Trade and Structural Change: An Empirical Investigation

Mariarosaria Comunale
Bank of Lithuania *

Giulia Felice
Politecnico di Milano
Centro Studi Luca D'Agliano (LdA)

This version: February 2022

Abstract

This paper investigates the role of international trade in explaining the decrease of the tradable sector employment share (agriculture, mining and manufacturing). Borrowing insights from the vast theoretical literature on the determinants of structural change, we build an empirical model that allows distinguishing between long-run and short-run effects. This model is used to investigate the relative importance of the main traditional demand-side and supply-side mechanisms of structural change, assessing, in this context, the role of trade variables. To this end, we use an unbalanced panel of countries for the period 1960–2011 from the EU-KLEMS and GGDC 10-sector databases. Our results suggest that both Engelian income effects, i.e. so- called demand-side drivers, and relative productivity, i.e. the supply-side mechanism, are relevant drivers of structural change, the former, particularly, in the long-run and the latter in the short-run only. We show that international trade directly contributes to structural change: imports are negatively related with employment shifts to tradable sectors in particular in the long-run. By contrast, exports and shifts of employment towards tradables are positively associated. Trade affects structural change also indirectly by enhancing the two internaldrivers of structural change, i.e. the supply-side and the demand-side one. When trade is split in intermediate and final goods, we show that in the long-run the negative elasticity of structural change to import is drivenby imports of intermediate goods, while the positive sign of exports is driven by exports of final goods.

Keywords: Structural change, Trade, ECM
JEL codes: F62, O11, C23.

*Bank of Lithuania, Economics Department, Applied Macroeconomic Research Division, Totoriu g. 4, LT-01121, Vilnius, Lithuania. E-mail: mariarosaria.comunale@gmail.com

(Corresponding author) Politecnico di Milano, DIG, via Raffaele Lambruschini 4, Milano 20156, Italy. +390223992727. E-mail: giulia.felice@polimi.it

Declarations of interest: none. The conclusions expressed in this paper are those of the authors and do not necessarily represent the official views of the Bank of Lithuania, the ESCB, or the European Central Bank. This project started when Giulia Felice wasa visiting researcher at the Bank of Lithuania. We are indebted to two anonymous referees, Julia Woerz, Aurelijus Dabušinskas, Massimiliano Bratti, Alessandro Gobbi and the participants of the internal seminar at the Bank of Lithuania and the Dynamics, Economic Growth and International Trade (DEGIT XXIII) conference for providing insightful comments and suggestions. We also thank Lukas Mann for proofreading and the language check service of the Bank of Lithuania.

1 Introduction

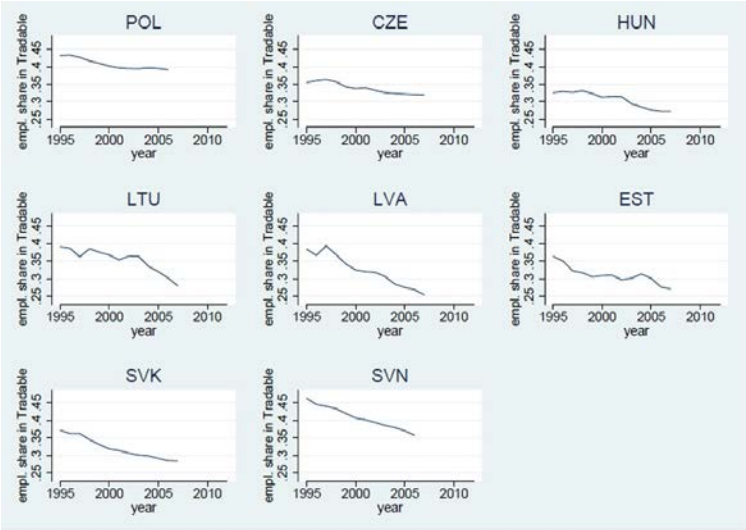
The shift in the sectoral composition of economies towards services characterises all countries along the process of development. This fact is well known and widely investigated in the literature on the determinants of structural change (Herrendorf et al., 2014). In the theoretical and empirical literature, 'Structural Change' is defined as the ever-changing sectoral composition of an economic system over time. As for the sectoral taxonomy, most of the literature refers to macro aggregates, with the taxonomy varying depending on the paper, the approach, and the focus of the analysis. When the focus is on the macro categories agriculture-manufacturing-services, if the time interval is long enough, an inverse U-shaped dynamic is observed, with the employment share of manufacturing initially increasing to the detriment of agriculture and then decreasing in favour of services. Since the second halfof the past century, we have been observing decreasing employment shares in the tradable sectors of the economy(i.e. agriculture, manufacturing, and mining) in countries at a different stage of development, namely mature economies, transition and developing countries (see Figures 1, 2, 3).

In this paper, because of the time frame and the sample of countries we rely on, we focus on tradable vs non-tradable sectors (see Section 3.1).

Figure 1: Employment share in tradable sectors in developed economies

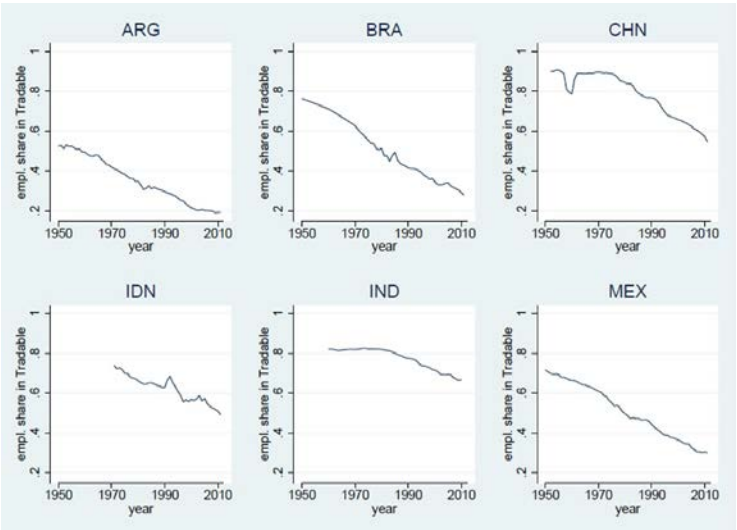
Note: Our elaborations on the GGDC 10-Sector Database and EUKLEMS Database. Tradable sectors include agriculture, manufacturing and mining, while non-tradable ones include the rest of the economy.

Figure 2: Employment share in tradable sectors in transition economies



Note: Our elaborations on the GGDC 10-Sector Database and EUKLEMS Database. Tradable sectors include agriculture, manufacturing and mining, while non-tradable ones include the rest of the economy.

Figure 3: Employment share in tradable sectors in developing economies



Note: Our elaborations on the GGDC 10-Sector Database and EUKLEMS Database. Tradable sectors include agriculture, manufacturing and mining, while non-tradable ones include the rest of the economy.

A second well-known fact characterizing recent decades is the increase in international trade, both in final and—more recently, due to the international fragmentation of production—in intermediate goods (Baldwin and

Lopez-Gonzalez, 2015). As reported by Kehoe et al. (2017), there is ample historical evidence on the relationship between the sectoral reallocation of resources and trade balance dynamics, such as the evidence related to Spain joining the EU in 1986 or Baltic countries' liberalization of capital markets in 1990, both involving a deterioration of the trade balance and a decrease in the share of good-producing sectors. More recently, Baldwin and Lopez-Gonzalez (2015) and Baldwin and Okubo (2019) highlighted the potential role of Global Value Chains (GVCs) in explaining differences in the patterns of countries' de-industrialization, while Autor et al. (2013) pointed out the role of trade in the de-industrialization path in the United States (US).

This paper makes an attempt to empirically investigate the role of international trade as a driver of structural change, particularly focusing on the transition to non-tradable sectors. The theoretical literature on determinants of structural change is mainly developed in a closed economy framework, with some relevant exceptions that are examined in Section 2.2. Demand-side and supply-side engines of structural change are usually highlighted in this literature as jointly affecting the dynamics of sectoral composition. As for the former, the literature refers to Engelian effects on demand, the service sector being the income-elastic one. The supply-side mechanism, or Baumol's effect, works instead through sector-specific productivity growth and low substitutability in either final or intermediate demand, where the service sector is typically the sector with lower productivity growth. In this framework, there are several channels via which a relationship between structural change and international trade flows might emerge, namely, a direct channel where foreign demand adds a new component to the domestic demand-side and supply-side factors (Matsuyama, 2009), and two indirect channels that work through the two main domestic engines of structural change: trade affects GDP per capita and relative productivity, this way activating the two internal demand-side and supply-side mechanisms (Matsuyama, 2019; Uy et al., 2015). Despite the common feature of a decreasing employment share in the tradable sectors, the speed and timing characterizingthese changes varies substantially from country to country. This casts doubt on the conjecture that convergence patterns of sectoral composition are identical across countries. Countries' asymmetries in structural change have recently been highlighted, such as differences in the speed of structural change between Korea and the US (Teigner,2017), the faster de-industrialization process in lower-income countries with respect to mature economies (and theAsian exception; Rodrick, 2016), and the slower decrease in the manufacturing employment share in countries belonging to clusters participating in GVCs (Baldwin and Lopez-Gonzalez, 2015).

Exploring the role of international trade flows in structural change is therefore relevant along two different dimensions. On the one hand, international trade might be a channel of structural change contributing to the common transition path we mentioned above. On the other hand, it might help explain differences across countries in the speed and timing of structural change since countries are asymmetric in their trade relationships but may not be so in the dynamics of preferences and technology. Focusing on trade could explain some of the puzzles mentioned above.

The sectoral composition of an economy and its dynamics are relevant factors affecting income levels and growth rates (Moro, 2015; Leon-Ledesma and Moro, 2020)—both along the transition path and in the long-run — together with employment levels and dynamics since structural change entails a reallocation of resources across sectors requiring different skills and education levels (Cravino and Sotelo, 2019). This implies that trade policies should also be considered in light of their potential role in asymmetrically affecting long-run growth and employment composition across countries through structural change. Therefore, a deeper understanding of the channels through which trade affects structural change, i.e. in which direction and to what extent, is key.

Our work contributes to the fast-growing literature on the determinants of structural change mentioned above.

There are only a few contributions in this literature that include trade as a potential determinant of structural change. These contributions, which we survey in the next Section, develop alternative theoretical frameworks in which trade can both directly and indirectly, through domestic channels and intersectoral linkages, affect an economy's sectoral composition and its dynamics. Results of the counterfactual exercises aiming at quantifying the relative weight of the different drivers of structural change are quite heterogeneous. For instance, Swieki (2017) and Kehoe et al. (2017) find that sectoral differences in productivity and not income effects are the main drivers, differently, for instance, from Uy et al. (2015), for which the main driver varies with the sector, or Comin et al. (2021), for which income effects prevail on sectoral substitution driven by unbalanced productivity. Trade emerges as a driver of structural change and, in general, it is less relevant than domestic channels, but with very different impacts across scholars' contributions. Not surprisingly, in the light of the theory, what clearly emerges is that Baumol's and Engel's effects are quite homogeneous across countries, at least in the sign if not in the magnitude of the effect, while instead countries are asymmetrically positioned when the relationship between trade and structural change is considered (Swieki, 2017; Sposi, 2018). These results are obtained by calibrating theoretical models and then conducting counterfactual exercises on either a single country (e.g. Uy et al. 2015) or several countries (e.g. Swieki, 2017; Cravino and Sotelo, 2019; Sposi, 2019) to quantitatively assess the weight of the different determinants of structural change. This approach has the big advantage of being theory driven, this way the analysis is able to single out and quantify the very specific channel under investigation. But there are also some limitations to be considered. Results are often dependent on the model assumptions, on the specific channel highlighted by the contribution and on the calibration strategy, i.e. methodology and countries considered to calibrate the model parameters. The counterfactual analyses, except in a few cases where the average effects are considered (Swieki, 2017; Cravino and Sotelo, 2019; Sposi, 2019), give a 'country specific perspective', from which it is sometimes difficult to draw general conclusions. In the light of these considerations, we think that taking a different methodological approach could complement these analyses and contribute to throw light on the forces driving structural change and, in particular, on the role of trade. We take here a purely empirical approach, testing the implications of existing models on a panel of countries instead of quantifying the contribution of the main determinants of structural change by calibrating a new theoretical model. By using a reduced form approach we remain agnostic on the preferences' structure and the technology. We consider separately exports and imports instead of net exports, as done in most of the above mentioned contributions, not to impose constraints on their role.[1] We consider a dynamic panel framework which allows us to simultaneously capture the intrinsic nature of structural change as a dynamic process and to take into account countries' heterogeneity. The dynamic panel setup, also allows us to distinguish between long-run and short-run effects, to investigate the relative importance of trade variables, controlling for the main traditional demand-side and supply-side mechanisms of structural change. This is done by using an Error Correction Model (ECM) framework. By looking at the coefficients in the long-run in the ECM, we can better capture the dynamics in the long-run as they are calculated taking into account (and correcting for) the short-run and the error correction term as speed of adjustment.[2] We also make an attempt to distinguish between direct and indirect channels through which trade potentially impacts structural change (through a panel Vector Autoregression analysis). EU-KLEMS data and the GGDC 10-Sector Database for the period of 1960–2011 for a panel of mature, developing, and transition economies, are used in the empirical analysis.

Our results confirm the role of Engelian effects on demand and differences in relative productivity growth, i.e.

[1]Indeed, the test rejects the null hypothesis that the sum of the export and import coefficients is equal to zero.

[2]This is also in the spirit of Fiorentini et al. (2018), among others, which use long-run coefficients from error corrections for the analysis of long-run equilibria as natural rates.

the so-called Baumol effect, in driving the shift towards services. In particular, Engelian effects are at work in the long run and are robust to the inclusion of relative productivity and trade variables. On the other hand, relative productivity is as a driver of structural change in the short-run, while no effect emerges in the long-run.

The elasticities of structural change to trade variables are similar across countries: exports and imports are positively and negatively associated with the shift to tradable sectors, respectively. The potential de-industrialization effect of trade therefore depends on the, country-specific, relative size of exports and imports and its dynamics. Moreover, the role of trade in driving structural change in the long-run is not less relevant than that of domestic income effects. From our explorations, an indirect effect of trade on structural change via relative productivity emerges. We also provide some insights on the differences between trade in final and intermediate goods. We show that exports of final goods are positively associated to the shift to tradable sectors while the elasticity of structural change to imports of intermediate goods is negative.

On the one hand, our findings generally confirm some previous results obtained using different approaches. On the other hand, we provide new insights on the relative role of the determinants of structural change in the short-run and in the long-run and on the role of trade, highlighting the relevance of asymmetries between countries.In general, we show that distinguishing between the short-run and long-run is important since the magnitude ofthe coefficients, and in some cases the signs, are different. Reallocation of resources across sectors takes time, and our analysis suggests that this dimension must be taken into account when assessing the determinants of sectoral dynamics.

The structure of the paper is as follows. Section 2 reviews the literature, illustrating the main channels through which trade and structural change are related. Section 3 describes our data and methodology. Sections 4 presents our empirical estimates of the relationship between trade and structural change and the main results, while Section 5 provides some robustness checks, and Section 6 some further investigations. Section 7 offers some concluding remarks.

2 Main drivers of structural change in the recent literature

In this section, we briefly review the main drivers of structural change, i.e. the dynamics of the sectoral composition of an economy, as highlighted by the recent literature (for exhaustive reviews, see Herrendorf et al., 2013 and van Neuss, 2019). Our main aim is to single out the channels via which the relationship between trade and structural change may develop. We are particularly interested in the contributions focusing on the transition to services or non-tradable sectors in modern economies.

2.1 Drivers of structural change in a closed economy framework

Most of the contributions on the determinants of structural change are developed in a closed economy framework. There are two main mechanisms highlighted, generally referred to as the *demand-side* and *supply-side* explanations of structural change.

The *demand-side* explanation points out the role of Engelian effects on final demand, i.e. non-homothetic or quasi-homothetic preferences, where agricultural goods are income-inelastic, manufacturing goods exhibit either unitary or less-than-unitary income elasticities depending on the stage of development and on the exact sectoral split adopted, and services are typically income-elastic (Echevarria, 1997; Kongsamut et al., 2001; Bonatti and Felice, 2008; Foellmi and Zweimuller, 2008; Herrendorf et al., 2013; Alonso-Carrera and Raurich, 2015, 2018;

Alonso-Carrera et al., 2018). This means that independently of potential sectoral heterogeneity in technology level and dynamics, the consumption share and the employment share shift to the service sector as income grows.

The *supply-side* mechanism works under the assumption of sectoral heterogeneity in technology levels and/or technological progress and/or factor intensities; this intrinsic industry characteristic, coupled with low substitutability between goods in either final demand (Ngai and Pissarides, 2007; Moro, 2012; Herrendorf et al., 2015) or intermediate demand (Acemoglu and Guerrieri, 2008; Alvarez-Cuadrado, et al. 2017) generates structural change. In particular, since agriculture and manufacturing are generally assumed to be capital-intensive and to exhibit higher rates of technological progress in emerging and mature economies, in these countries the employment share shifts to services if goods and services are low substitutes.

The most recent contributions jointly consider these two mechanisms in the same framework in order to quantitatively assess their relative weights (Boppart, 2015; Comin et al., 2021) by using, in particular, a preference system allowing for the disentangling of income effects from substitution effects in demand.[3] Both demand-side and supply-side engines are shown to be active. Boppart (2015), by calibrating his model on data for the US economy and conducting counterfactual simulations, shows that Engelian effects prevail at lower income levels while price substitutability gains importance as income grows. This result implies that Engelian effects are likely to be relevant in explaining the transition from agriculture to manufacturing sectors, while the shift from manufacturing to services is more driven by productivity differences. Comin et al. (2021), by contrast, find that income effects play a major role in accounting for the structural transformation during the postwar period in a large sample of countries at different stages of development.

As mentioned above, these contributions do not consider the potential role of countries' asymmetries in terms of trade specialisation for structural change.

2.2 Structural change in an open economy framework: the role of trade

In an open economy framework, the dynamics of the sectoral composition of the economy is driven not only by domestic demand and supply forces, as listed in the previous section, but also by foreign demand and its determinants (Matsuyama, 2000, 2009). Matsuyama (2019) provides a unified theoretical framework to study how income effects in demand, innovation, and trade are interconnected in generating structural change. As for the link between trade and structural change, direct and indirect effects are observed (Uy et al., 2015; Matsuyama, 2019).

Direct channel (or net export channel): trade affects structural change through foreign demand (trade specialisation). Going from autarky to trade could generate asymmetries between countries in terms of foreign demand due to trade specialisation according to comparative advantage.

The effect of this direct channel on structural change can be asymmetric across countries, depending on the source of the comparative advantage, i.e. the driver of the specialisation pattern. Countries that are relatively more productive in the manufacturing sectors (or more generally in the tradable sectors) will be net exporters in those sectors. For these countries, trade will slow down the domestic price-elasticity mechanism driving structural change, i.e. a shrinking of the tradable high-productivity sectors. Indeed, if domestic demand does not increase enough due to low substitutability in consumption, the increase in foreign demand may at least partially compensate forit. In this case, trade would work in the opposite direction to the domestic mechanism. On the other hand, if

[3]Other contributions focus on the role of labour market frictions (Lee and Wolpin, 2006), home production as a substitute for service goods (Buera and Kaboski, 2009, 2012; Bonatti and Felice, 2010), or the role of public expenditure composition for manufacturing and services (Felice, 2016).

countries differ in their per capita income levels, higher-income countries are likely to specialise in income-elastic sectors.[4] In this case, trade specialisation will imply an even larger shrinking of the tradable sector in high-income countries, working in the same direction as the internal mechanisms.

Indirect channel (I): enhancing the internal mechanism working through income effects on demand. Trade reduces average prices, either through trade specialisation, i.e. classical gains from trade, or through trade-induced productivity gains, therefore increasing the real GDP per capita which, in turn, will feed back to structural change through the Engelian effects on demand mentioned in Section 2.1.

Indirect channel (II): enhancing the internal mechanism working through productivity differences. Going from autarky to trade increases differences in relative prices across sectors. This can occur as a pure consequence of trade specialisation, according to either the Ricardian or Hecksher–Ohlin theory of comparative advantage. Alternatively, the changes in relative prices may depend on trade affecting relative productivity by increasing the market size and therefore the incentives for innovation in tradable goods (Schmookler, 1966; Matsuyama, 2019) and by increasing the number of varieties available as differentiated inputs in production (Krugman, 1980). This 'classical' effect through which trade works like technological progress is likely to affect sectors producing final tradable goods, where an initial comparative advantage is strengthened through trade, or sectors using relatively more intensively tradable intermediate inputs.

This effect of trade on productivity differentials across sectors then feeds back into structural change through the price elasticity channel, in particular, shifting resources to non-tradable sectors.

It is worth underlining how these mechanisms work in a two-sector framework of tradable versus non-tradable goods. All three channels will be at work for the tradable goods, while for the non-tradable sector, only the two indirect channels will potentially be active (Uy et al., 2015). Therefore, employment in non-tradable goods depends on domestic consumption shares only, these possibly being affected by trade through the two indirect channels listed above, which work by enhancing the demand-side and supply-side domestic mechanisms. The employment share in tradable goods depends on both foreign and domestic demand, where again, the latter is possibly affectedby trade through the two indirect channels. Table A1, in the Appendix, summarises the main drivers of structural change between tradable and non-tradable goods in closed and open economies.

There are only a few contributions in the structural change literature that consider structural change in an open economy framework and assess its role quantitatively. Uy et al. (2015) provide a two-country general equilibrium model with three sectors—agriculture, manufacturing (tradable goods) and services (non-tradable). Featuring non-homothetic preferences, an elasticity of substitution across sectors less than one, asymmetric and growing Total Factor Productivity (TFP) shocks overtime, changing trade costs over time, their model shows that in the short-run, the direct effect of net exports may prevail, increasing the employment share in the tradable sector. In the long-run, the non-tradable sector may exhibit an increase in employment shares when the indirect channels start working as contrasting forces: 1) TFP growth increases faster in the tradable sectors, activating the domestic supply channels (and therefore shifting employment to services); 2) income grows, activating the domestic demand-side channel (since services are income-elastic) again shifting employment to services. Over the entire period, the effects of trade are mainly explained by the indirect channels. They calibrate their two-country model on South

[4]This can be induced by several channels documented in the trade literature. Higher-income countries are more abundant in the factor used more intensively in income-elastic goods, which leads them to specialise in these goods according to a factor proportiontrade model (Caron et al., 2014). Higher-income countries may exhibit higher technologies/capabilities in income-elastic goods and therefore specialise in these goods in a Ricardian approach to trade (Matsuyama, 2009; Fieler, 2011). Specialisation in income-elastic goods could also be driven by the joint work of the Engelian effect on demand and a home market effect (Linder, 1961; Matsuyama, 2019).

Korea as one country and the rest of the world as the other country, built in order to include most of Korea's trade partners. They quantify the relative importance of two shocks, i.e. on trade costs and productivity, and the relative importance of openness and non-homothetic preferences in South Korea's structural change in the period of 1971–2005. They show that in general, trade works as a relevant transmission channel allowing the open economy model to fit the data better than the closed economy one. Income effects, i.e. non-homothetic preferences, nevertheless turn out to be more relevant than trade in improving the model fit. Productivity shocks affect structural change similarly in all sectors, while trade shocks are relevant in particular, for agriculture and manufacturing and income effects for services and agriculture.[5] Similarly, Teigner (2017) introduces Ricardian trade specialisation in a general equilibrium neoclassical growth model with two sectors (agricultural and non-agricultural sector). He shows that international trade explains a large part of the transition out of an agriculture-driven economy for Great Britain in the 19th century and explains the positive, but relatively smaller role, for South Korea in the period 1963-2015. Swieki (2017) quantitatively assesses in a unified framework the main forces driving structural change. He incorporates Ricardian trade specialisation, following Eaton and Kortum (2002), in a general equilibrium model of structural change where agriculture and manufacturing are among the tradable sectors and services are classified in the non-tradable one. He also allows for sectoral and aggregate trade imbalances. He calibrates the model by using cross-sectional and time-series data for a large number of countries. By conducting counterfactual simulations for all countries, he shows that sector-biased technological change is the most relevant mechanism driving structural change in particular, but not only, at later development stages. By contrast income effectsseem to be, in general, a less relevant engine, mainly active in shifting employment out of agriculture at earlier development stages. Trade and labour market frictions are important in labour reallocation over time for single countries only, and their effect is less systematic. There are two other relevant contributions that introduce trade relationships in a structural change framework, but focusing in particular on the role of intersectoral linkages. Sposi (2019) focuses on cross-country/cross-sectoral differences in the intensity of intermediate inputs. He documents that in the agricultural sector, rich countries use intermediate goods more intensively than poor countries andthat rich countries use services as intermediate goods more intensively than poor countries do, in particular in the service sector itself. Sectoral linkages matter for structural changes since they result in 1) asymmetric responsesof sectoral composition to identical changes in the composition of the final demand; 2) asymmetric responses of relative prices and comparative advantage to identical changes in productivity. He incorporates country-specific sectoral linkages into a multicountry, open economy general equilibrium model of structural change where income and price elasticities contribute to driving structural change. He uses time series data for 34 countries in theperiod 1995-2011 to calibrate common parameters, i.e. preferences and trade elasticities, and country-specific data in 2011 to calibrate country-specific parameters. He quantitatively assesses the weights of different engines ofstructural change by the use of counterfactual analysis on 41 countries. In his results, international trade plays a role in structural change, but this is less relevant than the differences in the intersectoral linkages across countries. The author himself underlines that by equalizing productivity growth across countries he limits the scope for comparative advantage to affect trade. Starting from the stylised fact that employment share in manufacturinghas been falling in both net exporters and net importers of manufacturing goods, Cravino and Sotelo (2019) highlight the role of the indirect channel in linking trade and structural change through productivity differences

[5]Recently, Sposi et al. (2018) extend Uy et al. (2015) by including other mechanisms driving structural change such as intersectoral linkages and allowing for trade imbalances. They calibrate the model on 28 countries in the period 1970-2011 and quantify the different engines of structural change by conducting counterfactual simulations for three middle-income countries, namely Hungary, South Korea and Portugal. They show trade to be a relevant determinant of structural change for these three countries but in a highly heterogeneous way, depending also on the time interval.

and investigate how trade contributes to reducing the relative size of the manufacturing sector and increasing the skill premium. They calibrate the model on US data and on time series data for 26 countries for intersectoral linkages and sectoral factor intensities. Their counterfactual simulations, country by country, show that trade enhances productivity growth in manufacturing sectors relatively more than in services, thus shifting employment into the service sectors in the presence of low substitutability across goods and services. They show that trade plays a substantial role in explaining the decrease in manufacturing employment, highlighting the role of intersectoral linkages in quantitatively accounting for the trade effect.

Kehoe et al. (2017) develop a three-sector model where intermediate and final goods (and services) are assumed to be tradable, while only the construction sector is taken as non-tradable. The preferences are non-homothetic and TFP growth is sector-specific. By calibrating their model on US data for the period of 1992–2012, the authors show that faster productivity growth in the goods sector is the main reason for the long-run shift to services and construction, while the saving glut affecting the trade balance is relevant but only temporarily.

Lastly, some recent contributions focus on the role of trade in investigating the so called 'premature de-industrialization' issue, i.e. the fact that some developing countries reach the peak of share of employmentin manufacturing at a lower level than now developed economies. Premature de-industrialization can also be considered from the point of view of the technological 'leapfrogging', according to which less-developed countries could skip intermediate stages in technological progress, typically thanks to the characteristics of the Information and Communication Technologies (ICTs) revolution and the involvement in international trade relationships, in particular, GVCs relationships. This could lead to a structural change path such that countries from being mainly agricultural economies become providers of international services, in an optimistic vein, taking advantage of the backwardness, or experiencing new forms of old diseases like terms-of-trade deterioration, structural dependency and technological domination (Lee, 2019; Schlogl and Sumner, 2020; Schlogl, 2020). Rodrick (2016) investigates the different path of structural change in both advanced and developing countries. By conducting fixed effects estimations on several groups of countries, he suggests that the structural change path in the now developed countries has been mainly driven by different rates of productivity growth between manufacturing and services, while he speculates that in (non-Asian) developing and low-income countries, the main engine of structural change has been trade specialisation. This asymmetry explains the different timing of structural change and the pre- mature de-industrialization in the latter. His analysis does not allow to distinguish between direct and indirect mechanisms through which trade may affect structural change nor he quantifies the different determinants. In particular, the role of income effects in demand is not conceptually included among the determinants of structural change. Similarly, Coricelli and Ravasan (2017), test the implications of a model with homothetic preferences and unbalanced productivity growth between manufacturing, assumed to be tradable goods, and services, the non- tradable sector. They show that trade plays a relevant role in explaining de-industrialization in OECD countriesin the period 1990-2007, by exploiting exposure to import from China to identify the role of trade in driving structural change, in the spirit of Autor et al. (2013).

We take here a reduced-form empirical approach to estimate the role of trade in structural change. In comparison with most of the extant literature, this allows us to remain agnostic as to the structure of preferences, technology, inter-sectoral and international linkages. At the same time, this framework allows us to investigate the 'average' relationship between trade and structural change in a sample including several countries, taking into account country heterogeneity and trade in intermediate versus final goods, using panel data. We think that this approach could complement well the theory-driven papers surveyed above, which in spite of giving more precise

insights into the mechanisms, are based on stronger (theoretical) assumptions.

Compared to the few contributions taking an empirical approach, we use a dynamic panel setup, suitable to investigate a process that is dynamic in its very nature. The ECM used here enables us to distinguish between short-run and long-run dynamics, something particularly relevant in the analysis of a long-run phenomena such as structural change. The analysis conducted by applying panel Vector AutoRegression (VAR) is useful to investigate the indirect channels through which trade may affect structural change, namely relative productivity and income.

3 Trade and structural change in the short-run and in the long-run

3.1 Description of the data and variables, taxonomy, and samples

In the structural change literature, in many cases, a sectoral taxonomy splitting the economy in agriculture-manufacturing-services is employed (e.g. Kongsamut et al., 2001; Herrendorf et al., 2013; Uy et al., 2015; Swieki, 2017; Sposi, 2019; Comin et al., 2021). But there are also many contributions using alternative aggregates. In this paper, we distinguish between tradable and non-tradable sectors, following the classification of Valentinyi and Herrendorf (2008), Buera and Kabosky (2011), Alonso-Carrera et al. (2018) and, under different labelling, that of Cravino and Sotelo (2019). We split the economy into two macro sectors: 1) non-tradable goods (NT), which consist of services, construction, and public utilities, i.e. electricity, gas and water supply, and 2) tradable goods (T), comprising the rest of the economy, i.e. agriculture, mining and manufacturing.

Our dependent variable is the relative employment (number of persons employed) share of tradable over non-tradable sectors. We make use of two main data sources to construct the relative employment share, namely, the GGDC 10-Sector Database (Timmer et al., 2015) and the EU-KLEMS database (November 2009 release, Timmer et al., 2010).[6] Our explanatory variables are the relative labour productivity, the GDP per capita and the trade variables. The relative labour productivity is the ratio of the labour productivity in the tradable sector over the labour productivity in the non-tradable sector. Labour productivity is computed as the ratio of value added at constant prices (2005) and employment in tradable and non-tradable sectors. We retrieve data on value added at constant prices from the GGDC 10-Sector Database (Timmer et al., 2015) and the EU-KLEMS database (2019 release, Stehrer et al., 2019).[7] We use Penn tables for the real GDP per capita (PWT 9.0, Feenstra et. al., 2015), while trade variables are obtained from the World Development Indicators (World Bank). Our trade variables are merchandise exports and imports as percentage of GDP.[8] In a robustness check we introduce a different control variable which is the ratio of merchandise trade (export plus imports) over services trade.[9] We exclude low-income countries from the sample since we are interested in the transition to services in economies where agriculture is a modern sector characterised by high productivity growth. This means that the empirical specification thatwe employ and the sectoral taxonomy that we use are borrowed from the literature analysing structural changein economies that have already undergone a take-off phase out of a poverty trap. We think that lower-income

[6]We use the GGDC 10-Sector Database (1947-2012) for non-EU countries and eight EU countries, namely Germany, Denmark, Spain, France, United Kingdom, Italy, Netherlands, Sweden; we integrate it with the EU-KLEMS database (1970-2007) for the rest of EU countries not included in 10-Sector data.

[7]We use the GGDC 10-Sector Database (1947-2012) for non-EU countries and eight EU countries (see previous footnote); we integrate it with the EU-KLEMS database (1995-2017) for the rest of EU countries not included in 10-Sector data.

[8]In World Bank data, merchandise exports/imports are defined as the f.o.b. value of goods provided to the rest of the world valued in current US dollars. The source is the World Trade Organization.

[9]In World Bank data services refer to economic output of intangible commodities that may be produced, transferred, and consumed at the same time. Data are in current US dollars from the International Monetary Fund, Balance of Payments Statistics Yearbook and data files, and from World Bank and OECD GDP estimates.

countries, and particularly African countries, would require a different framework. It would be misleading to pool them with countries in a development stage that is too different and in which goods and services are produced with completely different technologies. We also drop countries—mainly from Latin America—that do not report data for employment in the public sector, which is part of our non-tradable sector. We end up with an unbalanced panel of 38 countries for the period of 1960–2011 for the larger sample, when we do not control for the relative productivity, and with a slightly smaller sample of countries when we control for relative productivity (see Section A.2, for the list of countries). The time-interval varies significantly across country groups. Information for Eastern and Baltic countries are available mainly for the period 1995-2007. Information for some mature economies startin 1970, or later in some cases.[10] In the smaller sample, when controlling for relative productivity information forall the EU countries not included in GGDC-10 Sector Database are available starting in 1995 only, since we relyon EU-KLEMS (2019) data.[11]

3.2 Empirical strategy

Our empirical strategy consists of different econometric specifications. In all of them, the dependent variable, i.e. the proxy of structural change, is the relative employment share (tradable sector over non-tradable sector). In a baseline model where we consider Engelian effects (i.e. the demand-side) as a potential driver of structural change—proxied by real GDP per capita[12]—we introduce export and import shares in GDP, first separately and then jointly to avoid omitted variable issues. This is shown in Table 1.

As a second step, we consider an alternative baseline model where we also include relative productivity, proxied by the ratio of labour productivity in tradable sectors over non-tradable sectors, to capture the second main driver of structural change, i.e. the supply-side channel. Since we have to use GGDC 10-Sector data only, we rely on the second sub-sample of countries mentioned in Section 3.1. For comparison with the results in Table 1, we show the results in the new sample for the baseline model.

We then do some further analysis in order to explore different aspects potentially behind the average relationship emerging in the main analysis, by considering countries' heterogeneity and decomposing trade in intermediate goods versus final goods, and we make an attempt to investigate also the potential indirect channels through which trade might affect structural change, mentioned in Section 2.2. We therefore explore potential heterogeneous effects by interacting the trade variables with three country groups, i.e. mature, transition, and developing countries (see Section A.2 for the list of countries and their classification), where the reference group is that of mature economies in all specifications. The role of intermediate goods versus final goods trade is investigated by relying on World Input-Output Tables from World Input–Output Database (see Section 6.2 for a description of the new sample). In the main analysis and the above mentioned extensions we employ panel Error Correction Models (ECMs). By employing ECMs and controlling for proxies of the two main demand and supply channels of structural change, the coefficients of our trade variables capture mainly the direct effects of trade on structural change. Indeed, in order to explore the functioning of the potential indirect channels mentioned in Section 2.2, we turn to a different methodology by applying panel VAR techniques (explained in detail in Section 6.3). In this case, we deal with export and import shares and with the other main engines of structural change, i.e. GDP per capita and relative labour productivity.

[10]Data are available starting in 1970 for some mature countries (Australia, Austria, Germany, Finland, Greece, Ireland, Malta, Portugal), in 1975 (Cyprus), in 1966 (Denmark), 1999 (Belgium and Luxembourg).

[11]That is to say, all Eastern and Baltic countries, Austria, Belgium, Cyprus, Greece, Ireland, Luxembourg, Portugal.

[12]We will refer to GDP per capita also as 'income per capita'.

3.3 Methodology

We analyse the impact of the main determinants of structural change by making use of a dynamic panel setup. Our first baseline framework follows the structure of an Autoregressive Distributed Lag (ARDL) model.

3.3.1 Pre-estimation tests

First, we need to perform some regular tests in order to apply the best possible estimator and the correct setup given our dataset. We test for cross-sectional dependence (CSD), non-stationarity, and cointegration.[13] We start applying the test of Pesaran (2004) for cross-sectional independence, which is strongly rejected for every specification.[14] Therefore, in order to properly test for the presence of unit roots, we use a second-generation panel unit root test by Pesaran (2003) that is designed for this specific situation.[15] The null hypothesis assumesthat all series are non-stationary. In our panel, indeed, the null of non-stationarity is accepted for most of the series(including the dependent variable). For cointegration, we apply an error-correction-based panel cointegration test, i.e. the Westerlund (2007) and also, as a further check, the one in Pedroni (1999, 2004). Westerlund (2007) method works in case of panel data with cross-sectional dependence. The null of no cointegration by using either Westerlund (2007) or Pedroni (1999, 2004) test is rejected at the 5% significance level.

3.3.2 Econometric framework: the Error Correction Model

With this in mind, we reparametrised our ARDL model. Indeed, in a panel regression model with lagged endogenous variables, the fixed effects (FE hereafter) estimator has been proven to be inconsistent for finite T (Nickell, 1981). The bias in the dynamic FE estimator is almost negligible only in the case of a large enough T (Roodman, 2006). T could not always be large enough in our case, mostly due to the annual frequency and unbalanced number of time observations in some specifications (see Section 3.1). Furthermore, we may also have a problem of endogeneity between the dependent variable and its lag and among explanatory variables (such as between GDP per capita, labour productivity, and trade variables). The solution to this issue is usually found in IV-GMM estimators. However, the moment conditions of the GMM estimators are only valid if there is no serial correlation in the idiosyncratic errors (i.e. no CSD) and the slope coefficients are invariant across individuals (i.e. homogeneous coefficients). In addition, IV-GMM cannot disentangle the effects in the short and long-run, which is one of the main novelties of our contribution, and it is not designed for cointegrated series.

One possible way to deal with these issues is to reparametrise our ARDL setup (equation 1) into a panel ECM, as shown in equation (2). We keep a limited number of lags (with a maximum of 2), having data in annual frequency. The number of lags was selected based on Schwarz's Bayesian information criterion (SBIC). This method has been proven to provide more accurate results also in case of small samples for VARs and Vector ECMs (Ivanov and Kilian, 2005). We implemented this criterion country by country for the largest dataset and the highest number of regressors. Only for a few countries would the SBIC criterion have chosen 2 lags. Hence,in our setup, we applied only one lag for the overall panel to keep a higher degree of freedom.

Recalling an ARDL (1,1) model for the baseline:

[13]The full set of outcomes are available upon request.

[14]Not correcting for CSD results in misleading inference (Pesaran and Tosetti, 2011).

[15]This *t*-test is also based on Augmented Dickey–Fuller statistics as IPS (2003), but it is augmented with the cross-section averages of lagged levels and first differences of the individual series (CADF statistics).

$$Y_{i,t} = \alpha_i + \beta_i Y_{i,t-1} + \zeta_{1i} X_{i,t} + \zeta_{2i} X_{i,t-1} + \varepsilon_{i,t}, \quad (1)$$

we take the difference of $Y_{i,t} - Y_{i,t-1}$ as the dependent variable $\Delta Y_{i,t}$ and we use the equation for $Y_{i,t-1}$ in the expression above on the right hand side as well. Reshuffling the terms, we obtain the panel ECM as follows:

$$\Delta Y_{i,t} = \varphi_i (Y_{i,t-1} - \vartheta_{0i} - \vartheta_{1i} X_{i,t-1}) + \zeta_{1i} \Delta X_{i,t} + \mu_i + \varepsilon_{i,t}. \quad (2)$$

Here, $Y_{i,t}$ is the relative employment share (tradable sector over non-tradable sector) and $\Delta Y_{i,t}$ is our proxy for structural change, our dependent variable. $\Delta X_{i,t}$ is the first difference of the vector of main explanatory variables, which, depending on the specification, will include GDP per capita, relative labour productivity (tradable over non-tradable), exports and imports as shares in GDP. μ_i are countries' fixed effects and $\varepsilon_{i,t}$ is the error term.

Moreover, φ_i is basically $(\beta_i - 1)$ and represents the error-correcting speed of the adjustment term. This parameter is expected to be significant and negative and signals that the variables tend to the long-run equilibrium (Blackburne and Frank, 2007). The vector $\vartheta_{\cdot i}$ contains the long-run relationships between the variables, and the short-run coefficient is instead ζ_{1i}. As for the long-run coefficients: ϑ_{0i} is $(\alpha_i/(1-\alpha_i))$ and ϑ_{1i} is $(\zeta_{1i}+\zeta_{2i})/(1-\alpha_i)$.

In this setup, the estimators we can apply are the following: the Mean Group (MG) of Pesaran and Smith (1995), the Dynamic Fixed Effects (DFE), or the Pooled Mean Group (PMG) of Pesaran, Shin, and Smith (1999). In the first, all of the coefficients in the short and long-run are heterogeneous across individuals and then averaged. In the DFE, all of the coefficients except the constant are taken as homogeneous. We believe that both short- and long-term coefficients may be different across countries,[16] so in theory, the MG estimator should be preferred. We tested for the best estimator by using a Hausman test as in Blackburne and Frank (2007) in every setup, finding that the difference in coefficients between the MG and DFE is not systematic in any of the setups we consider. Moreover, in some specifications with more regressors, we could not compute the MG given the limited number of observations. For these reasons, we apply the DFE.

4 Results

In this Section we report the main results of our analysis, following the empirical strategy described in Section 3.2. We first report results obtained by employing the ECM, i.e. investigating the direct effects of trade variables and the main determinants of structural change, highlighted by the literature. Table 1 shows that the GDP per capita is significantly and negatively related to the relative employment share in tradable sectors, in all specifications. This holds true both in the short-run and in the long-run. This allows us to say that the demand channel of structural change is at work, i.e. expenditure shares for tradable goods decrease as income grows (Engelian effects).

[16] In between, the PMG gives only heterogenous short-run coefficients. We do not consider the PMG here because for our case, there is no reason to have only heterogeneous short-term coefficients.

Table 1: Baseline

VARIABLES	(1) D.Empl. (T/NT)	(2) D.Empl. (T/NT)	(3) D.Empl. (T/NT)	(4) D.Empl. (T/NT)
SHORT-RUN				
EC	-0.0336***	-0.0330***	-0.0379***	-0.0358***
	(0.005)	(0.005)	(0.005)	(0.0055)
D.GDP per capita	-0.0906***	-0.0852***	-0.0941***	-0.0821***
	(0.025)	(0.025)	(0.026)	(0.026)
D.Exports		0.0317***		0.0178
		(0.010)		(0.012)
D.Imports			0.0285***	0.0241**
			(0.010)	(0.011)
Constant	0.350***	0.342***	0.367***	0.385***
	(0.051)	(0.051)	(0.051)	(0.051)
LONG-RUN				
GDP per capita	-1.254***	-1.253***	-1.048***	-1.199***
	(0.090)	(0.129)	(0.090)	(0.114)
Exports		-0.00853		0.718***
		(0.131)		(0.223)
Imports			-0.377***	-0.974***
			(0.115)	(0.228)
Observations	1316	1316	1316	1316

Note: Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The dependent variable is the first difference of the relative employment share (tradable sector over non-tradable sector), i.e. the proxy of structural change. All the variables are taken in natural logs; *EC* stands for the error correction term. *D.* stands for the first difference operator. Exports and Imports are computedas shares of GDP. The test of the null hypothesis that the sum of the coefficients of exports and imports is equal to zero is rejected ($p-$value=0.000 in the SR and $p-$value=0.040 in the LR), i.e. the model cannot be estimated using the net exports share.

It is worth noting that the elasticity[17] of structural change to income per capita is larger in the long-run (ranging between –0.08 and –0.09 in the short-run and between –1.04 and –1.25 in the long-run, depending on the specification, but always statistically significant at the 1% level), suggesting that Engelian effects are especially important in the long-run. Indeed, it takes time to reallocate resources across sectors following changes in demand composition.

When trade variables are included, the coefficient of income per capita should capture the effect of income per capita on structural change beyond that induced by trade. Results show that the coefficient of GDP per capita does barely change either in the short-run or in the long-run (–0.09 vs –0.08 in Columns 1 and 4, respectively, in the short-run; –1.25 vs –1.2 , in Columns 1 and 4, respectively, in the long-run).

Turning attention to the trade proxies, we note that in the short-run, when included separately, both trade proxies are positively and significantly related to structural change, i.e. to the relative employment in tradable sectors. When included separately, exports are only related to structural change in the short-run (Column 2, Table 1) while the import coefficient is positive in the short-run and negative in the long-run (Column 3, Table 1), all statistically significant at the 1% level.

In the last specification (Column 4, Table 1), we include export and import shares simultaneously. This reveals, in the long-run, a positive relationship of export share with the relocation of employment towards tradable sectors and a negative and significant relationship of import shares (the coefficients are 0.72 and –0.97, both statistically significant at the 1% level). The short-run effect of imports remains small and positive (the coefficient is 0.02).

[17]In all specifications, the dependent variable and all explanatory variables are taken in natural logarithm. Therefore the coefficients must be interpreted as elasticities.

Since in this specification we include GDP per capita, we control for one of the two main indirect channels mentioned in Section 2.2: indirect channel (I), i.e. trade-induced domestic income effects. We can therefore claim that the coefficients here should capture both the direct effects of trade on structural change, i.e. foreign demand composition, and possibly, the effects due to the indirect channel (II), i.e. industry productivity differences induced by trade. The negative long-run coefficient of import share should be capturing both the direct effect of import substitution and an effect due to trade-induced productivity increases in the tradable sector that are not compensated by the increases either in foreign demand, i.e. exports, or in domestic demand for tradable goods.

Interestingly enough, when exports and imports are included simultaneously, the coefficient of the export share is positive both in the short-run and in the long-run, although it is not statistically significant in the former, while the coefficient of import share changes sign, and is positive and significant in the short-run and negative in the long-run. This might be explained by the role of trade in intermediate goods and GVC participation. In the short-run, importing intermediate inputs might reduce costs and increase the availability of inputs, which in turn rises the domestic production of the tradable sector. The latter is indeed more intensive in intermediate goods (Moro, 2012; Cravino and Sotelo, 2019). In the long-run, this channel might be more than offset by the substitution of the domestic production of intermediate inputs with imported goods, explaining the change in the sign. We make a first attempt to further investigate this aspect by distinguishing between trade in intermediate and final goods in Section 6.2 later in this paper.

As described in Section 3.2, as a second step we include labour productivity in the analysis in order to consider the supply-side channel of structural change, i.e. differences in productivity growth across sectors. This also allows us to control for the indirect channel (II) mentioned in Section 2.2 and Table A1.

As a consequence, in this analysis the coefficients of the trade variables should capture mainly the direct effect of trade on structural change, i.e. the effect of foreign demand composition. Including labour productivity implies relying on a smaller sample (See Section A.2 in the Appendix). The results, reported in Table 2, where we replicate the baseline analysis on this smaller sample are in line with those of the larger sample.[18]

[18]In Columns 1 and 3 in Table 2 we replicate the analysis in Columns 1 and 4, respectively, of Table 1.

Table 2: Baseline with labour productivity

VARIABLES	(1) D.Empl. (T/NT)	(2) D.Empl. (T/NT)	(3) D.Empl. (T/NT)	(4) D.Empl. (T/NT)
SHORT-RUN				
EC	-0.0452***	-0.0289***	-0.0490***	-0.0371***
	(0.007)	(0.008)	(0.007)	(0.008)
D.GDP per capita	-0.125***	-0.0403*	-0.116***	-0.0305
	(0.027)	(0.024)	(0.028)	(0.024)
D.labour prod. (T/NT)		-0.432***		-0.432***
		(0.023)		(0.023)
D.Exports			0.00428	0.0213**
			(0.012)	(0.010)
D.Imports			0.0261**	0.0243**
			(0.012)	(0.010)
Constant	0.424***	0.310***	0.435***	0.305***
	(0.061)	(0.053)	(0.060)	(0.052)
LONG-RUN				
GDP per capita	-1.119***	-1.265***	-0.963***	-0.910***
	(0.071)	(0.256)	(0.087)	(0.163)
Labour prod. (T/NT)		0.0353		-0.220
		(0.231)		(0.156)
Exports			0.395**	0.617***
			(0.165)	(0.209)
Imports			-0.704***	-0.875***
			(0.177)	(0.226)
Observations	1019	1019	1019	1019

Note: Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The dependent variable is the first difference of the relative employment share (tradable sector over non-tradable sector), i.e. the proxy of structural change. All the variables are taken in natural logs; *EC* stands for the error correction term. *D.* stands for the first difference operator. Exports and Imports are computedas shares of GDP. The test of the null hypothesis that the sum of the coefficients of exports and imports is equal to zero is rejected (p−value=0.000 in the SR and p−value=0.024 in the LR), i.e. the model cannot be estimated using the net exports share.

Turning to the role of relative productivity in Table 2, Column 2, we observe that in the short-run it is negatively and significantly related to structural change towards tradable goods, i.e. the employment share inthe short-run decreases in the sectors where labour productivity increases faster (–0.43, statistically significant at the 1% level), while in the long-run it is not statistically significant anymore. This suggests that the supply-side engine of structural change is relevant in the short-run, i.e. higher productivity growth in the tradable-goodsector coupled with low substitutability between tradable and non-tradable goods shifts resources to non-tradable sectors. It is worth noting, by comparing Columns 1 and 2 in Table 2, that the inclusion of relative productivityin the baseline model strongly reduces the absolute magnitude of the coefficient of income per capita (from –0.12 to –0.04) in the short-run. By contrast, in the long-run, the coefficient of GDP per capita increases in the model including relative productivity (from –1.12 to –1.26). When we include the trade variables (Column 4 in Table2), the coefficient of the income per capita in the short-run, which was statistically significant at the 10%level, is small and not significant anymore; in the long-run the coefficient is still statistically significant at the 1% level but of a slightly smaller magnitude (-0.91 vs -1.26). The coefficient of labour productivity does not changein the short-run (negatively and significantly associated with structural change) and it remains not statistically significant in the long-run. This suggests that the demand-side engine of structural change is present in particularin the long-run while the supply-side channel, i.e. differences in productivity growth, seems to be relevant in the short-run.

Turning the attention to the trade variables, we see that in Column 4, both the trade variables are significantly related to structural change in both the short-run and the long-run similarly to the model not including labour productivity in Column 3. Both exports and imports are positively and significantly related to increasing employment share in the tradable sector in the short-run (both significant at the 5% level, with a coefficient of a similar magnitude, about 0.02). In the long-run the coefficient on imports turns negative and both trade variable coefficients are larger than those in Column 3 not including labour productivity (the coefficients are now 0.62 and
-0.87 for exports and imports respectively, both significant at the 1% level, versus 0.39 and -0.70, in Column 3). It is worth noting that the negative coefficient of the income per capita in the long-run is still larger than that of imports (coefficients are - 0.91 vs - 0.87).

All in all, the analysis suggests that, on average, trade works as an engine of structural change. The negative elasticity of structural change to imports is larger than the positive elasticity to exports. But whether this implies a shift of the employment composition towards non-tradable goods clearly depends on a country's relative dynamics of imports and exports. We observe in general larger elasticities of structural change to income and trade variables in the long-run than in the short-run, in particular the coefficient of the income per capita is not statistically significant in the short-run when controlling for labour productivity. This suggests that the demand-side channelof structural change requires time to produce effects. On the other hand, the elasticity of structural change to labour productivity is relevant in the short-run only, suggesting that the supply-side channel of structural change works in particular in the short-run.

These findings are in line with those of previous work, highlighting through the use of a different methodology the role of income effects in the shift to services (Uy et al., 2015; Comin et al., 2021), while contrasting with Swieki (2017) and Kehoe et al. (2017) for which unbalanced productivity is the main engine at work. Interestingly enough, we find that on average in the short-run trade variables play a role in affecting sectoral composition while the income mechanism is not statistically significant. In the long-run, both trade and income channels are active and the magnitude of the elasticities is similar in the case of imports and income, while it is slightly smaller in the

case of exports.

5 Robustness

5.1 Considering the potential role of trade in services.

As described in Section 3.1, the sectoral taxonomy that we adopt in this paper collapses all services, construction and public utilities in the non-tradable sector. But, in particular in most recent decades, trade in some type of services is relevant and increasing. Nonetheless, the lack of consensus on which type of services should be considered tradable and since our sample period includes decades in which trade in services was somehow negligible, we preferred to take a conservative approach following the contributions mentioned in 3.1, and therefore including all services in the non-tradable aggregate. As a consequence, to be consistent with this choice, the trade variables we consider include trade in goods only. In this Section, we conduct a robustness check by including in our preferred specifications a control variable which is the ratio of merchandise trade (sum of exports and imports) over services trade, the *relative trade* (M/S) variable. Results are reported in Table A3 in Section A.3. In Columns 1 and 3 we estimate models as in Column 4 in Table 1 and Column 4 in Table 2, respectively, on the sub-sample for whichtrade in services is available, but not including the new control variable. The results of our main analysis are confirmed in this sub-sample, with the exception of the coefficient of the income per capita in the short-run, which is now positive and statistically significant when including labour productivity (Column 3).[19]

In Columns 2 and 4 we include the *relative trade* control variable. Including the relative trade variable does not change the results, as can be checked by comparing the results in Columns 1 and 3 with Columns 2 and 4, respectively. The *relative trade* variable is positively related with the employment in the tradable goods in the short-run (statistically significant at the 5% level) but not in the long-run, when is not statistically significant anymore.

5.2 Structural change in value-added shares at constant 2005 prices

In this Section, we explore the relationship between trade, income per capita, relative efficiency, and structural shifts in the value-added shares in tradable and non-tradable goods at constant prices. We substitute our dependent variable, i.e. the ratio of employment share in tradable over employment share in non-tradable sectors, with the ratio of the share of value added in tradable over the share of value added in non-tradable sectors at constant 2005prices.[20] This check should provide further information on the relative role of price and income effects on sectoral composition, according to Herrendorf et al. (2013), and it should represent a check for the role of trade. Results are shown in Table A4 in Section A.3. Both the relevance of income and relative productivity with respect to structural change are confirmed. In particular, income per capita is negatively and significantly (at the 1% level) related to the sectoral change in value added in the long-run, confirming the role of non-homothetic preferencesin driving demand towards services. In the short-run, the relationship is negative but not statistically significant

[19]In general, the coefficient of income per capita in the short-run is small in magnitude and the sign is not robust to changes in the sample. In the baseline analysis, the sign is negative, both in the large and in the small sample, but not statistically significant when controlling for relative productivity (Table 2); in the sub-sample used in the analysis reported here, for which we have informationfor trade in services, the sign turns to be positive (and statistically significant when controlling for relative productivity). The twosamples differ mainly in the number of countries for which information are available in the seventies. The positive sign in the short-run emerges also in some specifications in the sub-samples used for the analysis in Section 5.3 and 6.2 below in the paper, where again the sample is reduced by the availability of data for gravity estimation and GVCs' indicators, respectively.

[20]We rely on the smallest sample, i.e. that of the analysis including labour productivity.

(like in Column 4 of Table 2). Relative productivity is positively and significantly (at the 1% level) related to structural change in value-added shares both in the short-run, with an elasticity of about 0.5, and in the long-run, with an elasticity close to 1 (1.08 and 0.80 in Column 1 and 2 respectively, Table A4). The positive and lower than one coefficient of labour productivity in the short-run is consistent with the negative relationship between relative productivity and relative employment in our baseline analysis in the short-run (Column 2 and 4, Table 2). Indeed, according to the theory, when the elasticity of substitution between tradable and non-tradable goods in demand is lower than one, the supply-side driver of structural change is at work. Demand increases for the sector in which the relative price decreases (here proxied by relative productivity), implying an increase of the relative value-added shares at constant prices. But, nonetheless, low substitutability implies that the increase in demand is not enough to compensate the increase in relative efficiency and, therefore, the relationship with the relative employment share is negative. In the long-run the elasticity of relative value added to relative productivity is close to 1, this implying that relative demand increases for the sector in which the relative efficiency increases, at a rate such that the relative employment remains almost constant. This is again consistent with our finding in the long-run when considering the relative employment as dependent variable. As for the role of trade, results in Column 2 of Table A4 confirm those of Column 4 in Table 2, both in the signs and in the magnitude of the coefficients.

5.3 Endogeneity of trade

In the main analyses in Section 4, we look at the relationship between trade variables and the sectoral dynamics of the economy, including GDP per capita and relative productivity, but there might be other factors simultaneously affecting trade and structural change that we are not controlling for. A potential source of endogeneity could arise should either positive or negative selection take place. We address this potential source of endogeneity by estimating the baseline model in Table 2 using as trade variables the values of exports and imports predicted by a standard gravity model, in the spirit of Frankel and Romer (1999) and more recently Ortega and Peri (2014). We use the 'Gravity' database from Cepii described in Head et al. (2010), Mayer and Zignago (2011) and Head and Mayer (2014). The gravity model we employ includes time-invariant bilateral variables (common language, language spoken by at least 9% of the population, common colonizer post 1945, common religion, currentlyin colonial relationship or dependency, population-weighted bilateral distances, contiguity), it includes origin and destination real GDP per capita and bilateral time-variant dummies for regional trade agreements. It also includes origin, destination, and year fixed effects.[21]

We build new export (import) variables as predicted by year fixed effects, all of the bilateral time-invariant variables, regional trade agreement dummies, the real GDP per capita of the destination (origin) country and destination (origin) fixed effects.

We present the results in Table A5 in Section A.3. In this robustness check, we run the regressions on the same sample with our actual variable and the predicted one, separately for the two trade variables, export (Columns 1 and 2, Table A5) and import (Columns 3 and 4, Table A5), and then including jointly the two variables as in Column 4 of Table 2 (Columns 5 and 6, Table A5). Results with the predicted values confirm those with ouractual variable, with the exception of imports in the long-run, which is negative, but not statistically significant when using the predicted values. In Columns 5 and 6 where we include simultaneously import and exports the signs are confirmed, but coefficients are not statistically significant. This is due to the fact that the predicted

[21]Standard errors are clustered at the origin and destination level.

values are strongly correlated with each other by construction.

6 Further investigations

6.1 Exploring heterogeneous effects by level of development

Since what we find is an average effect across countries that might differ in their positions in global markets, we proceed by exploring potential countries' heterogeneity, considering interactions with country groups, as explained in Section 3.2.

The excluded category is that of mature economies.[22] Column 1 in Table 3 shows the results of considering different groups for the largest sample, i.e. decomposing results in Column 4 in Table 1. Columns 2 and 3 consider the restricted sub-sample where we can control for labour productivity, the former replicating the specification in Column 1 without including labour productivity, i.e. decomposing results in Column 3 in Table 2, and the latter including labour productivity, i.e. decomposing results in Column 4 in Table 2.

In all models, the interacted term is statistically significant in a small number of cases. Therefore in general we observe that the relationship between the trade variables and structural change is similar for different groups of countries. This is always the case in the long-run, in particular for mature and developing countries, which show coefficients of the same sign and similar magnitude. For transition countries it is still true, but the gross coefficients are mostly not statistically significant. This is probably due to the fact that estimates are not very precise for this group of countries, due to the small and unbalanced number of observations by year. There are nonetheless some notable exceptions in the short-run. Exports in the short-run are positive for mature economies, but negative and not statistically significant for developing countries (the gross coefficient is -0.003). Importsin the short-run are positive for mature economies, but negative and not statistically significant for transition countries, and also for developing countries when including labour productivity (the gross coefficient are -0.082 and 0.006, respectively). It is worth underlining that countries' asymmetries in their external position even with similar elasticities of structural change to trade variables entail that they can display differences in the speed and direction of structural change, i.e. trade can have different implications in terms of countries' de-industrialization path.

6.2 Some insights on trade composition: intermediate goods versus final goods

In this section we make an attempt to further investigate the relationship between trade and structural change by distinguishing between trade in intermediate goods and trade in final goods, since this distinction could give us insights on the role of a country's involvement and position in the GVCs. The larger the share of exports and imports of intermediate goods, the larger the involvement in GVCs. For this analysis we rely on data from the World Input–Output Database (WIOD, Timmer et al. 2015). The 2013 release of WIOD data reports data for 40 countries plus the Rest of the World for the period of 1995–2011. By using GGDC 10-Sector data combined with EU-KLEMS for sectoral employment and valued added and WIOD 2013 for the trade variables, we end up withan unbalanced panel of 31 countries for 1995–2011.[23] We split both exports and imports into four new variables

[22]The excluded category is mature economies; therefore, the coefficient for mature economies is the coefficient of the variable not interacted, while the coefficient for transition and developing countries is the sum of the interacted one and the not-interacted one. We will call it the 'gross coefficient'.

[23]For consistency with our main analysis we consider trade in goods only, excluding trade in services.

Table 3: Baseline with interactions

VARIABLES	(1) D.Empl. (T/NT)	(2) D.Empl. (T/NT)	(3) D.Empl. (T/NT)
SHORT-RUN			
EC	-0.0353***	-0.0492***	-0.0390***
	(0.006)	(0.007)	(0.008)
D.GDP per capita	-0.0895***	-0.120***	-0.0358
	(0.030)	(0.029)	(0.024)
D.labour prod. (T/NT)			-0.441***
			(0.023)
D.Exports	0.0535***	0.0432	0.0450**
	(0.020)	(0.027)	(0.023)
D.Imports	0.0392**	0.0420*	0.0681***
	(0.019)	(0.023)	(0.019)
D.ExportsXdev	-0.0573**	-0.0481	-0.0359
	(0.024)	(0.030)	(0.025)
D.ExportsXtransit	-0.0298	-0.0849	0.0265
	(0.072)	(0.091)	(0.077)
D.ImportsXdev	-0.0216	-0.0214	-0.0611***
	(0.024)	(0.027)	(0.023)
D.ImportsXtransit	-0.122*	-0.0637	-0.113
	(0.074)	(0.090)	(0.076)
Constant	0.369***	0.430***	0.281***
	(0.055)	(0.064)	(0.055)
LONG-RUN			
GDP per capita	-1.193***	-0.967***	-0.850***
	(0.121)	(0.0906)	(0.153)
Labour prod. (T/NT)			-0.292*
			(0.158)
Exports	0.716**	0.418	0.587**
	(0.303)	(0.261)	(0.287)
Imports	-0.979***	-0.657***	-0.758***
	(0.291)	(0.249)	(0.275)
ExportsXdev	-0.0251	-0.0287	0.0190
	(0.356)	(0.290)	(0.314)
ExportsXtransit	1.113	0.577	0.822
	(1.933)	(1.735)	(1.846)
ImportsXdev	-0.0142	-0.0642	-0.117
	(0.399)	(0.309)	(0.329)
ImportsXtransit	0.0206	-0.308	0.0870
	(2.560)	(2.209)	(2.358)
Observations	1316	1019	1019

Note: Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The dependent variable is the first difference of the relative employment share (tradable sector over non-tradable sector), i.e. the proxy of structural change. Exports and Imports are computed as share in GDP. *X* indicates the interaction between trade variables and groups of countries, namely developing (dev) and transition (transit). The excluded category is mature economies. All the variables are taken in natural logs; *EC* stands for the error correction term. *D.* stands for the first difference operator.

computed as shares of GDP: the export share of final goods (Exports Fin.), the export share of intermediate goods (Exports Int.), the import share of final goods (Imports Fin.), the import share of intermediate goods (Imports Int.).[24] Results are reported in Table 4. In Columns 1 and 3 we estimate the model as in Columns 4 of Table 1 and Table 2 on the WIOD sample, in order to compare with our main results on the whole sample. In this sample, in the short-run the trade variables are all positively related with structural change towards tradable goods, as in our main analysis, but they are never statistically significant. In the long-run, the signs of our main analysis are confirmed, but the magnitude of the coefficients is slightly different. Turning the attention on the trade decomposition, in the most complete specification where we include labour productivity, our preferred one, we see that again, clearly, trade variables are not statistically significant in the short-run. In the long-run, we observe that the positive effect of total exports is driven by exports in final goods, while the negative effect of total imports is driven by imports of intermediate goods (the coefficients in Column 4, where we include labour productivity are 0.59 and -0.37 for exports in final goods and imports in intermediate goods respectively, all statistically significant at the 1% level).[25] These results provide some initial insights suggesting that involvement in the upstream levels of a GVC by importing intermediate goods could lead to de-industrialization, through import substitution, but this channel could be compensated by the positive effects of exports in final goods. Nonetheless, we want to be upfront about the data limitations in this part of the analysis, since they cover a period of time which is too short to investigate changes in the sectoral composition, typically a long-run phenomenon.

6.3 A panel VAR: the role of indirect channels

As mentioned in Section 2.2, export and import shares can be related to the sectoral employment dynamics both directly and indirectly, through the effects that both export and import may have on GDP per capita, the indirect channel (I), and productivity, the indirect channel (II) (see Table A.1). We can investigate the indirect effects in this extension by using a panel VAR setup.[26]

6.3.1 Econometric framework: the panel VAR

In order to show the possible indirect effect (via GDP per capita or labor productivity) of the trade variables on structural change, we provide a panel VAR model like the one in equation (3). This setup allows us looking at the indirect effects as it considers the endogenous characteristics of our variables of interest, their interconnectness and we can identify each shock (see Canova and Ciccarelli, 2013).

$$Y_{i,t} = A_{0i}(t) + A_i(l)Y_{i,t-1} + u_{i,t}, \tag{3}$$

$Y_{i,t}$ is now the vector of our variables described in a preferred identification scheme. We compact into $A_{0i}(t)$ all the deterministic components of the data (constants, seasonal dummies, and deterministic polynomial in time) if present. $A_i(l)$ are polynomials in the lag operators and $u_{i,t}$ are the identically and independently distributed errors. Lags of all endogenous variables of all units enter the model for i, i.e. we allow for 'dynamic interdependencies'.

We provide this panel VAR identified by a Cholesky scheme and estimated by using a GMM-style estimator as in Albrigo and Love (2015). In this case, the coefficients are also homogeneous. We consider one standard

[24] Descriptive statistics are reported in Table A2 in the Appendix.

[25] The elasticities of structural change to export of intermediate goods and imports of final goods are positive and negative, respectively, but not statistically significant.

[26] It is important stressing that our VAR setup is not fully comparable with the panel error correction model, as, for instance, the latter includes fixed effects and is in first differences.

Table 4: Trade in intermediate goods and final goods.

	(1)	(2)	(3)	(4)
VARIABLES	D. Empl. (T/NT)	D. Empl. (T/NT)	D. Empl. (T/NT)	D. Empl. (T/NT)
SHORT-RUN				
EC	-0.0896***	-0.106***	-0.104***	-0.124***
	(0.0193)	(0.0207)	(0.0215)	(0.0223)
D.GDP per capita	0.0476	0.0860*	0.0678	0.120**
	(0.0481)	(0.0495)	(0.0464)	(0.0476)
D.labour prod. (T/NT)			-0.158***	-0.173***
			(0.0344)	(0.0340)
D.Exports (WIOD)	0.0138		0.0151	
	(0.0286)		(0.0286)	
D.Imports (WIOD)	0.0167		0.0324	
	(0.0302)		(0.0297)	
D.Exports Int.		-0.0196		-0.0166
		(0.0239)		(0.0228)
D.Exports Fin.		0.0231		0.0235
		(0.0216)		(0.0211)
D.Imports Int.		0.0285		0.0381
		(0.0270)		(0.0258)
D.Imports Fin.		0.00542		0.0108
		(0.0215)		(0.0205)
Constant	0.698***	0.716***	0.534***	0.559***
	(0.157)	(0.156)	(0.154)	(0.151)
LONG-RUN				
GDP per capita	-0.946***	-0.812***	-0.690***	-0.591***
	(0.152)	(0.126)	(0.135)	(0.109)
labour prod. (T/NT)			-0.364***	-0.305***
			(0.126)	(0.105)
Exports (WIOD)	0.613***		0.762***	
	(0.216)		(0.195)	
Imports (WIOD)	-0.522**		-0.616***	
	(0.242)		(0.206)	
Exports Int.		-0.0318		0.00843
		(0.170)		(0.141)
Exports Fin.		0.521***		0.592***
		(0.137)		(0.119)
Imports Int.		-0.307		-0.372**
		(0.210)		(0.172)
Imports Fin.		-0.111		-0.109
		(0.166)		(0.135)
Observations	403	403	403	403

Note: Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The dependent variable is the first difference of the relative employment share (tradable sector over non-tradable sector), i.e. the proxy of structural change. Exports and Imports are computed as share in GDP; Exports (Imports) Fin., the export (import) share of final goods, Exports (Imports) Int., the export (import) share of intermediate goods. All the variables are taken in natural logs; *EC* stands for the error correction term. *D.* stands for the first difference operator.

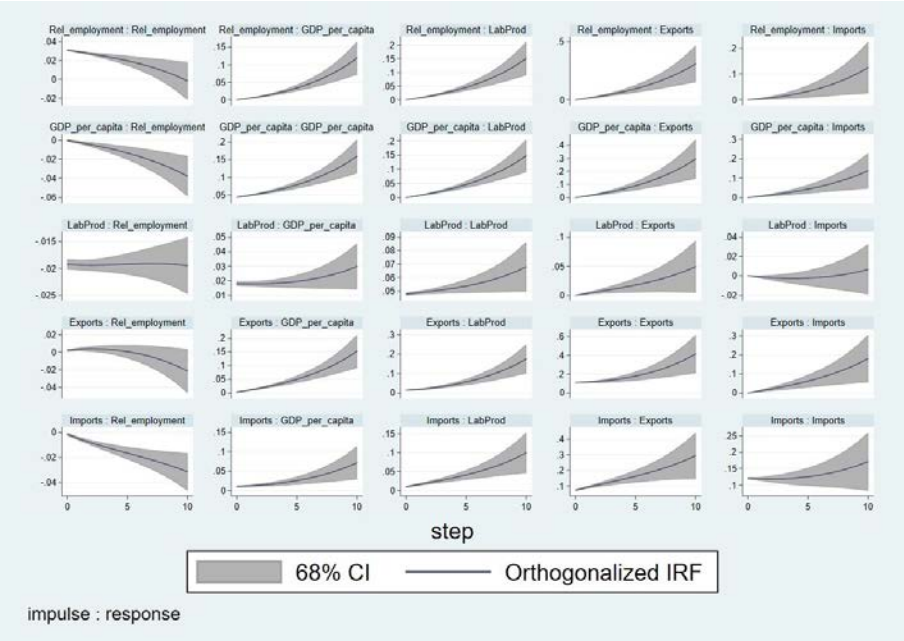
deviation shocks and the confidence bands are set at 68%.[27] We report here the complete setup with both trade variables and both indirect mechanisms in place, i.e. via labour productivity and GDP per capita, as described in Section 2.2.[28] The identification ordering applied is as follows: we include first imports, then exports, labour productivity, GDP per capita, and we have the employment ratio as our 'most' endogenous variable. All the variables can affect the employment ratio at time t, while this can influence the others only after one period.

We also run several sensitivity analyses, including one assuming exports affecting imports at time *t* and not vice versa and GDP per capita influencing at impact labour productivity and not vice versa. All the sensitivity checks are available upon request and deliver very robust outcomes.

6.3.2 Results: the indirect effects in the panel VAR

Figures 4 shows the results of our attempt to investigate the direct and indirect channels linking export and import shares to relative employment by focusing on labour productivity and GDP per capita as the mediating factors.[29]

Figure 4: Panel VAR with exports and imports - Impulse Responses



Note: shocks are of 1 standard deviation, 68% confidence bands are applied following Sims and Zha (1999). We shock the first variable and we look at the impact on the second one (impulse:response). Therefore, we have the same shock in each row and different responses in each column. The indirect effect is here as 'Imports or Exports : Labour productivity or GDP per capita' and 'Labour productivity or GDP per capita : Rel. Employment'. The direct effect in the VAR is 'Imports or Exports : Rel. Employment'.

[27]This is common in the macroeconomic literature following the seminal paper Sims and Zha (1999) where the authors stress that these confidence bands may communicate the "shape" of the results better. In any case, using 95% confidence intervals, the indirect effects are still present and significant at all horizons.

[28]The setup with only one trade variable at the time show overall similar responses.

[29]We use here the full sample as we cannot perform the group-specific VARs not having enough observations in the N dimension for the sub-groups. This is also the main motivation for the use of interactive terms instead of reporting sample split estimates in Table 3. Such small N for the sub-samples would make the results of the tables and in the panel VARs unreliable.

Exports and imports positively affect labour productivity and GDP per capita which both turn to negatively affect relative employment. The increasingly positive effect of exports on labour productivity may imply that exports work as technological progress by increasing the market size, as argued by Matsuyama (2019). The positive effect of imports on relative productivity is in line with the extensive literature on the import of intermediate goodsand efficiency gains (Halpern et al., 2015). This confirms that trade activates the two indirect channels highlighted by the literature (see Table A.1). In particular, our results are in line with both Cravino and Sotelo (2019), pointing out the role of the indirect channel going through the effect of trade on relative productivity, i.e. the supply-side channel, and Uy et al. (2015), which stresses the role of both the indirect channels, i.e. the supply-side channeland the demand-side one. As for the direct effects of trade variables on relative employment, we can clearly see a negative and significant effect of imports. We do see also a positive impact of imports on exports and vice versa, suggesting that GVCs relationships may be relevant.

7 Conclusions

This paper investigates the role of international trade in structural change, in particular in the transition from tradable, i.e. agriculture, mining and manufacturing, to non-tradable sectors, i.e. services, construction and public utilities in our study, by using a dynamic panel setup. Our analysis distinguishes between long-run and short-run effects. We use EU-KLEMS data and the GGDC 10-Sector Database for the period of 1960–2011 for an unbalanced panel of mature, developing and transition economies. We account for the demand-side and supply-side channels of structural change singled out by the literature, and also make an attempt to distinguish between direct and indirect channels through which trade potentially impacts structural change (by applying a panel VAR).

Our results suggest that both domestic channels of structural change, the demand-side (i.e. Engelian effects in presence of income elastic services) and the supply-side (i.e. lower productivity growth in services coupled with low substitutability between goods and services) contribute to increasing the employment share of non-tradable sectors. In particular, Engelian effects are mostly relevant in the long-run, suggesting that it takes time to reallocate resources across industries following changes in final demand, while supply-side effects are larger in the short-run and not statistically significant in the long-run. Trade emerges as a relevant direct driver of structural change, i.e. foreign demand matters in the reallocation of resources across sectors, in particular in the long-run. The import share has a large and negative relationship with the relative employment share in tradable goods, while the export share is positively related to it. In the short-run the elasticities of structural change to trade variables are both positive and of a smaller magnitude. Interestingly enough, the import share coefficient changes sign between the short-run and the long-run, i.e. imports are negatively related with the shift to tradable sectors in the long-run.In the short-run, importing intermediate goods might increase productivity or reduce costs in sectors that are intermediate goods-intensive. In general, we can conclude that in the long-run imports contribute to the dynamics observed in all countries of transition to non-tradable sectors, while exports contrast this dynamics.

We find indirect effects of trade on structural change going through changes both in the relative labour productivity and income per capita. By relying on the smaller sample for which information of intersectoral linkages are available (WIOD data), we provide some preliminary evidence on the role of trade in intermediate goods versus final goods. In particular, in the long-run the positive elasticity of structural change to exports is driven by exports in final goods, while the negative elasticity to imports is driven by imports of intermediate goods. These results open room for further investigation focusing on the role of intersectoral linkages and of a country's participation in the

GVCs in mediating the relationship between trade and structural change, possibly relying on larger samples and a longer period. We conducted several robustness checks, by considering a different proxy for structural change as dependent variable, i.e. value added, by using values predicted from a gravity model for exports and imports, and by controlling for the potential role of trade in services.

References

[1] Acemoglu, D. and Guerrieri, V. (2008). Capital deepening and non-balanced economic growth. *Journal of Political Economy* 116, 467–498.

[2] Abrigo, M.R.M. and Love, I. (2015). Estimation of panel vector autoregression in Stata: A package of programs. University of Hawai'i at Manoa (USA), working paper.

[3] Alonso-Carrera, J. and Raurich, X. (2015). Demand-based structural change and balanced economic growth. *Journal of Macroeconomics*, 46, 359–374.

[4] Alonso-Carrera, J. and Raurich, X. (2018). Labor mobility, structural change and economic growth. *Journal of Macroeconomics*, vol. 56(C), 292-310.

[5] Alonso-Carrera, J., Felice, G. and Raurich, X., (2018). Inequality and Structural Change under Non-Linear Engels' Curve, *UB Economics Working Papers 2018/374*.

[6] Alvarez-Cuadrado, F., Van Long, N. and Poschke, M. (2017). Capital Labor Substitution, Structural Change and Growth. *Theoretical Economics*, 12, 1229–1266.

[7] Autor, D.H., Dorn, D. and Hanson, G.H. (2013) The China syndrome: local labor market effects of import competition in the United States. *American Economic Review*, 103(6), 2121–2168.

[8] Baldwin, R. and Lopez-Gonzalez, J. (2015). Supply-chain trade: A portrait of global patterns and several testable hypotheses. *The World Economy*, 38(11), 1682–1721.

[9] Baldwin, R. and T. Okubo, (2019). GVC journeys: Industrialisation and deindustrialisation in the age of the second unbundling. *Journal of the Japanese and International Economies*, 52(C), 53–67.

[10] Blackburne III, E.F. and Frank, M.W. (2007). Estimation of nonstationary heterogeneous panels. *Stata Journal*, 7(2), 197–208.

[11] Boppart, T. (2014). Structural Change and the Kaldor Facts in a Growth Model with Relative Price Effects and Non-Gorman Preferences. *Econometrica*, 82, 2167–2196.

[12] Buera, F. and Kaboski, J. (2009). Can traditional theories of structural change fit the data? *Journal of the European Economic Association*, 7, 469–477.

[13] Buera, F. and Kaboski, J., Shin, Y. (2011). Finance and Development: A Tale of Two Sectors. *American Economic Review*, vol. 101(5), 1964-2002.

[14] Buera, F. and Kaboski, J. (2012). The Rise of the Service Economy, *American Economic Review*, vol. 102(6), 2540-2569.

[15] Canova, F. and Ciccarelli, M. (2013). Panel Vector Autoregressive Models: A Survey. In *VAR Models in Macroeconomics – New Developments and Applications: Essays in Honor of Christopher A. Sims*. 2013, 205–246, Emerald Group Publishing Limited.

[16] Caron, J., Fally, T. and Markusen, J.R. (2014). International Trade Puzzles: A Solution Linking Production and Preferences. *Quarterly Journal of Economics*, 129(3), 1501–1552.

[17] Chudik, A. and M. H. Pesaran (2015). Common Correlated Effects Estimation of Heterogeneous Dynamic Panel Data Models with Weakly Exogenous Regressors. *Journal of Econometrics* 188(2), 393–420.

[18] Comin, D., Lashkari, D. and Mestieri, M. (2021). Structural Change with Long-run Income and Price Effects. *Econometrica* 89(1), 311-374.

[19] Comunale, M. (2017). Dutch disease, real effective exchange rate misalignments and their effect on GDP growth in EU. *Journal of International Money and Finance*, 73, Part B, 350–370.

[20] Connolly, M. and Yi, K.-M. (2015). How much of south korea growth miracle can be explained by trade policy? *American Economic Journal: Macroeconomics*, 7(4), 188–221.

[21] Coricelli, F. and Ravasan, F.R. (2017). Structural Change and the China Syndrome: Baumol vs Trade Effects. *CEPR Discussion Papers 12069*, C.E.P.R. Discussion Papers.

[22] Cravino, J. and Sotelo, S. (2019). Trade Induced Structural Change and the Skill Premium. *AEJ: Macroeconomics*, 11(3), 289–326.

[23] Eberhardt, M. (2012). Estimating panel time-series models with heterogeneous slopes. *Stata Journal*, 12(1),61–71.

[24] Felice, G. (2016). Size and composition of public investment, sectoral composition and growth. *European Journal of Political Economy*, 44, 136–158.

[25] Feenstra, R.C., Inklaar, R. and Timmer, M.P. (2015). The next generation of the penn world table. *American Economic Review,* 105(10), 3150–3182.

[26] Fieler, A.C. (2011). Non-homotheticity and Bilateral Trade: Evidence and A Quantitative Explanation. *Econometrica*, 1069–1101.

[27] Fiorentini, G., Galesi, A., Pérez-Quirós, G. and Sentana, E. (2018). The rise and fall of the natural interest rate. *Working Papers 1822, Banco de España.*

[28] Foellmi, R. and Zweimüller, J. (2008). Structural change, Engel's consumption cycles and Kaldor's facts of economic growth. *Journal of Monetary Economics,* 55, 1317–1328.

[29] Frankel, J.A. and Romer, D. (1999). Does trade cause growth? *American Economic Review*, 89 (3), 379–399.

[30] Gali, J. (1999). Technology, employment, and the business cycle: do technology shocks explain aggregate fluctuations? *American Economic Review*, 89.1, 249–271.

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

[32] Head, K., Mayer, T. and Ries, J. (2010), The erosion of colonial trade linkages after independence Journal of International Economics, 81(1):1-14

[33] Head, K. and T. Mayer, (2014), "Gravity Equations: Toolkit, Cookbook, Workhorse." Handbook of International Economics, Vol. 4,eds. Gopinath, Helpman, and Rogoff, Elsevier.

[34] Herrendorf, B., Rogerson, R. and Valentinyi, Á. (2013). Two Perspectives on Preferences and Structural Transformation. *American Economic Review*, 103, 2752–2789.

[35] Herrendorf, B., Rogerson, R. and Valentinyi, Á. (2014). Growth and structural transformation. In *Handbook of Economic Growth,* P. Aghion and S.N. Durlauf (eds.). Amsterdam: North-Holland Publishing Company.

[36] Herrendorf, B., Herrington, C. and Valentinyi, Á. (2015). Sectoral technology and structural transformation. *American Economic Journal: Macroeconomics*, 7, 104–133.

[37] Kapetanios, G., M. H. Pesaran, and T. Yamagata (2011). Panels with Non-Stationary Multifactor Error Structures. *Journal of Econometrics* 160(2), 326–348.

[38] Kehoe, T. J., Ruhl, K. J. and Steinberg, J. B. (2018). Global Imbalances and Structural Change in the United States. *Journal of Political Economy*, vol. 126(2), pages 761-796.

[39] Kongsamunt, P., Rebelo, S., Xie, D. (2001). Beyond balanced growth. *Review of Economic Studies*, 68, 869–882.

[40] Im, K.S., Pesaran, M.H. and Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics*, 115(1), 53–74.

[41] Ivanov V. and Kilian, L. (2005). A Practitioner's Guide to Lag Order Selection for VAR Impulse Response Analysis. *Studies in Nonlinear Dynamics & Econometrics*, De Gruyter, vol. 9(1), pages 1–36, March.

[42] Lee, K. (2019). The Art of Economic Catch-Up: Barriers, Detours and Leapfrogging in Innovation Systems. Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, Sao Paulo: Cambridge University Press.

[43] Lee, D. and Wolpin, K.I. (2006). Intersectoral Labor Mobility and the Growth of the Service Sector. *Econometrica,* 74, 1–46.

[44] León-Ledesma, M. and Moro, A. (2020). The Rise of Services and Balanced Growth in Theory and Data. *American Economic Journal: Macroeconomics*, vol. 12(4), 109-146.

[45] Linder, S.B. (1961). An Essay on Trade and Transformation. John Wiley and Sons.

[46] Mano, R. and Castillo, M. (2015). The Level of Productivity in Traded and Non-Traded Sectors for a Large Panel of Countries. IMF Working Paper, WP/15/48.

[47] Matsuyama, D. (1992). A simple model of sectoral adjustment. *Review of Economic Studies*, 59, 375–388.

[48] Matsuyama, K. (2000). A Ricardian Model with a Continuum of Goods under Nonhomothetic Preferences: Demand Complementarities, Income Distribution and North-South Trade. *Journal of Political Economy*, 108, 1093–1120.

[49] Matsuyama, K. (2009). Structural Change in an Interdependent World: A Global View of Manufacturing Decline. *Journal of the European Economic Association*, 7, 478–486.

[50] Matsuyama, K. (2019). Engel's Law in the Global Economy: Demand-Induced Patterns of Structural Change, Innovation and Trade. *Econometrica*, 87, 497–528.

[51] Mayer, T. and Zignago, S. (2011). Notes on Cepii's distances measures: the geodist database. Cepii, WP No. 2011-25.

[52] Moro, A. (2012). The Structural Transformation between Manufacturing and Services and the Decline in the US GDP Volatility. *Review of Economic Dynamics,* 12(3), 402–415.

[53] Moro, A. (2015). Structural Change, Growth, and Volatility. *American Economic Journal: Macroeconomics* 7 (3): 259–94.

[54] Ngai, R. and Pissarides, C. (2007). Structural change in a multisector model of growth. *American Economic Review,* 97, 429–443.

[55] Nickell, S. (1981). Biases in dynamic models with fixed effects. *Econometrica*, 49(6), 1417–26.

[56] Ortega, F. and Peri, G. (2014). Openness and income: The roles of trade and migration. *Journal of International Economics*,92(2), 231-251.

[57] Pedroni, P. (1999). Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors, *Oxford Bulletin of Economics and Statistics*, Department of Economics, University of Oxford, vol. 61(S1),pages 653-670, November.

[58] Pedroni, P. (2004). Panel cointegration: Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. *Econometric Theory* 20: 597-625.

[59] Pesaran, M.H. and Smith, R.P. (1995). Estimating long-run

relationships from dynamic heterogeneous panels. *Journal of Econometrics*, 68, 79–113.

[60] Pesaran, M.H., Shin, Y. and Smith, R.P. (1999). Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American Statistical Association*, 94, 621–634.

[61] Pesaran, M.H., (2003). A Simple Panel Unit Root Test in the Presence of Cross Section Dependence. Cambridge Working Papers in Economics 0346, Faculty of Economics (DAE), University of Cambridge.

[62] Pesaran, M.H., (2004). General Diagnostic Tests for Cross Section Dependence in Panels. CESifo Working Paper Series No. 1229; IZA Discussion Paper No. 1240.

[63] Pesaran, M. H. (2006). Estimation and Inference in Large Heterogeneous Panels with a Multifactor Error Structure. *Econometrica* 74(4), 967–1012.

[64] Pesaran M.H. and Tosetti, E. (2011). Large panels with common factors and spatial correlation. *Journal of Econometrics,* 161, 182–202.

[65] Rodrick, D. (2016). Premature deindustrialization. *Journal of Economic Growth*, 21, 1–33.

[66] Roodman D. (2009). A Note on the Theme of Too Many Instruments. *Oxford Bulletin of Economics andStatistics*, 71(1), 135–158.

[67] Schlogl, L., and A. Sumner (2020). Disrupted Development and the Future of Inequality in the Age of Automation. Cham: Palgrave Macmillan.

[68] Schlogl, L.(2020). Leapfrogging into the unknown. WIDER Working Paper 2020/25.

[69] Schmookler, J. (1961). *Invention and Economic Growth*. Cambridge: Harvard University Press.

[70] Sims, C. A. T. Zha, 1999. Error Bands for Impulse Responses, *Econometrica*, Econometric Society, vol. 67(5), pages 1113-1156, September.

[71] Stehrer, R., A. Bykova, K. Jäger, O. Reiter and M. Schwarzhappel (2019). Industry level growth and productivity data with special focus on intangible assets, wiiw Statistical Report No. 8.

[72] Sposi, M., Yi, K.M., Zhang, J. (2018). Accounting for Structural Change Over Time: A Case Study of Three Middle-Income Countries. Unpublished.

[73] Sposi, M. (2019). Evolving Comparative Advantage, Sectoral Linkages and Structural Change. *Journal of Monetary Economics*, 103, 75–87.

[74] Swiecki, T. (2017). Determinants of Structural Change. *Review of Economic Dynamics,* 24, 95–31.

[75] Teigner, M. (2018). The Role of Trade in Structural Transformation. *Journal of Development Economics*, 130, 45–65.

[76] Timmer, M.P., Inklaar, R., O'Mahony, M. and van Ark, B. (2010). *Economic Growth in Europe*. Cambridge Books, Cambridge University Press.

[77] Timmer, M.P., de Vries, G.J. and de Vries, K. (2015). Patterns of Structural Change in Developing Countries. In J. Weiss, M. Tribe (eds.), *Routledge Handbook of Industry and Development*, (pp. 65–83). Routledge.

[78] Timmer, M.P., Dietzenbacher, E., Los, B., Stehrer, R. and de Vries, G.J. (2015). An illustrated user guide to the world input-output database: the case of global automotive production. *Review of International Economics*, 23(3), 575–605.

[79] Uy, T., Yi, K. and Zhang, J. (2013). Structural change in an open economy. *Journal of Monetary Economics*, 60, 667–682.

[80] Valentinyi, Á. and Herrendorf, B. (2008). Measuring factor income shares at the sectoral level. *Review of Economic Dynamics*, 11, 820–835.

[81] van Neuss, L. (2019). The Drivers Of Structural Change. *Journal of Economic Surveys*, 33(1), 309-349.

[82] Westerlund, J. (2007). Testing for error correction in panel data. *Oxford Bulletin of Economics and Statistics*, 69(6), 709–748.

A Appendix

A.1 Summary of the theoretical framework

Table A1: Drivers of Structural Change (tradable and non-tradable goods)

Mechanisms	Explanation
Internal (closed economy)	
– Income (-)	Demand-side engine of SC: Engelian effects in demand. Non-tradable are income elastic. As income grows, the expenditure composition shifts to non-tradable goods.
– Sectoral relative productivity (-)	Supply-side engine of SC: Baumol's effect. Higher rate of productivity growth in tradable joint with low substitutability in demand shift employment to non-tradable goods.
External (open economy)	
Direct:	
– Trade specialisation (+/-)	Trade specialisation. Countries will be net exporters/importers depending on the relative productivity of tradable and non-tradable sectors.
Indirect:	
– Income (-)	To the extent that trade induces real income growth, the internal income mechanism is enhanced.
– Sectoral relative productivity (-)	To the extent that trade specialisation increases (decreases) the relative productivity (price) of the tradable goods the internal sectoral relative productivity mechanism is enhanced.

Note: The signs in brackets refer to the effect on the employment share in the tradable sector.

A.2 List of countries, split and descriptive statistics

The whole sample of 38 countries obtained by combining the GGDC-10 Sector Database and EU-KLEMS (2009), as explained in Section 3.1, includes: Argentina, Australia, Austria, Belgium, Brazil, China, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong, Hungary, India, Indonesia, Ireland, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Malta, Mexico, Netherlands, Poland, Portugal, South Africa, Slovakia, Slovenia, Spain, Sweden, Thailand, United Kingdom, United States. The sub-sample we rely on when controlling for the relative productivity, i.e. combining the GGDC-10 Sector Database and EU-KLEMS (2009 and 2019) does not include Australia, Korea, Hong-Kong and Malta.

The groups of countries (referring to the largest sample) are:

Mature economies: Australia, Austria, Belgium, Cyprus, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Italy, Japan, Korea, Luxembourg, Malta, Netherlands, Portugal, Spain, Sweden, United Kingdom, United States.

Transition economies: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia.

Developing economies: Argentina, Brazil, China, India, Indonesia, Mexico, South Africa, Thailand.

Table A2: Descriptive Statistics

	Large sample			Restricted sample			Wiod sample		
Variable	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
ln Empl. (T/NT) (D)	1,316	-0.03	0.04	1,019	-0.03	0.04	403	-0.03	0.03
ln GDP per capita (D)	1,316	0.03	0.04	1,019	0.03	0.04	403	0.03	0.04
ln labour prod. (T/NT) D				1,019	0.03	0.05	403	0.03	0.05
ln Exports (D)	1,316	0.02	0.11	1,019	0.02	0.11			
ln Imports (D)	1,316	0.02	0.11	1,019	0.02	0.12			
ln Empl. (T/NT) (lagged)	1,316	-0.46	0.87	1,019	-0.40	0.91	403	-0.89	0.66
ln GDP per capita	1,316	9.35	0.94	1,019	9.25	1.01	403	9.80	0.78
ln labour prod. (T/NT)				1,019	-0.39	0.55	403	-0.17	0.40
ln Exports	1,316	2.89	0.77	1,019	2.79	0.76			
ln Imports	1,316	3.00	0.75	1,019	2.88	0.73			
ln Exports Int. (D)							403	0.02	0.11
ln Exports Fin. (D)							403	0.01	0.10
ln Imports Int. (D)							403	0.02	0.11
ln Imports Fin. (D)							403	0.01	0.09
ln Exports Int.							403	2.51	0.66
ln Exports Fin.							403	2.22	0.65
ln Imports Int.							403	2.68	0.53
ln Imports Fin.							403	2.24	0.56

A.3 Robustness checks

Table A3: Trade composition: merchandise over service trade

VARIABLES	(1) D.Empl. (T/NT)	(2) D.Empl. (T/NT)	(3) D.Empl. (T/NT)	(4) D.Empl. (T/NT)
SHORT-RUN				
EC	-0.0389***	-0.0401***	-0.0329***	-0.0324***
	(0.007)	(0.007)	(0.009)	(0.009)
D.GDP per capita	0.0284	0.0147	0.0893***	0.0798***
	(0.031)	(0.031)	(0.030)	(0.030)
D.labour prod. (T/NT)			-0.386***	-0.388***
			(0.025)	(0.025)
D.Exports	0.0173	0.0113	0.0281**	0.0210*
	(0.012)	(0.013)	(0.012)	(0.012)
D.Imports	0.0330***	0.0273**	0.0277**	0.0217*
	(0.013)	(0.013)	(0.012)	(0.012)
D.Relative Trade (M/S)		0.0269**		0.0305**
		(0.012)		(0.013)
Constant	0.311***	0.304***	0.224***	0.235***
	(0.071)	(0.071)	(0.070)	(0.072)
LONG-RUN				
GDP per capita	-1.096***	-1.043***	-1.002***	-1.051***
	(0.124)	(0.129)	(0.250)	(0.278)
Labour prod. (T/NT)			-0.442**	-0.420**
			(0.208)	(0.212)
Exports	1.073***	1.019***	1.314***	1.344***
	(0.288)	(0.278)	(0.393)	(0.410)
Imports	-0.757***	-0.782***	-0.898***	-0.900***
	(0.250)	(0.244)	(0.319)	(0.326)
Relative Trade (M/S)		0.139		-0.0356
		(0.147)		(0.185)
Observations	943	943	762	762

Note: Standard errors in parentheses; *** $p < 0.01$,** $p < 0.05$, * $p < 0.1$. The dependent variable is the first difference of the relative shares of employment (tradable sector over non-tradable sector). Exports and Imports are computed as share in GDP. Relative tradeis the ratio of merchandise trade over service trade. All the variables are taken in natural logs; *EC* stands for the error correctionterm. *D.* stands for the first difference operator.

Table A4: Baseline with value-added shares at constant prices as dependent variable

VARIABLES	(1) D.VA (T/NT)	(2) D.VA (T/NT)
SHORT-RUN		
EC	-0.0269***	-0.0347***
	(0.007)	(0.008)
D.GDP per capita	-0.0355	-0.0270
	(0.023)	(0.023)
D.labour prod. (T/NT)	0.484***	0.475***
	(0.022)	(0.021)
D.Exports		0.0245**
		(0.010)
D.Imports		0.0287***
		(0.010)
Constant	0.312***	0.306***
	(0.050)	(0.050)
LONG-RUN		
GDP per capita	-1.355***	-0.969***
	(0.288)	(0.177)
Labour prod. (T/NT)	1.083***	0.804***
	(0.250)	(0.162)
Exports		0.649***
		(0.217)
Imports		-0.912***
		(0.237)
Observations	1019	1019

Note: Standard errors in parentheses; *** $p < 0.01$,** $p < 0.05$, * $p < 0.1$. The dependent variable is the first difference of the relative shares of value added at constant prices (tradable sector over non-tradable sector), i.e. the alternative proxy of structural change. Exports and Imports are computed as share in GDP. All the variables are taken in natural logs; *EC* stands for the error correctionterm. *D.* stands for the first difference operator.

Table A5: Results with predictors from gravity

VARIABLES	(1) D.Empl. (T/NT)	(2) D.Empl. (T/NT)	(3) D.Empl. (T/NT)	(4) D.Empl. (T/NT)	(5) D.Empl. (T/NT)	(6) D.Empl. (T/NT)
SHORT-RUN						
EC	-0.0289***	-0.0263***	-0.0358***	-0.0197**	-0.0371***	-0.0286***
	(0.00780)	(0.00938)	(0.00795)	(0.00913)	(0.00788)	(0.00970)
D.GDP per capita	-0.0292	0.0984***	-0.0453*	0.0940***	-0.0305	0.105***
	(0.0238)	(0.0243)	(0.0239)	(0.0242)	(0.0242)	(0.0250)
D.labour prod. (T/NT)	-0.442***	-0.366***	-0.429***	-0.371***	-0.432***	-0.365***
	(0.0232)	(0.0219)	(0.0232)	(0.0219)	(0.0230)	(0.0220)
D.Exports	0.0365***				0.0213**	
	(0.00896)				(0.0105)	
D.Imports			0.0305***		0.0243**	
			(0.00848)		(0.0101)	
D.Exports pred.		0.0412***				0.0349*
		(0.00843)				(0.0212)
D.Imports pred.				0.0353***		0.00710
				(0.00766)		(0.0192)
Constant	0.309***	0.186***	0.319***	0.140***	0.305***	0.181***
	(0.0528)	(0.0565)	(0.0526)	(0.0538)	(0.0521)	(0.0567)
LONG-RUN						
GDP per capita	-1.246***	-0.921***	-0.944***	-0.971***	-0.910***	-0.873***
	(0.265)	(0.224)	(0.176)	(0.315)	(0.163)	(0.200)
labour prod. (T/NT)	0.0690	-0.0937	-0.0302	-0.0551	-0.220	-0.163
	(0.237)	(0.228)	(0.176)	(0.316)	(0.156)	(0.205)
Exports	-0.0732				0.617***	
	(0.136)				(0.209)	
Imports			-0.380***		-0.875***	
			(0.122)		(0.226)	
Exports pred.		-0.0504				0.297
		(0.148)				(0.372)
Imports pred.				-0.113		-0.345
				(0.173)		(0.331)
Observations	923	923	923	923	923	923

Note: Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The dependent variable is the first difference of the relative employment share (tradable sector over non-tradable sector), i.e. the proxy of structural change. Exports and Imports are computed as share in GDP; Export-pred (Import-pred) are predicted by year fixed effects, all bilateral time-invariant variables, regional trade agreements dummy, real GDP per capita of the destination (origin) country and destination (origin) country fixed effects, included in a gravity model. All the variables are taken in natural logs; *EC* stands for the error correction term. *D.* stands for the first difference operator.