACI database (Gaulier and Zignago 2010). This source provides data on bilateral trade flows for 200 countries at the product level, with 5,000 products corresponding to the Harmonized System nomenclature (six-digit code). For our research question we collect in particular the values of the yearly trade flows originating from China towards the developing countries of our sample (expressed in constant dollars).

We also add to our sample control variables taken from the World Development Indicators. These include GDP per capita (constant 2015 US dollars) and the size of the population, to account for the level of economic development and demographic pressure, respectively. After merging the different data sources, we obtain a strongly balanced panel dataset containing 46 countries (excluding China) from 1995 to 2017.

**Trade patterns.** In our sample, 29 countries had higher trade openness (sum of imports plus exports in total GDP) in 2017 than in 1995, sometimes by a large extent. According to the World Development Indicators, openness increased by 47 percentage points (p.p.) in Cambodia over that period, and by 38 p.p. in Mozambique. In Mexico it increased by over 30 p.p. On the contrary, trade represented a lower share of total GDP in 2017 than in 1995 in other countries, including Costa Rica (–14.7 p.p.), Kenya (–35.7 p.p.), and Pakistan (–10.7 p.p.).

Let us now turn to the variable of interest for our study: the change in manufacturing imports from China. In Figure 1 we report these time series (in values) for two key regions that host 27 of the 46 countries of our final sample: Latin America and Sub-Saharan Africa.

Figure 1: Change in the value of manufacturing imports from China since 1995




(a) Latin America

(b) Sub-Saharan Africa

Source: authors' compilation.

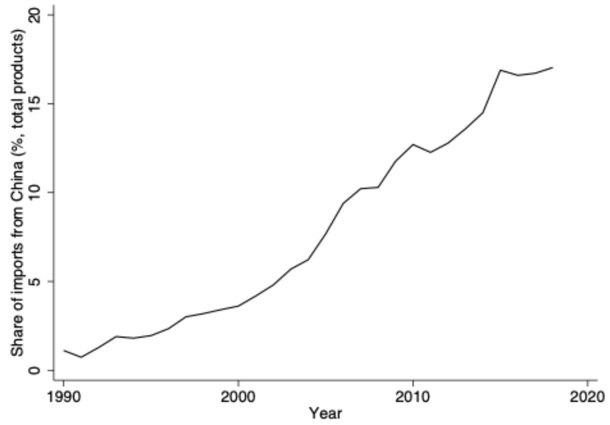
We observe that imports from China increased in every country. In Latin America, Brazil and Mexico were the most exposed, while in Sub-Saharan Africa it was South Africa and Nigeria. Not all countries have observed the same growth in manufacturing imports from China, and it is in part this unequal exposure to the China shock that we exploit in our empirical strategy.

## 3.2 Identification strategy

In this section we describe in detail our approach to capturing the effect of trade on structural transformation. One way to do it could be to regress the degree of trade openness (i.e. the sum of imports and exports in total GDP) over the sectoral allocation of resources (labour and value-added) for all the countries in our sample. However, the variables of structural transformation are likely to impact trade openness. For instance, a country investing in manufacturing may want to establish trade agreements with economic partners in order to export products outside its home market. This issue of reverse causality can be a threat to causal identification and can lead to biased estimates. For this reason, our identification strategy instead exploits the China shock.

**Shift-share setting and the 'China shock'.** To work around the fact that a country's volume of trade may be affected by its stage of structural transformation, we use a proxy for trade itself. Precisely, we exploit the surge in international competition for manufacturing products faced by most countries consecutively to the 'China shock'. This approach has several advantages. First, the China shock represents a massive shock to trade that has affected the world economy, including poor countries. Figure 2 shows that while only 2 per cent of total imported products in Sub-Saharan Africa were coming from China in 1990, this number has increased by almost 15 p.p. by 2018. It is thus likely to have sizeable impacts.

Figure 2: Sub-Saharan share of imports from China




Source: authors' compilation based on data from the World Bank.

Second, the unexpected nature of this shock makes it a relevant natural experiment in international trade that can be used to work on causality. On this point, Autor et al. (2016) discuss how unanticipated for many observers was the fact that China would become the world's global manufacturing supplier. At the time, many experts had underestimated China's economic potential and the speed of its economic growth. Prior to 2001, the country had been largely closed off to international trade and investment, making it difficult for outsiders to gauge its economic prospects. Moreover, the fact that the scale of China's industrialization and export-led growth was unprecedented was also a reason why many observers did not anticipate the shock.

Given these elements, we estimate the following model:

$$y_{ikt} = \beta\left(\omega_{ik,1990}\Lambda_{ikt}\right) + \xi X_{it} + \nu_{it} \tag{1}$$

where $y_{ikt}$ is the outcome variable in country $i$, sector $k$, and year $t$. Our dependent variable $y$ will be alternatively the share of employment (percentage of labour force) and value-added (percentage of GDP) of sector $k$ in country $i$.

Our variable of interest, on the right-hand side (RHS) of Equation (1), displays two components. The share part $\omega_{ik,1990}$ is the (initial) level of outcome $y$ in sector $k$ and country $i$ at year 1990. In our case, this is either the share of employment (percentage of total labour force) or value-added (percentage of total GDP) in sector $k$. The parameter $\omega_{ik,1990}$ thus informs us on the initial exposure of country $i$ to the China shock in sector $k$. For instance, all things being equal, countries with lower $\omega_{ik,1990}$ are likely to be less affected by the shock since they were initially less specialized in this sector. This term is then multiplied by the log of the realized imports from China $\Lambda_{ikt}$ made by country $i$ in sector $k$ at year $t$. This is the shift component incorporating the variation in Chinese imports penetration.

On the RHS of Equation (1), $X_{it}$ designates a country-level set of controls. These controls include, in all our estimates, GDP per capita and population size. The first variable accounts for how the level of economic development in country $i$ can affect structural transformation. The second one accounts for the influence of demographic trends on our outcomes, as in Kruse et al. (2022). Systematically, we take the value of those two variables lagged by three years in order to avoid simultaneity or reverse causality.

The term $\nu_{it}$ incorporates the error term as well as individual and time fixed effects, which we denote:

$$\nu_{it} = \text{FE}_i + \text{FE}_t + \mu_{it} \tag{2}$$

with the error term $\mu_{it}$ capturing potentially unobserved components affecting $y_{ikt}$. The individual fixed effects $\text{FE}_i$ allow us to eliminate all unobserved confounding factors that would be country-specific and constant in time (e.g. the influence of culture).

**Instrumental variable.** In our shift-share setting, the realized imports from China, $\Lambda_{ikt}$, may be correlated with unobserved shocks in demand in country $i$. If this is the case then our estimation would suffer from an endogeneity bias. To avoid this bias and clearly establish causality, we use an IV-2SLS strategy.

We instrument $\Lambda_{ikt}$ by the log of imports from China realized in *neighbouring countries* over our period of study. Using data from Mayer and Zignago (2011), for any country $i$, we instrument the term $\Lambda_{ikt}$ by the imports from China realized by its ten closest geographical neighbours: $M_{ikt} = \sum_{j \in N_i} \Lambda_{jkt}$, with $N_i$ the set of neighbours of country $i$.

In a first stage, we estimate the following regression:

$$\Lambda_{ikt} = \gamma M_{ikt} + \alpha X_{it} + \nu_{it} \tag{3}$$

where $M_{ikt}$ is the excluded instrument, capturing the imports trends in neighbouring countries. Armed with this estimation, we then estimate in a second-stage regression:

$$y_{ikt} = \beta \left( \omega_{ik,1990} \hat{\Lambda}_{ikt} \right) + \xi X_{it} + \nu_{it} \tag{4}$$

in which $\hat{\Lambda}_{ikt}$ is the prediction from the first-stage regression.

By doing so, we follow the original setting proposed by Autor et al. (2013) and our estimation of Equation (4) (IV-2SLS) delivers the causal impact of Chinese competition on structural transformation in the countries of our sample.

## 4 The impact of the China shock

In this section we present our results. We start with our baseline specification, which includes all countries of our sample, by instrumenting observed trade. In the following subsection we separate our set of countries by regions between East and South Asia, Sub-Saharan Africa, and Latin America. Finally, the last part of this section is dedicated to the effects on labour productivity.

In every estimation presented in this section we specify the variable of interest, $\omega_{ik,1990}\Lambda_{ikt}$, such that $k = \{\text{manufacturing}\}$. We do so because manufacturing products are by far the most exported products by China since the 2000s, thus making it a relevant instrument (Autor et al. 2016).

### 4.1 Baseline results

Results showing the average impact of manufacturing imports from China on structural transformation are displayed in Table 1. For these baseline IV results we have aggregated the 12 sectors from the ETD into agriculture, industry, and services, following Herrendorf et al. (2014). All the estimations presented here include country and time fixed effects, and standard errors are computed using a White correction (robust standard errors).

Table 1: The impact of the China shock on the three broad sectors

| | Employment (% total) | | | Value-added (% GDP) | | |
|---|---|---|---|---|---|---|
| | Agr. | Indu. | Serv. | Agr. | Indu. | Serv. |
| Imports from CHN (US$) | 0.438*** | –0.490*** | 0.052 | 0.181*** | –0.329*** | 0.147*** |
| | (0.058) | (0.058) | (0.061) | (0.030) | (0.057) | (0.046) |
| GDP per capita (t-3) | –1.751 | 0.655 | 1.096 | –14.642*** | 9.248*** | 5.394*** |
| | (1.232) | (0.956) | (0.988) | (0.873) | (1.103) | (0.677) |
| Population size (t-3) | –18.689*** | 1.680 | 17.008*** | –13.251*** | 4.443 | 8.808*** |
| | (3.748) | (2.776) | (2.660) | (1.905) | (2.830) | (1.928) |
| F-stat | 184.392 | 184.392 | 184.392 | 184.392 | 184.392 | 184.392 |
| *N* | 920 | 920 | 920 | 920 | 920 | 920 |
| $R^2$ | 0.177 | 0.004 | 0.089 | 0.564 | 0.192 | 0.019 |

Note: ***, **, * significant at the 10, 5, and 1 per cent level, respectively. Robust standard errors in parentheses. Each specification includes country and year fixed effects. All control variables are in log. Sectoral assignments were built following Herrendorf et al. (2014). *Industry* encompasses manufacturing, mining, and construction. *Services* contains the following International Standard Industrial Classification (ISIC-4) categories: utilities, trade, transport, business, finance, real estate, government, and other. The variable 'Imports from CHN (US$)' is the exposure to the China shock. It is instrumented by the 'Imports from China' in the ten closest neighbours. The controls are lagged by three years.

Source: authors' compilation.

Before going into the details of the results, let us examine the F-statistic that informs us on the quality of the instrumentation strategy. It is well above the level of 100 for any of the six estimations in Table 1, confirming that our instrument is not weak. Put differently, realized manufacturing imports from a country's neighbours explains well a country's own exposure to Chinese imports.

**Employment.** Looking at employment first, the China shock has a sizeable average impact on structural transformation in the country of our sample. We find that a 1 per cent increase in the value of manufacturing imports from China increases agricultural employment by 0.44 per cent (significant at the 1 per cent level). The same shock generates a 0.49 per cent drop in the share of workers employed in the industrial sector. We find no effect on labour allocation in the services sector, with a quite low and positive coefficient (0.05), not significantly different from zero.

This indicates that trade, as measured by exposure to manufacturing imports from China, tends to slow down structural change out of agriculture. Indeed, all things being equal, if a developing economy is more exposed to Chinese imports it will have a significantly larger share of labour force in agriculture and a lower one in industry.

Examining the effect of the set of controls included in our regressions, we see that the level of economic development, measured by the log of GDP per capita, has no significant impact on the sectoral allocation of labour. In any of the three aggregated sectors, the signs of the coefficient for GDP per capita are in line with the literature but are not significantly different from zero in our sample. We find, however, a significant impact of the size of the population. A larger population increases employment in services while it has the opposite effect on agriculture. There is no effect, however, on industrial employment. We now turn to the average effect at the baseline on the share of value-added between sectors.

**Value-added.** Looking at value-added, we find similar patterns as for employment. Overall, more exposure to manufacturing imports from China shrinks the industrial sector and expands the agricultural one. Yet, we note two important comments complementary to the results on employment.

First, the values of the coefficients are lower than for employment, indicating slightly weaker effects. Here, a 1 per cent increase in manufacturing imports from China generates a 0.3 per cent decrease in industrial value-added (significant at the 1 per cent level). While this is not the 0.49 per cent found for employment, this is still a quite sizeable effect. Second, and contrary to the results on employment, we now find that the services sector is significantly and positively impacted by international trade. When manufacturing imports from China increase by 1 per cent, the value-added of the services sector increases by about 0.15 per cent (significant at the 1 per cent level). This suggests that opening to trade causes, on average across the developing countries of our sample, a reallocation of the industrial value-added between agriculture and services. This reallocation is quite symmetric, with increases of 0.18 per cent and 0.15 per cent in agriculture and services, respectively. This is an important difference with sectoral employment, where trade actually removed workers from industry almost fully towards agriculture.

We note that the level of economic development explains part of the variation in sectoral value-added across the three broad sectors. Indeed, GDP per capita (lagged by three years) decreases the share of value-added in agriculture while it increases it in the other two aggregated sectors. The largest positive impact is to be found in industry, where a 1 per cent increase in GDP per capita leads to a 9.2 per cent increase in the share of industrial value-added. The effect of the size of population is very similar to what we found for employment, showing the importance of accounting for demographic trends.

To get a sense of how important could be the issue around endogeneity in our estimations, we further provide in Table A1 of Appendix A the estimation of Equation (1) using OLS two-way fixed effects (TWFE). The variable of interest is the actual realized imports in manufacturing products from China made by country $i$. We can see that for employment allocation, while our main result remains, the values of the coefficient are much lower. An increase in 1 per cent in Chinese imports yields a 0.17 per cent increase in agricultural employment (significant at the 10 per cent level). Conversely, the same shock leads to a 0.15 per cent decrease in the size of the industrial sector. In addition to displaying lower coefficients, the estimates are also less precise. In the case of value-added, the estimation using OLS-TWFE shows that trade has no significant impact on structural transformation. Overall, this suggests that the IV-2SLS strategy we adopt is particularly relevant.

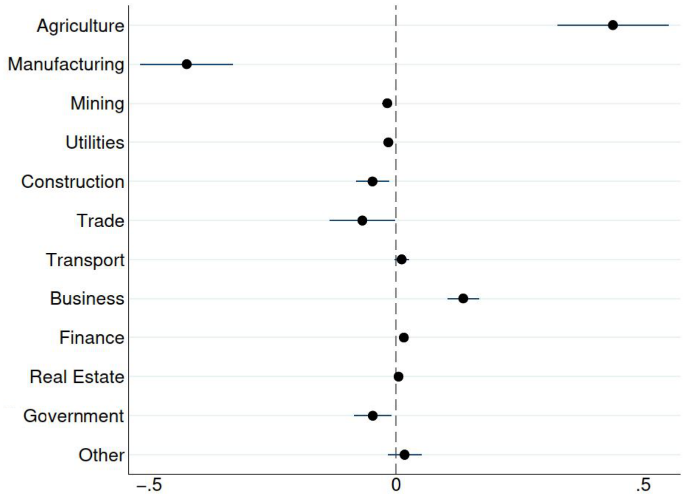
### 4.2 Sector decomposition

So far in our baseline results we have exploited a definition of structural transformation that relies on the three broad sectors of agriculture, industry, and services. We now go into further detail and exploit all the information provided by the ETD. More precisely, we run the exact same IV-2SLS estimation but for the 12 sectors of the database.

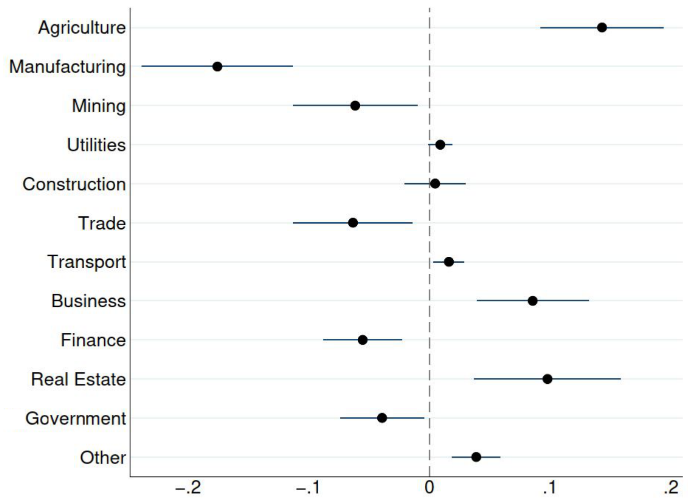
One important motivation for doing this is to shed light on what drives the contraction of the industrial sector, a critical result of Section 4.1. Since that sector encompasses the manufacturing, mining, and construction sectors, we should now see whether the results for industry are driven by one of these three in particular.

Figure 3 displays the coefficients of our variable of interest, $\omega_{ik,1990}\Lambda_{ikt}$, for both employment and value-added.

Figure 3: Decomposition of the average impact across the 12 sectors




(a) Employment




(b) Value-added

Note: this figure plots the coefficient of interest of the IV shift-share of the log of manufacturing imports from China. The dependent variables are the sectoral shares of employment (percentage of total) in panel (a) and value-added (percentage of GDP) in panel (b).

Source: authors' compilation.

The results make clear that, within the aggregated industrial sector, it is manufacturing that is largely and negatively impacted by the China shock. While the mining and construction sectors are also negatively impacted, the coefficients are not nearly as high as for manufacturing. The share of employment in the latter decreases by 0.43 per cent when manufacturing imports from China increase by 1 per cent (significant at the 1 per cent level). Regarding value-added, the negative impact is about –0.18 per cent for the same shock. For employment in mining and construction, we find a significant and negative coefficient, but very low (less than 0.1 per cent).

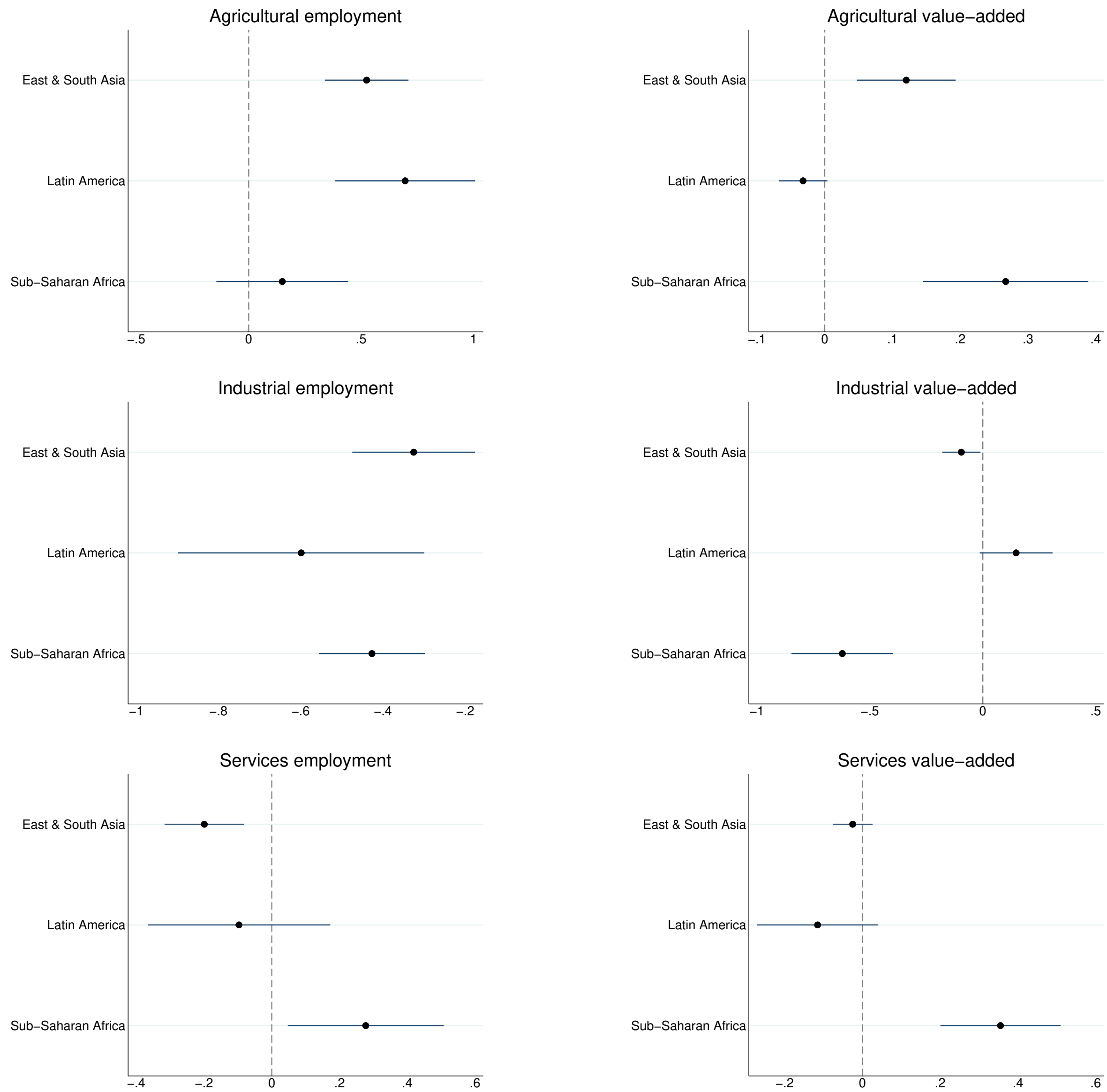
This suggests that the negative impact on industrialization that we have documented with our results from Section 4.1 is primarily driven by manufacturing. Hence, the results provide evidence of a *competition effect* where the comparative advantage of China in producing manufacturing products has a negative and significant impact on the size of the manufacturing sector in exposed developing economies.

In this section and the previous one, we uncovered the average effects of Chinese competition on structural transformation in the countries of our sample. These results may hide important differences, depending on the geographic regions that are studied. This is what we investigate in the next section.

### 4.3 Geographic heterogeneity

Here we present the results of our IV-2SLS estimation, with a shift-share setting, when we divide our sample between three main geographical regions: Asia (East and South), Latin America, and Sub-Saharan Africa. The results are presented in Figure 4 as well as in the tables reported in Appendix A2. All the regressions include country and time fixed effects.

Figure 4: Heterogeneous impacts across regions: IV-2SLS estimates of $\hat{\beta}$




Note: this figure plots the coefficient of interest of the IV shift-share of the log of manufacturing imports from China. The dependent variables are the sectoral shares of employment (percentage of total) and value-added (percentage of GDP). The corresponding tables are reported in Appendix A2.

Source: authors' compilation.

**Employment.** We start by examining how trade affects employment shares between sectors and regions. First, it is important to notice that the negative effect of the China shock on the industrial sector holds for the three regions of our sample. Figure 4 shows that the average effect we highlight in Section 4.1 is mainly driven by Latin America and to a lesser extent by Sub-Saharan Africa. In the group of countries from Latin America, a 1 per cent increase in manufacturing imports from China leads to a decrease of 0.6 per cent in industrial employment (significant at the 1 per cent level). This is a higher coefficient than our average effect of –0.49 per cent, presented in Table 1. In East and South Asia, the corresponding decrease is –0.32 per cent, while it is –0.43 per cent in Sub-Saharan Africa.

In East and South Asia, the shock also affects employment in the services sector. We find that the share of labour allocated to this sector decreases by 0.21 per cent when imports rise by 1 per cent (significant at the 1 per cent level). It reveals that in this region, the competition stemming from China slows down structural transformation out of agriculture towards both industry and services. In other words, in the absence of the rise of China as a major supplier of manufacturing goods, the size of both industrial and services sectors would have been larger in East and South Asia.

The effect on employment in services is different for Latin America and Sub-Saharan Africa. For the former, it is slightly negative but not significantly different from zero. For Sub-Saharan Africa, the effect is positive and quite large. The coefficient is significant at the 1 per cent level and its value is 0.23. It indicates that in this region competition from China has led to less employment in industry and more in services without any effect on agriculture. It implies that in Sub-Saharan Africa trade has favoured a form of structural transformation pushing employment in services and away from industry.

In Latin America, we find the largest positive effect of trade on employment in agriculture. There, a 1 per cent increase in manufacturing imports from China increases agricultural employment by almost 0.7 per cent. According to our estimates, it is a pure reallocation away from industry, with no significant effect on services. In East and South Asia, the same shock increases agricultural employment by 0.52 per cent. By causing an increase in the size of the agricultural sector (measured by employment), the China shock thus slows down the transformation out of agriculture in Latin America and Asia.

**Value-added.** We can now examine the impacts on value-added. For Asia and Sub-Saharan Africa, we find that Chinese imports generate larger shares of value-added in the primary sector. The case of Sub-Saharan Africa is more insightful. There, the negative impact of trade on industry is associated to a reallocation of value-added not only towards services but also towards agriculture. This was not the case for employment. Also, we note that the coefficients for African value-added are much higher than for any other region. Here, agricultural value-added grows by 0.27 per cent and industrial value-added drops by 0.62 per cent when imports from China rise by 1 per cent. This is five times more than what is observed in Asia or Latin America. Eventually, with an increase of 0.36 per cent in services value-added, it is clear that it is Sub-Saharan Africa that is driving the results of Table 1 on this matter.

### 4.4 Output per worker

In this section we test the hypothesis according to which the trade shock can affect sectoral productivity in developing economies importing manufacturing goods from China. This part of the analysis is complementary to the results obtained in Sections 4.1 and 4.2. Here, instead of labour and value-added shares, we study the rate of change in value-added relative to labour allocation.

To do this, we continue to exploit the information provided by the ETD and build a variable of labour productivity for each sector. Our dependent variable in this section is now the ratio of the value-added (in 2015 constant prices) in sector $k$ over employment (number of workers) in that sector at year $t$. Formally, we estimate the model described in Equation (4), and our dependent variable is the log of the following: $y_{ikt} = \text{VA}_{ikt}/\text{EMP}_{ikt}$.

The potential effect of manufacturing imports from China on the outcome $y_{ikt}$ is ambiguous. On the one hand, the trade shock can raise the value of output per worker through the supply of intermediate inputs that are not produced locally. In this case, thanks to the imported inputs, value-added, $\text{VA}_{ikt}$, in sector

$k$ increases at a faster rate than the number of workers, $\text{EMP}_{ikt}$. We call this an *input effect*. On the other hand, labour productivity, measured by $y_{ikt} = \text{VA}_{ikt}/\text{EMP}_{ikt}$, can also be negatively impacted by the shock. If workers are removed from *other* sectors $k' \neq k$ as a result of the competition imposed by China in the production of final goods in sectors $k'$, then this reallocation of labour from $k'$ to $k$ decreases $y_{ikt}$, all things being equal. This is the *competition effect* presented earlier. Our goal in this section is to empirically examine this relationship between input and competition effects.

Table 2 presents the results of our estimations for the three broad sectors of agriculture, industry, and manufacturing.

Table 2: The impact of the China shock on Labour productivity

| | Log of output per worker | | |
|---|---|---|---|
| | Agr. | Indu. | Serv. |
| Imports from CHN (US$) | –0.008*** | 0.015*** | 0.007*** |
| | (0.003) | (0.002) | (0.002) |
| GDP per capita ($t$ – 3) | 0.290*** | 1.126*** | 0.805*** |
| | (0.056) | (0.082) | (0.053) |
| Population size ($t$ – 3) | –0.455*** | –0.435** | –0.845*** |
| | (0.173) | (0.200) | (0.125) |
| F-stat | 184.392 | 184.392 | 184.392 |
| *N* | 920 | 920 | 920 |
| $R^2$ | 0.042 | 0.354 | 0.478 |

Note: ***, **, * significant at the 10, 5, and 1 per cent level, respectively. Robust standard errors in parentheses. Each specification includes country and year fixed effects. All control variables are in log. Sectoral assignments were built following Herrendorf et al. (2014). *Industry* encompasses manufacturing, mining, and construction. *Services* contain the following ISIC-4 categories: utilities, trade, transport, business, finance, real estate, government, and other. The variable 'Imports from CHN (US$)' is the exposure to the China shock. It is instrumented by 'Imports from China' in the ten closest neighbours. The controls are lagged by three years.

Source: authors' compilation.

The results of our IV-2SLS, applied to labour productivity, call for several comments. First, the F-stat is logically the same as before, and the controls are both significant and exhibit the expected signs. A larger amount of GDP per capita raises labour productivity in all three aggregated sectors of the economy. This shows that, all things being equal, more developed countries tend to reach higher levels of output per worker. The largest effect is in industry: a 10 per cent increase in the level of GDP per capita raises the value-added per worker in that sector by 11.26 per cent. The size of population has logically the opposite impact: when it increases, the output per worker in each sector decreases.

Manufacturing imports from China impact the log of output per worker differently between the three sectors. In agriculture, a higher degree of exposure to the shock is detrimental to our measure of labour productivity, while it is the opposite sign for industry and services. We note that the coefficients, despite being significant at the 1 per cent level for the three estimations, are quite low. In agriculture, for instance, a 10 per cent increase in imports from China decreases labour productivity by only 0.08 per cent.

In the industrial sector the same type of shock raises the value of output per worker by 0.15 per cent. Again this effect is very small, yet it is interesting to find a positive sign. Indeed, in all the results presented in Sections 4.1 and 4.2 we systematically found that the China shock decreases the size of the industrial sector. Here, however, we observe that it increases output per worker, suggesting a positive *input effect*.

The decomposition of the results on these three aggregated sectors into 12 separated ones is presented in Figure A1 in the Appendix. We can see that the positive effect in the industrial sector is mainly supported by manufacturing and construction. In the mining sector the coefficient is negative and non-significant. The trade shock also impacts positively on most of the service sectors. We find the largest impact in *business*, where a 1 per cent increase in exposure to the China shock causes an increase of 0.03 per cent of output per worker.

To summarize the findings of this section, we identify small effects of the China shock on the value of output per worker. In some sectors, such as industry, the shock raised our productivity index presumably through what we called an input effect. That being said, we saw in Sections 4.1 and 4.2 that the shock reduced the size of sectors such as industry, and by a large amount. We conclude that the competition effect—that is, the detrimental effect of the supply of manufacturing final goods by China—is much stronger than this input effect. In other words, importing manufacturing goods from China decreases the size of the industrial sector in developing countries by a much larger extent than it raises its labour productivity.

## 5 Conclusion

In this paper we studied how international trade affects structural transformation in developing economies. This question is important to economists and policy-makers since the reallocation of labour across sectors can have sizeable effects on poverty alleviation (Gollin et al. 2013). We measure trade by the exposure to the China shock and exploit the ETD (De Vries et al. 2021) between 1995 and 2017. To obtain plausibly causal impacts, we build an IV that is the imports of manufacturing products realized by the closest neighbours of a given country.

Several findings structure our results. First, competition from Chinese manufacturing reduces the size of the industrial sector in other developing countries. This result holds both for employment and value-added measures, but this negative effect is larger on employment. Second, this trend of deindustrialization, generated by trade, occurs along with a push-back of resources towards agriculture. Indeed, we find that agricultural employment and value-added increase as a result of the China shock, whether on average across all countries or by geographical regions. The third main result of this paper is related to Sub-Saharan Africa. In this region, manufacturing imports from China tend to cause a reallocation of labour out of industry towards the services sector, not agriculture. We do not observe the same dynamics in Asia or Latin America. Finally, we find that while the China shock can help increase the productivity of labour in some sectors, the size of the effects is very small.

Overall, our results suggest that in the absence of the rise of China over the last decades structural transformation in other developing economies would have occurred at a faster rate. By becoming the major supplier of world manufactured products, China slowed down transformations out of agriculture in other growing economies. This is of importance for growth theory as many scholars have argued that industry brings the largest long-run returns to a developing economy (e.g. Rodrik 2016). If this is to be verified, then our results at the macro-level imply that the competition from China is harmful to economic development elsewhere. For this reason, we believe that a careful assessment of the growth impacts of development dynamics without industrialization is a promising research avenue for the future.

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# Appendix

## A Supplementary results

### A1 OLS estimates

Table A1: The impact of the China shock on structural transformation: OLS estimates

| | Employment (% total) | | | Value-added (% GDP) | | |
|---|---|---|---|---|---|---|
| | Agr. | Indu. | Serv. | Agr. | Indu. | Serv. |
| Imports from CHN (US$) | 0.173* | –0.146* | –0.024 | 0.056 | –0.046 | –0.010 |
| | (0.088) | (0.082) | (0.063) | (0.043) | (0.064) | (0.038) |
| GDP per capita (*t* – 3) | –3.896 | 3.435* | 0.630 | –15.629*** | 11.514*** | 4.116*** |
| | (3.256) | (1.981) | (2.322) | (2.533) | (3.195) | (1.403) |
| Population size (*t* – 3) | –26.716*** | 12.083* | 14.694** | –18.000*** | 13.780* | 4.220 |
| | (9.285) | (6.490) | (6.491) | (4.461) | (7.046) | (4.631) |
| Constant | 517.211*** | –204.554* | –213.704* | 439.216*** | –292.310** | –46.905 |
| | (161.949) | (116.501) | (113.435) | (85.367) | (132.564) | (83.142) |
| *N* | 920 | 920 | 899 | 920 | 920 | 920 |
| $R^2$ | 0.677 | 0.267 | 0.716 | 0.741 | 0.242 | 0.510 |

Note: ***, **, * significant at the 1, 5, and 10 per cent level, respectively. Robust standard errors in parentheses. Each specification includes country and year fixed effects. All variables are in log. Sectoral assignments were built following Herrendorf et al. (2014). *Industry* encompasses manufacturing, mining, and construction. *Services* contain the following ISIC-4 categories: utilities, trade, transport, business, finance, real estate, government, and other. The variable 'Imports from CHN (US$)' is the log of realized manufacturing imports from China. The controls are lagged by three years.

Source: authors' compilation.

## A2 Results by region

Table A2: Geographic heterogeneity: East and South Asia

| | Employment (% total) | | | Value-added (% GDP) | | |
|---|---|---|---|---|---|---|
| | Agr. | Indu. | Serv. | Agr. | Indu. | Serv. |
| Imports from CHN (US$) | 0.524*** | –0.325*** | –0.213*** | 0.120*** | –0.095** | –0.025 |
| | (0.094) | (0.076) | (0.063) | (0.037) | (0.043) | (0.026) |
| GDP per capita (*t* – 3) | –5.960*** | 6.538*** | –0.735 | –17.900*** | 15.734*** | 2.165*** |
| | (1.647) | (1.158) | (0.772) | (0.994) | (1.037) | (0.578) |
| Population size (*t* – 3) | –1.928 | 11.301*** | –9.649*** | –14.121*** | 5.569 | 8.552*** |
| | (5.161) | (4.277) | (2.898) | (3.528) | (3.615) | (2.082) |
| F-stat | 151.308 | 151.308 | 132.348 | 216.141 | 216.141 | 216.141 |
| *N* | 340 | 340 | 319 | 340 | 340 | 340 |

Note: ***, **, * significant at the 1, 5, and 10 per cent level, respectively. Robust standard errors in parentheses. Each specification includes country and year fixed effects.

Source: authors' compilation.

Table A3: Geographic heterogeneity: Latin America

| | Employment (% total) | | | Value-added (% GDP) | | |
|---|---|---|---|---|---|---|
| | Agr. | Indu. | Serv. | Agr. | Indu. | Serv. |
| Imports from CHN (US$) | 0.696*** | –0.599*** | –0.097 | –0.032* | 0.147* | –0.115 |
| | (0.157) | (0.152) | (0.136) | (0.018) | (0.082) | (0.079) |
| GDP per capita (*t* – 3) | –6.571** | –2.697 | 9.268*** | –3.894*** | –3.777 | 7.672*** |
| | (2.954) | (2.710) | (1.773) | (0.587) | (2.365) | (2.174) |
| Population size (*t* – 3) | –74.807*** | –11.179 | 85.986*** | –14.749*** | 36.273*** | –21.524** |
| | (11.209) | (10.506) | (8.736) | (2.981) | (9.393) | (9.304) |
| F-stat | 26.993 | 26.993 | 26.993 | 12.649 | 12.649 | 12.649 |
| *N* | 180 | 180 | 180 | 180 | 180 | 180 |

Note: ***, **, * significant at the 1, 5, and 10 per cent level, respectively. Robust standard errors in parentheses. Each specification includes country and year fixed effects.

Source: authors' compilation.

Table A4: Geographic heterogeneity: Sub-Saharan Africa

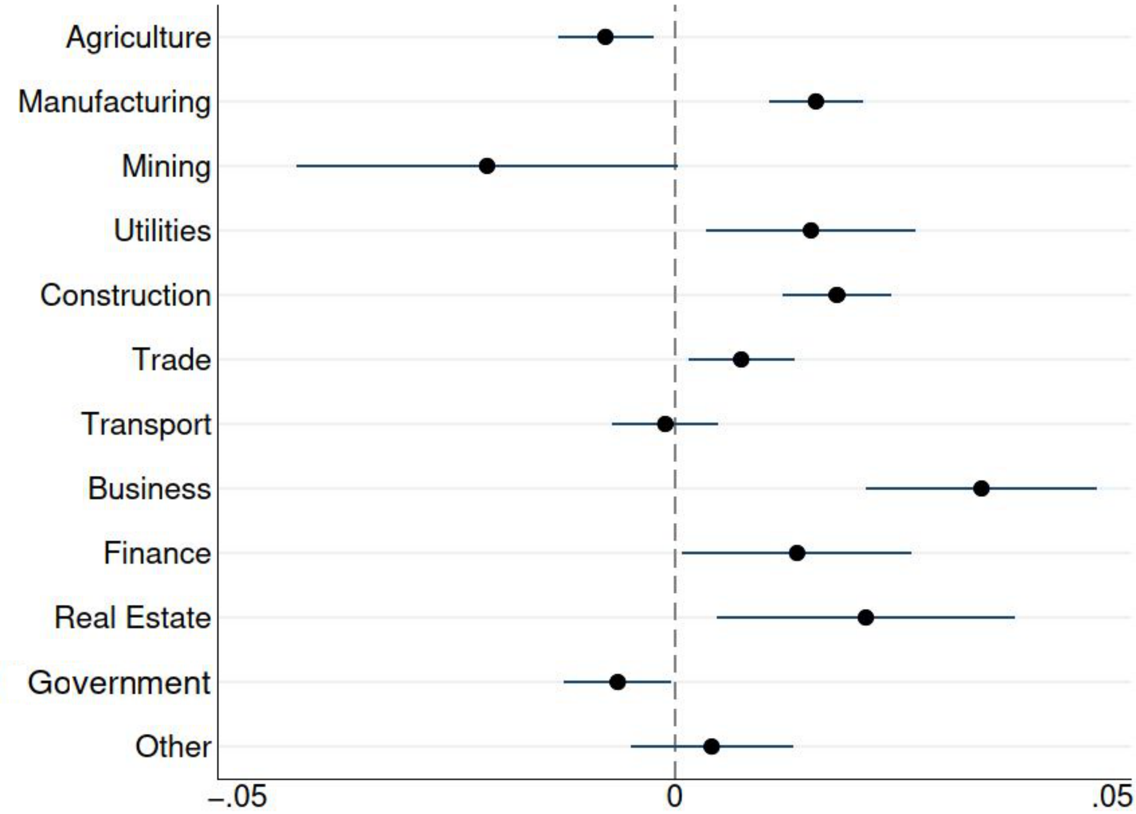
| | Employment (% total) | | | Value-added (% GDP) | | |
|---|---|---|---|---|---|---|
| | Agr. | Indu. | Serv. | Agr. | Indu. | Serv. |
| Imports from CHN (US$) | 0.149 | –0.427*** | 0.277** | 0.267*** | –0.622*** | 0.355*** |
| | (0.149) | (0.066) | (0.117) | (0.062) | (0.114) | (0.079) |
| GDP per capita (*t* – 3) | 6.566** | –7.661*** | 1.095 | –9.687*** | –4.983* | 14.669*** |
| | (2.880) | (1.248) | (2.450) | (1.687) | (2.904) | (1.970) |
| Population size (*t* – 3) | –32.458*** | 20.471*** | 11.987 | –20.628*** | 25.730*** | –5.102** |
| | (10.059) | (4.241) | (7.980) | (1.559) | (2.685) | (2.398) |
| F-stat | 230.862 | 230.862 | 230.862 | 336.939 | 336.939 | 336.939 |
| *N* | 300 | 300 | 300 | 300 | 300 | 300 |

Note: ***, **, * significant at the 1, 5, and 10 per cent level, respectively. Robust standard errors in parentheses. Each specification includes country and year fixed effects.

Source: authors' compilation.

## A3 Impacts on labour productivity

Figure A1: The impact of the China shock on labour productivity in the 12 sectors of ETD: IV-2SLS estimates of $\hat{\beta}$




Note: this figure plots the coefficient of interest of the IV shift-share of the log of manufacturing imports from China. The dependent variables are the logs of the sectoral value-added per worker.

Source: authors' compilation.