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Specialize or diversify? And in What? Trade composition, quality of specialization and persistent growth

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Specialize or diversify? And in What?
Trade composition, quality of specialization and persistent growth⋆

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Abstract. This paper, using a long-term, product-level cross-country dataset, analyzes the trade-growth nexus by introducing two novel indicators able to capture demand and supply attributes of countries' *quality of specialization*. The Keynesian efficiency index measures demand attractiveness of the export baskets, estimating product-level demand elasticities and weighting them by diversification; the Schumpeterian efficiency index tracks the export basket' technological dynamism proxied by product-level patent intensities. These two dimensions of quality of specialization are effective in explaining the rate and volatility of growth and the duration of growth episodes, identified as periods longer than 8 years of 2% average growth and, even more, of exceptional growth episodes ($\geq$5%). Our results, robust to a wide range of control variables, suggest that specialization *per sé* is detrimental for growth resilience while countries with a diversified export structure, specialised either in demand-elastic and technological-dynamic productions are likely to experience longer growth episodes.

Keywords: Structural Change · International Trade · Growth Episodes
JEL classification: F41, O11, O14

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1 Introduction

The relationship between output composition and growth has been a central theme from the dawn of political economy, at least since Serra (1613), who was puzzled by the relative wealth of Venice compared to Naples, despite the lack in the former of most primary resources. Later on, Ferrier (1805) reflected on the role of manufacturing for the potential growth of the European continent, and especially for France. It remained a central theme to address and understand the process of catching-up in List (1904), as reconstructed by Reinert (2007).

The issue boils down to three main inter-dependencies: (i) differences across products in their dynamic increasing returns, (ii) opportunities of learning and innovation, (iii) and income elasticities of demand. The theme is then rediscovered in the technology-gap/evolutionary theory of trade and growth (Dosi, Pavitt, and Soete, 1990) which distinguishes along the foregoing dimensions products and sectors in terms of *Schumpeterian efficiency* (i.e. learning potential) and *Keynesian efficiency* (i.e. demand potential). The bottom-line of the structural-evolutionary theory of growth is that producing potato chips is not equivalent to producing micro-chips in terms of growth potential (Dosi et al., 2021). More recently, such inter-product differences have been captured and studied by means of synthetic indicators combining trade specialization and country performance (Hidalgo et al., 2007; Tacchella et al., 2013).

However, output composition has to be understood vis-à-vis continuing processes of structural change. In fact, national patterns of production and export are not there forever. Indeed, structural changes lie at the core of modern economic growth in such a way that growth and productive structure go intimately hand in hand (Syrquin, 1988):

> Some structural changes, not only in economic but also in social institutions and beliefs, are required, without which modern economic growth would be impossible.
>
> [Kuznets, 1971 , p. 348]

In turn, such patterns of change in the structure of production and export along the development path are far from invariant, but there appear to be robust statistical regularities in the dynamics of broad aggregates such as agriculture, industry and services (Kuznets, 1971). Nonetheless, countries differ in the way they climb up the ladder and ultimately in their success in doing it at all (Chang, 2011). In fact, they might remain stuck in detrimental development trajectories if incurring in bad specialization, such as in goods with stagnant demand and/or productivity, or whose demand is hugely volatile, as the case of natural resources. Conversely, structural change favouring more complex sectors, with greater learning potential, and facing international demand expansions, underpins successful growth experiences (more in Dosi et al., 1990; Dosi et al., 1990; Dosi and Tranchero, 2021).

Not only internal production but also international trade influences growth prospects, enabling countries to take advantage of global demand and potentially circumvent consumption bottlenecks typical of the development process. In turn, the first task of this work, making use of product-level information of export flows, is to detect the importance of the "quality of specialization" on the growth process, accounting for different development stages. In fact, the rates of growth of each country are subject to both short-run fluctuations related to national or worldwide macroeconomic turbulence, on the one hand, and to more persistent structural drivers of change, on the other – e.g. the development of backward and forward intersectoral linkages (Hirschman, 1958), and/or the Schumpeterian "fits and starts" associated with episodes of innovation and imitation.

The empirical growth literature has highlighted that stable trajectories are less common than generally expected. For example, Pritchett (2000) has shown that growth experiences are generally not persistent, both over time and across countries. This is not the place to discuss the tangled relations between "cycle" and "trends". More modestly, we shall try to detect the relevance of the (product) composition of output – proxied by the structure of export – of the various countries for the volatility and persistence of their growth patterns, and together the probability of exceptional growth spells. These are the second and third major tasks of the work.

More in detail, using long-term, cross-country, 4-digit level data on trade flows, we first construct three indicators to characterize countries' productive composition and ensuing trade flows. The first indicator represents a standard Balassa specialization index that neglects any specific feature of each good. This index captures revealed comparative advantages, irrespective of their "quality". The second indicator, labeled *Keynesian specialization efficiency*, reflects demand patterns by weighting export flows' diversification with the product-level income elasticities of importing countries. The third, called *Schumpeterian specialization efficiency*, matches patent and trade data, and weights exports with their patent intensity, taken as a proxy of the opportunity of technological learning which they incorporate.

Next, we investigate the relationship between the three indicators of the structure of export – understood also as a proxy of the structure of good production of a country, lacking direct product-level data – and the patterns of growth. The latter are analysed in terms of first, growth rates; second, growth volatility; and third, duration of the growth spells, i.e. persistent episodes of growth, at least 8 years, above a certain average growth threshold.

Our analysis shows that patterns of increasing sheer specialization negatively correlate with average growth rate, positively affecting its volatility and reducing the duration probabilities of successful growth experiences. The opposite holds for diversification patterns into "virtuous" – i.e. having Keynesian and Schumpeterian efficiencies – productions and exports, displaying higher rates of growth, lower volatility and longer duration of growth spells.

In the remainder of this paper, in Section 2 we outline the state of the art; then, Section 3 introduces our trade composition indices. Section 4 is devoted to the identification of growth spells and the analysis of their drivers. Finally, Section 5 concludes.

2 Output structure, trade patterns and growth: the state of the art

In this section, we briefly overview the conjecture and results on the impact of the composition of output upon growth, mainly from the point of view of the supply side (Subsection 2.1) – the "structuralist" tradition – and of aggregate demand (Subsection 2.2) – the "post-Keynesian" one. Finally, in Subsection 2.3 we briefly discuss the evidence on patterns of growth and its volatility.

2.1 The composition of output matters

We have already mentioned the long "heretic tradition" challenging the Ricardian view according to which trade and international specialization just improve the international allocation of resources and thus world welfare without however affecting growth itself. One of the clearest early statements is by Ricardo himself:

> No extension of foreign trade will immediately increase the amount of value in a country, although it will very powerfully contribute to increase the mass of commodities, and

> therefore the sum of enjoyments. As the value of all foreign goods is measured by the quantity of the produce of our land and labour, which is given in exchange for them, we should have no greater value, if by the discovery of new markets, we obtained double the quantity of foreign goods in exchange for a given quantity of ours.
>
> [Ricardo, 1951, p.25]

On the contrary, the interaction between patterns of specialization and patterns of growth is at the core of the implicit denial of any General Equilibrium view of the international economy and its dynamics. Again, we find a quite sharp statement very early on by Ferrier (1805):

> I compare a nation which with its money buys abroad commodities it can make itself, although of poorer quality, with a gardener who, dissatisfied with the fruit he gathers, would buy juicier fruits from his neighbours, giving them his gardening tools in exchange.
>
> [Ferrier (1805), p.288]

The central importance of mastering domestically the production of capital goods is also in the spirit of the structuralist perspective (Prebisch, 1950; Singer, 1950; Furtado et al., 1964). And, as such, the production of capital goods represents a major source of technological learning in all processes of successful catching-up (see from Hirschman, 1958 to Lee and Malerba, 2016). However, finer sectoral and product desegregation had to wait, in the theory, for the convergence between structuralist and evolutionary approaches (Cimoli, 1988).[1]

At a more historical level, a long debate in which the sectoral composition of output plays a central role concerns the *natural resource curse*. Quite a few of less developed countries are rich in oil, other minerals and agricultural resources, but in most cases, they are stuck in ”vicious” regimes of low technological learning, high variability of export prices and thus of GDP growth, very skewed patterns of the income distribution, often corrupt rent-seeking governments (within an enormous literature, see Sachs and Warner, 1995; Palma, 2005; Cimoli et al., 2009; Alcorta et al., 2021). Of the whole phenomenon, the so-called ”Dutch Disease” is a relatively wild example: export of (temporarily) high-priced mineral resources (in the original case, gas) leading to over-value exchange rates and ultimately de-industrialization tendencies.

We believe that the case on the detrimental composition effect of natural resources upon growth is quite strong. However, one needs to move beyond that particularly striking example to the universe of commodities and services. In this vein, Lall (2000) explores the properties of broad sectors categorised by their R&D intensities. Dosi et al. (2021) distinguishes the patterns of production of different countries according to Pavitt (1984) taxonomy and finds that indeed the possibility and timing of ”early de-industrialization” depends inversely upon specialization in science-based and specialised suppliers sectors.

Product-level export data have been recently used to overcome the sectoral level analysis and better understand the productive structures’ composition. Trade data have two main advantages: they allow first to study the role of export competitiveness in the development process; and second, to deploy a much more detailed source of information, both cross-country and over time.

Along this line, a stream of contributions as those by Hausmann et al. (2007) proposes the Export Sophistication Index based on the idea that each good is “typically” produced at a specific stage of development, attributing to each product the average GDP per capita of the ex-

[1] For an equilibrium variant see Matsuyama (1992).

porting country weighted by export shares of the same product. The attempt is to compute the implicit GDP per capita deriving from the export baskets' and compare it with the actual one to formulate hypotheses on future performances. Similarly, the Open Forrest index (Hausmann and Klinger, 2007) provides a glimpse of the potential dynamic path economies can undertake to move towards higher product sophistication.

However, the "first generation" of these measures puts an overwhelming emphasis just on the specialization in "good" products, yielding quite far-fetched results (a discussion is in Tacchella et al., 2013). A "second generation" of indicators overcomes this problem, duly weighting also the importance of the "quality" of the patterns of diversification. So is the Fitness Ranking (Tacchella et al., 2013), as such a synthetic measure of countries' productive capabilities. This index recursively combines information on the ubiquity of products (i.e. how many countries produce a given product) and countries' degree of diversification into them. The foregoing indices are zero parameter statistics. This is their advantage – they are synthetic indicators which do not require any econometric estimate – but also their drawback – they black box together all technological and economic characteristics of different products. And this is precisely what we shall disentangle in the analysis which follows.

2.2 The demand side: income elasticities and diversification

The emphasis of the literature discussed so far is mainly on the structure of the supply side. However, consumption patterns are indeed fundamental to set in motion the "virtuous cycle" of development (Pasinetti, 1993; Saviotti and Pyka, 2017). Since Engel (1857) pioneering studies, demand has been found to shift from basic needs to more complex ones as income grows. In turn, if the country masters the "right" capabilities, demand shifts might translate into product diversification and match the emergence of new industries (Dosi et al., 2021). Moreover, an expanding demand guarantees improvements in production efficiency due to learning by doing and economies of scale.

All this concerns the structure of domestic demand. However, a fundamental link between the structure of demand and growth goes through the Kaldorian/Post-Keynesian conjecture on a balance-of-payment (BOP) constrained growth rates (Thirlwall, 1979). If growth is demand-driven and demand-constrained as in the whole Keynesian tradition, and if the only genuinely exogenous component of demand is export, then the levels and dynamics of the latter determines the long-term growth of each country. In turn, the structure of import and export and their income elasticities are the underlying determinants (see from Kaldor, 1967 and Thirlwall, 1979 to Dosi et al., 1988 and Cimoli, 1988).

Here, the investigation of the Schumpeterian and Keynesian efficiencies of specialization and diversification patterns bridge the more *micro* evolutionary perspective with the *meso* structuralist and the *macro* post-Keynesian levels of analysis.

2.3 Output growth, volatility and structural shifts

The last centuries have been characterised by an unprecedented rise in living standards driven by processes of cumulative and self-sustained technological advances (see Landes, 1969, Maddison, 1980 and Freeman, 2019, among many). Even if modern economic growth features a remarkably stable exponential increase in income per person, economic prosperity did not spread worldwide. To paraphrase Abramovitz (1986), we recognise rare episodes of catching up and forging ahead while most fall behind. Indeed, moving beyond the global picture, only a few countries closed the gap with economic leaders, whereas the majority observed stagnation and unstable/erratic growth patterns.

At least since the pioneering contribution of Easterly et al. (1993) and later Pritchett (2000), the economic growth literature has well acknowledged the importance of output volatility in the development process. Long-run growth averages hide a persistent instability in the growth rates, especially in developing countries. Ubiquitous tent-shaped income growth rate distributions imply more frequent extreme events (i.e. crisis or miracles) than those predicted by a Gaussian distribution (Fagiolo et al., 2008; Castaldi et al., 2009; Bottazzi and Duenas, 2012 and Campi and Dueñas, 2020).

Indeed, volatility is a quite broad concept and ranges from simple movements of the averages along a trend to structural shifts in the dynamics of the long-run trend. Severe volatility might indeed be the source of the beginning of new growth and development cycles, quite far from the simple variation captured by the standard deviations. Volatility might therefore turn into breaks defining the beginning of new growth episodes, fuelled by the hysteretic properties of macroeconomic time series, which under some circumstances, mainly structural crises, present strong remanence and persistence in the memory process (Dosi et al., 2018).

Going beyond the macroeconomic dichotomy between trend and business cycle, Ramey and Ramey (1995) finds that volatility and growth show a negative correlation, with the former having a long-run impact on the latter. Gradually, the literature has added to cross-country long-run analyses and panel regressions based on average growth rates also the study of distinct growth episodes. So, for example, Pritchett (2000) shows that a single time trend is often not adequate to understand the evolution of income per capita and proposes to break it down into shorter trends characterised by a different average growth rate. Using either statistical tools (Jones and Olken, 2008; Berg et al., 2012) or simple rules of thumb (Hausmann et al., 2005; Aizenman and Spiegel, 2010), or both (Kar et al., 2013; 2016), it is possible to split GDP per capita time series into distinct growth episodes separated by a clear trend-shift. Such literature has introduced therefore the notion of growth spells. This framework allows to study the characteristics of successful episodes, but also failures, take-offs and stagnation (see Hausmann et al., 2005; Jones and Olken, 2008; Aizenman and Spiegel, 2010; Berg et al., 2012; Bluhm et al., 2016; Foster-McGregor et al., 2015). For these reasons, this methodology is the best suited to investigate developing countries' growth experiences often characterised by "booms and bursts" dynamics.

There are subtle but important differences in the interpretation of such persistent discontinuities. In one view, they are mainly due to political and institutional shocks (the implicit assumption being that otherwise, each economy would have marched to some equilibrium steady-state). Conversely, in another perspective, the foregoing breaks, discontinuities and fluctuations are an inherent feature of capitalist development that are influenced in their depth and duration by the institutional characteristics of each economy, revealed for example by the degree of inequality in income distribution (Berg et al., 2012), but also by its technological capabilities and its productive structure.

In that, the analysis which follows is well in line with more scattered incumbent evidence. For example, it happens that natural resource exporters are less likely both to "sustain" take-offs and keener to lengthy stagnation (Aizenman and Spiegel, 2010; Minoiu and Reddy, 2010). Similarly, Berg et al. (2012) find preliminary evidence that more sophisticated export is likely to extend the length of growth episodes. Building on the structuralist and evolutionary tradition, Foster-McGregor et al. (2015) focuses on the relationship between productive systems' structural characteristics and their ability to sustain growth, finding that higher manufacturing shares and a more diversified productive structure contribute to lengthening growth episodes.

In the following, we shall go further in identifying the "quality of specializations" and their links with patterns of growth.

3 Trade anatomy and patterns of growth: data and indicators

Let us now turn to our data sources and the indicators evaluating countries' trade specialization strategy, namely, a standard revealed comparative advantage indicator (RCA thereafter), a Schumpeterian efficiency indicator (SE thereafter), a Keynesian efficiency indicator (KE thereafter), updating and refining the indices proposed in Dosi et al. (1990).

Data Sources We first employ export and import data from the United Nations International Trade Statistics Database (UN-COMTRADE) for 170 countries starting in 1962, at 4-digit product level. However, the high heterogeneity in product classification across countries and time demands the reconstruction of time consistent series, involving the aggregation of some product classes from 4- to 3-digit level.

In order to construct the Schumpeterian efficiency index, we employ the USPTO database linking 4-digit IPC classes to 4-digit SITC categories. This dataset contains the universe of patents released by the USPTO from 1962 onward.

Finally, we employ the Penn World Table 9.1 (Feenstra et al., 2015) and the World Development Index from the World Bank for country-specific variables used as controls in the econometric analysis. The only exceptions are education variables drawn from the Barro and Lee (2013) dataset. Appendix A lists descriptive statistics and sources of all variables used.

Revealed Comparative Advantage Intensity A standard proxy to measure the degree of specialization of a given country is the Revealed Comparative Advantage Index (RCA) (Balassa, 1965): as known, it simply compares a country's export share in a given product to the share of the same exported product in the world export.

Given $x_{i,k}$ as the export flow of country i in product k the RCA is:

$$RCA_{i,k} = \frac{x_{i,k} \;/\; \sum_i x_{i,k}}{\sum_k x_{i,k} \;/\; \sum_i \sum_k x_{i,k}} \tag{1}$$

To obtain a time-dependent, country-level measure, we compute the *RCA intensity* using product-level export shares as weighting factors.[2]

$$RCA\ intensity_{i,t} = \sum_k \frac{x_{i,k,t}}{\sum_k x_{i,k,t}} \cdot Log\,(1 + RCA_{i,k,t}) \tag{2}$$

Appendix A shows descriptive statistics disaggregated by stages of development at the country level. Overall, low-income countries show higher specialization intensities than high-income ones.[3]

It is important to identify also in what type of sector/product specialization occurs. Figure 3 compares specialization intensity distributions across Pavitt's classes (Pavitt, 1984; Dosi and

[2] We take the log-transformation of country-product RCA to smooth extreme values, adding 1 to RCA to have a lower bound in 0.

[3] Roughly in line with Imbs and Wacziarg (2003) according to whom advanced countries, after a diversification phase, however, tend to specialise again in technology-intensive sectors.

Nelson, 2010) plus natural resources, distinguishing between developing (left-hand side) and developed countries (right-hand side), as defined by the United Nations, enabling a comparison across sectors and development stages. To recall, Pavitt Taxonomy is one of the most widely adopted sectoral-technological classifications based on the type of technology employed in the production processes where the knowledge they embody comes from the type of products they yield and how learning takes place. It aggregates 2-digit sectors in four categories, named from the most to the least technological advanced, *science-based*, *specialised suppliers*, *scale intensive*, *supplier dominated*. The first two classes have also been mainly associated with capital goods and intermediate inputs, hence "upstream" classes, and the other two with final goods, hence "downstream" (Dosi et al., 2021).

In all classes, the supports of the distributions are wide, showing the coexistence of heterogeneous specialization patterns across technological classes and development levels. Overall, developing countries are more specialised in downstream and natural resources sectors, while developed in upstream ones. Natural resources and supplier dominated productions drive the high specialization intensities of developing countries. Conversely, the remaining three Pavitt classes are right-skewed, with Specialised suppliers showing the longest right tail. Developed countries present a far more balanced export structure with specialization intensities close to one in all five groups. Distributions' supports are narrower and relatively similar across classes. However, natural resources and suppliers dominated classes present higher specialization levels and wider distributions. This evidence alone already provides a glimpse of the association between extreme degrees of specialization and lower levels of development.

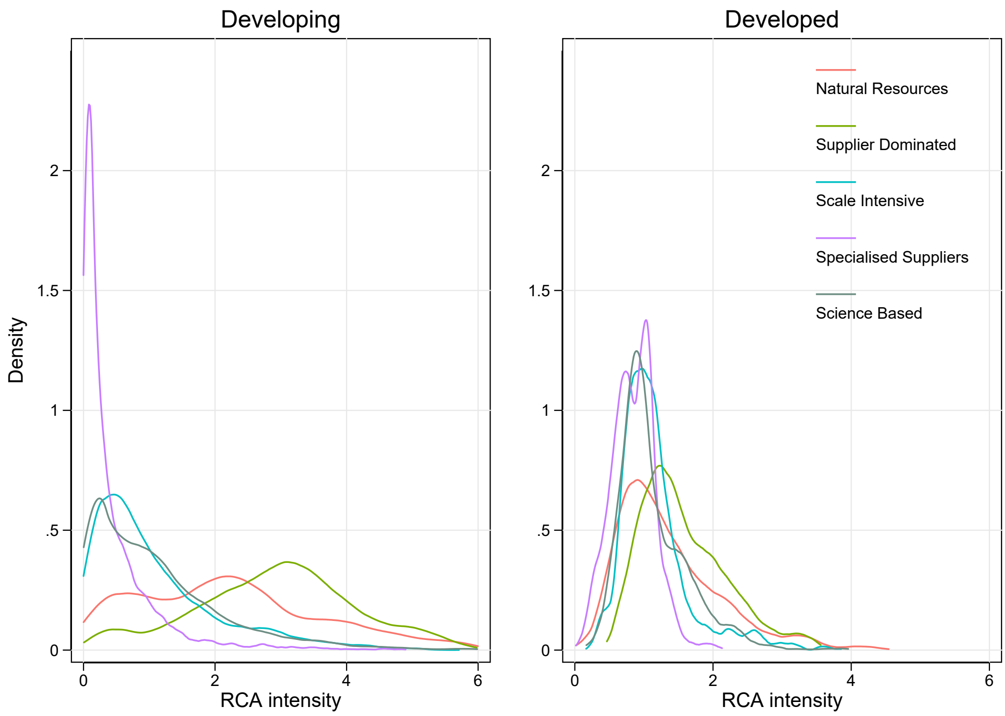

Fig. 1. Kernel density distribution of RCA intensity by development level and Pavitt classes.

Figure 3 shows the export baskets' composition and its evolution over the period 1962-2010, in terms of Pavitt taxonomy (plus natural resources), unweighted averages across world regions. Indeed, the patterns highlight how development unfolds, switching production/export toward more advanced technological sectors. First, natural resources and supplier dominated productions are the most volatile over time. This instability partly reflects price volatility. Second, supplier dominated and natural resources exports taken together account for more than 70% of export flows in all regions but North America, Europe, Japan and the Asian miracles, in which traditional sectors account for around 50% of total export. Third, upstream sectors steadily expand in all regions but at remarkably different paces, except in Sub-Saharan countries. They reach almost 20% of total export in Asia and Latin America and go beyond 40% in Europe and North America. Not surprisingly, China shows the most remarkable performance with a steady increase in both specialised suppliers and science-based sectors, while supplier dominated sectors reduce their shares.

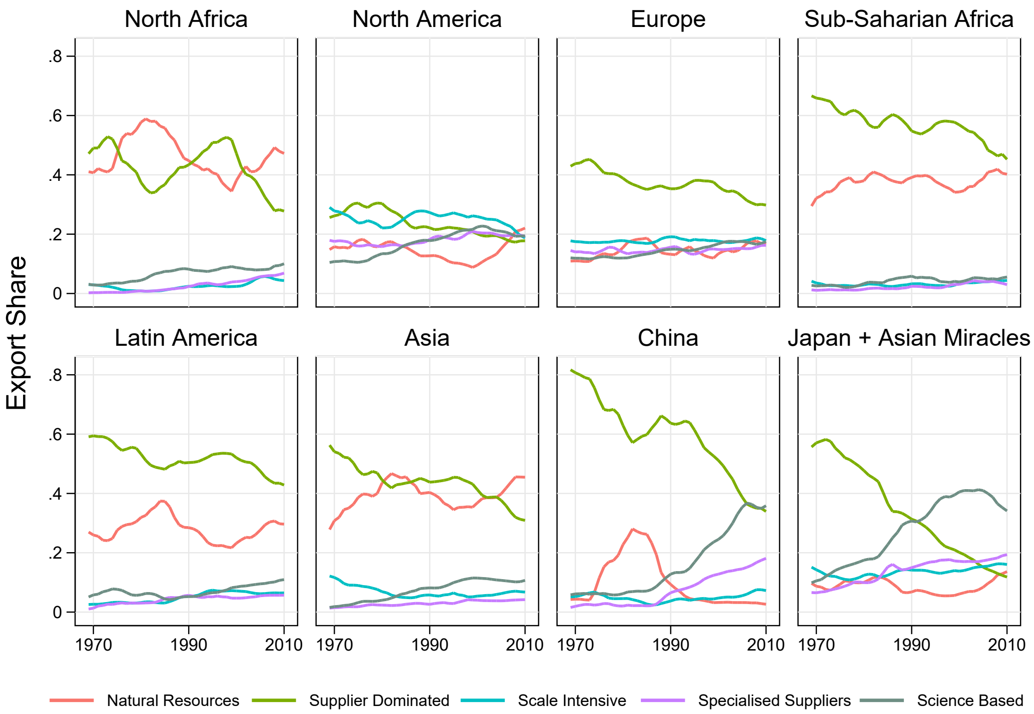

Fig. 2. Time evolution of export shares by Pavitt classes across World's regions. Each line represents the mean value of the corresponding region. The five aggregated shares might not sum up to 1 since we excluded "special productions" (section 9 of SITC Revision 2 classification).

Schumpeterian efficiency Schumpeterian efficiency is meant to capture the "technological quality" of the productive structure of a country proxied here by its export patterns. The difficult task is to detect the underlying potential of learning – in terms of innovation and imitation – by products and sectors. Of course, imitation shall be more important in catching-up countries, but it is reasonable to consider the learning opportunities higher in some products than in others, irrespective of the level of development: pharmaceutical products are more likely to have higher learning opportunities than a t-shirt.

We link 4-digit International Patent Classification data from USPTO to SITC Rev. 2 4-digit product classes using the probabilistic crosswalk proposed by Lybbert and Zolas (2014). We compute the 8-year cumulative patents count and attribute the technology-class patent measure to the ensemble of products belonging to the 4-digit category. Finally, we measure product-specific patent intensity comparing products total world export with their patent shares. In a relatively loose analogy with RCA, we call it Revealed Patenting Advantage Index (RPA):

$$RPA_k = \frac{\frac{Pt\ count_k}{\sum_k Pt\ count_k}}{\frac{\sum_i x_{i,k}}{\sum_i \sum_k x_{i,k}}} = \frac{Patent\ count\ share_k}{Export\ share_k} \tag{3}$$

where k stands for products and i for countries. An RPA greater than one means that the product has a patent share higher than its world export share. Therefore it is more technologically/patent-intensive than trade intensive.

This index has still the drawback that the product-specific opportunities vary a lot within each class: even at the 4-digit level, there are relevant differences across products (moon boots and shoes are in the same category). Granted all that, we suggest that the index still captures some information on the different learning opportunities by sector and by product.[4]

The top panel of Figure 3 presents the time evolution of patent shares by ISIC categories, the numerator of the RPA index. Corroborating our index, Machinery, ICT and Chemical sectors represent the lion share covering almost 50% of total patents granted in the final decade. Note also that patent shares show the booming technological opportunities in the ICT sectors after the 1990s. The bottom panel of Figure 3 presents the distributions of the RPA over the whole period under consideration. As a check, we compared the index across broad ensembles of sectors. Chemicals plus Pharmaceutical lead, followed closely by ICT and Industrial Machinery. At the opposite extreme appear Food and Beverage and Natural Resources.

To aggregate the product-level RPA index at the country level, we sum the export shares of those products having Revealed Patenting Advantage greater or equal to one (i.e. with above-average patenting intensities):

$$SE_{i,t} = \sum_k xsh_{i,k,t} \qquad \forall \quad k: \ RPA_k \geq 1 \tag{4}$$

Keynesian efficiency The notion of Keynesian efficiency is meant to capture the varying degrees of responsiveness of countries' production to the evolution of international demand and shifts in specialization patterns toward sectors whose market grows faster. That is basically the income elasticity of demand of the various products. Ideally, one would like to have these measures on the total demand of each product conditional on different income levels and their dynamics. Statistically short of that, we must revert to the elasticities of exports to the income of importing countries.

We define as *dynamic* those goods whose international demand grows faster than the GDP/c of the importing countries (i.e. the elasticity of demand for import is greater than one). We estimate product-specific income elasticity for import based on the following 8-years rolling equation:

[4] Note that here we use patent-intensity as an admittedly very noisy proxy of Schumpeterian opportunities, forced to neglect the intersectoral variability in the degree and forms of appropriability of innovation. More in Dosi and Nelson (2010).

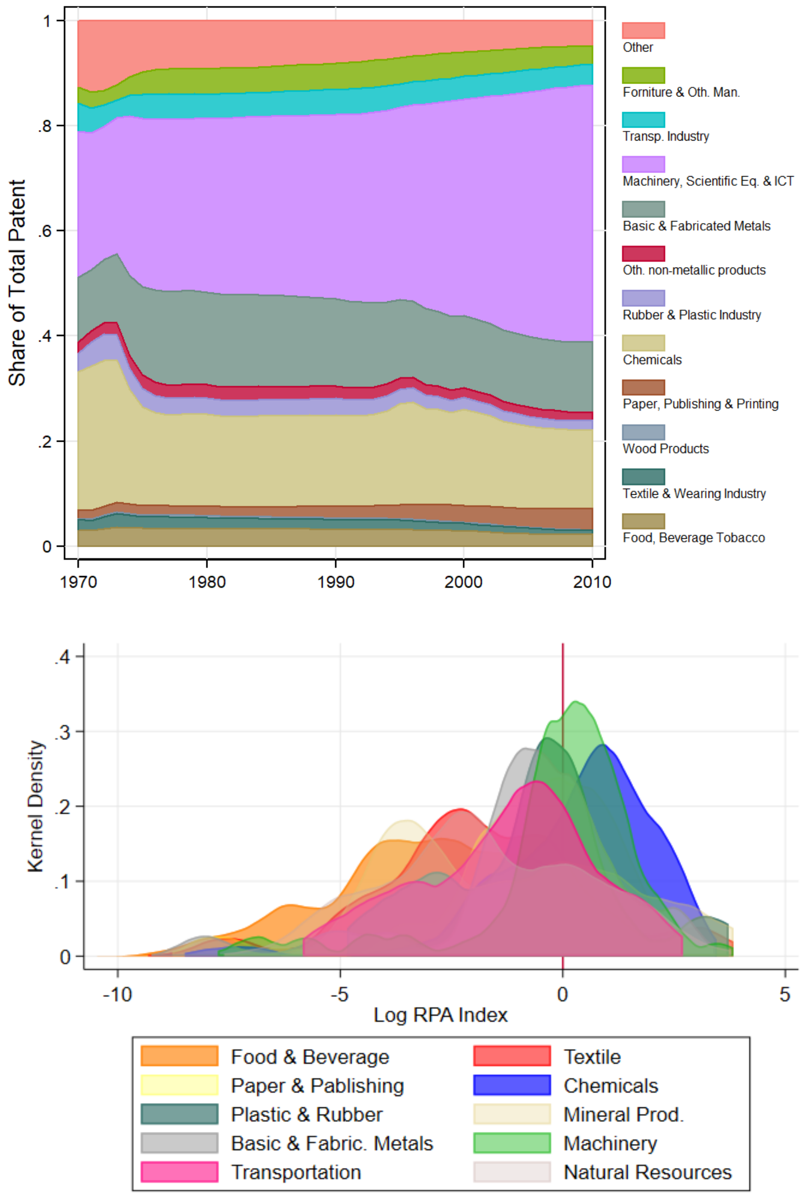

Fig. 3. Top: Patent share evolution by ISIC classes. Bottom: kernel density distribution of product level Log RPA divided by Pavitt Classes in the period 1970-2010.

$$x_{k,i,j,t} = \alpha_1 + \alpha_2 \cdot y_{i,t} + \alpha_3 \cdot xr_{i,t} + \alpha_4 \cdot pop_{i,t} + \alpha_5 \cdot \sum_{w \neq j} x_{k,i,w,t} + \gamma_i + \delta_{j,t} + \omega_t + \epsilon_{k,i,j,t} \tag{5}$$

where j and w stand for the exporter, i the importer, k the 4-digit product-level code. Equation (5) regresses the log-transformed bilateral trade flow of product k in time t between importer j and exporter i on the log income per capita of the importer ($y_{i,t}$), the importer exchange rate ($xr_{i,t}$), and the importer population to account for possible size effects ($pop_{i,t}$). Further, to account for possible substitution effects between exporters we introduce the total import of product k by importer i minus the trade flows on the left-hand side. Finally, to account for exporter time-varying factors, we add exporter-year fixed effect ($\delta_{j,t}$), while γ_i and ω_t are respectively importers fixed effect and year fixed effect.[5] The coefficient α_2 represents the dynamic product-specific demand elasticity for imports. Appendix C shows the R^2 of the regression and p-values correspondent to α_2, our coefficient of interest.

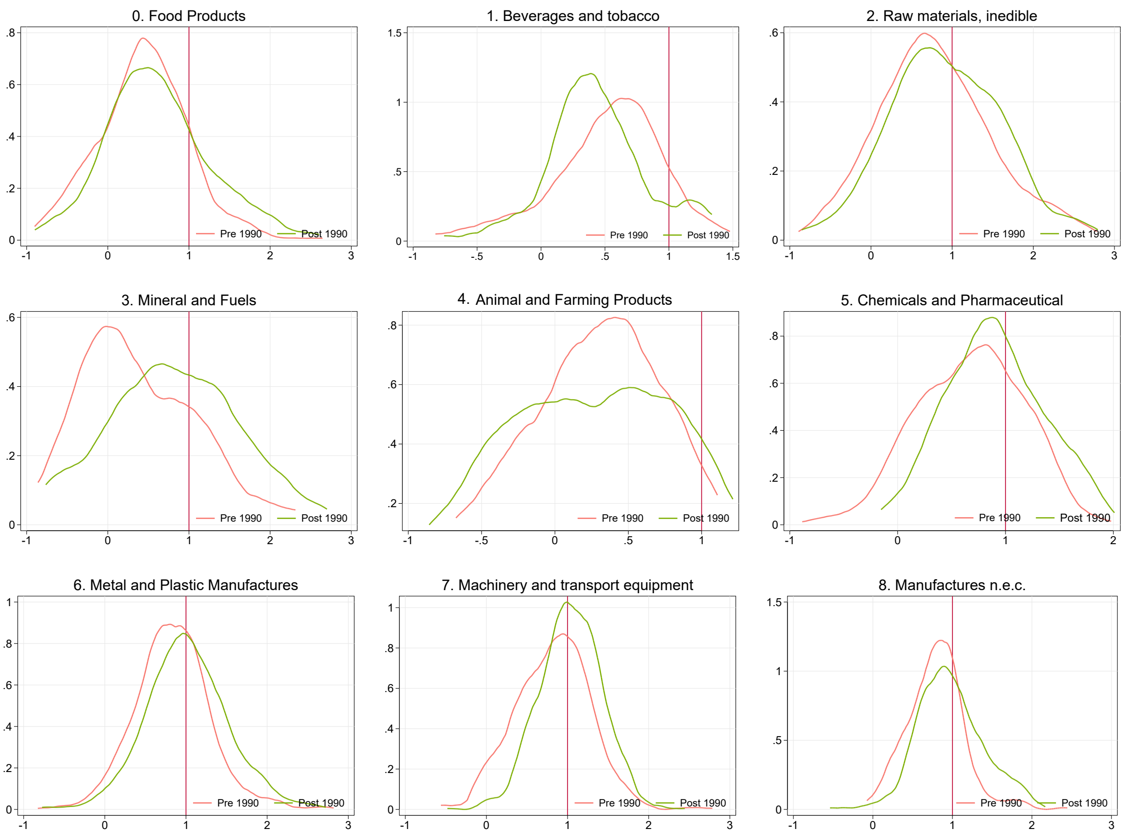

Fig. 4. Pre- and post- 1990 kernel density distributions of α_2 of eq. 5 at 1-digit Standard International Trade Classification.

Figure 4 presents the kernel density plots of α_2 of eq. 5 at 1-digit of standard International trade classification. The distributions are split in before and after 1990 to highlight the possible time shifts due to globalization (Rodrik, 2016). The red vertical line (at elasticity=1) constitutes the reference level. Indeed, the observation falling on the left (right) of the red line are those

[5] Implicitly, we are assuming that prices are homogeneous within product-exporter-year.

for which an increase in income per capita corresponds to a growth in imports less (more) than proportional. In analogy with Dosi et al. (1990), we call dynamic products those having income elasticity greater than one.

The categories [0-4] represent agricultural and natural resources-based goods, while [5-8] primarily represent manufacturing products. First, we notice that manufacturing products densities have narrower supports, with chemicals as the only exception. Wider distributions translate into higher dispersion for agricultural and natural resources based productions. Second, notice that products in the first ensemble are left-skewed, and most observations are on the left of the red line (i.e., $\alpha_2 < 1$). Particularly, agricultural productions (codes 0, 1 and 4) display very few products classified as dynamics. Manufacturing goods classified as materials, machinery, and transport equipment belong to broad categories with more frequent import elasticities greater than one. Looking at time shifts, manufacturing broad categories (codes 5, 6, 7) witness a rightward shift and, therefore, improvements in average group elasticities, while beverages and tobacco toward the left.

Figures 5 and 6 show a graphical representation of the time evolution of product-level import elasticities at 4-digit. Each heat map represents a group of products defined by the first digit of their SITC Rev. 2 code. The analysis allows to detect both within and between heterogeneity across product categories.[6] Notably, the estimation of time-varying elasticities at 4-digit informs about heterogeneity within sectoral aggregates, evolving over time. In addition, a widespread heterogeneity emerges across each macro-product group signalled by red (high-dynamic products) versus blue (low-dynamic products) heat maps. Machinery and transportation equipment, the darkest red map, is the sectoral aggregation wherein elasticities are higher and more homogeneous across sub-categories, with the majority of products having average elasticities greater than one. Similarly, chemicals, although with lower elasticities. Overall, manufacturing related classes behave better along three dimensions: first, more products are 'dynamic'; second, they are characterised by lower dispersion; finally, manufacturing goods improve their elasticities over time. In contrast, food and beverage and animal-derived productions are characterised by lower income elasticities along the entire time span. Finally and in line with expectations, crude materials and fuels display the most volatile behaviour, with several products having extreme elasticities, both with positive and negative values. In line with the super-cycle literature (Erten and Ocampo, 2013), we find higher income elasticities in the final decades especially in natural resources based productions.

To transform product level elasticities into country-level indicators, we use a transformation of export shares putting a premium on diversification across products. Thus, instead of aggregating using simple export shares, as in the RCA intensity, we employ "entropy-transformed" weights which penalise concentration:[7]

$$e_{i,k,t} = -\frac{x_{i,k,t}}{\sum_k x_{i,k,t}} \cdot log_2(\frac{x_{i,k,t}}{\sum_k x_{i,k,t}}) \tag{6}$$

Therefore the final Keynesian efficiency Index will be:

$$KE_{i,t} = \sum_k e_{i,k,t} \cdot \alpha_{2_{k,t}} \tag{7}$$

[6] We exclude the residual group "Other commodities and transaction n.e.c." (1-digit SITC Rev. 2 code 9).

[7] Entropy is a diversification index widely used in economic literature. Saviotti and Frenken (2008) among the others employ this indicator to evaluate related and unrelated varieties of export structure.

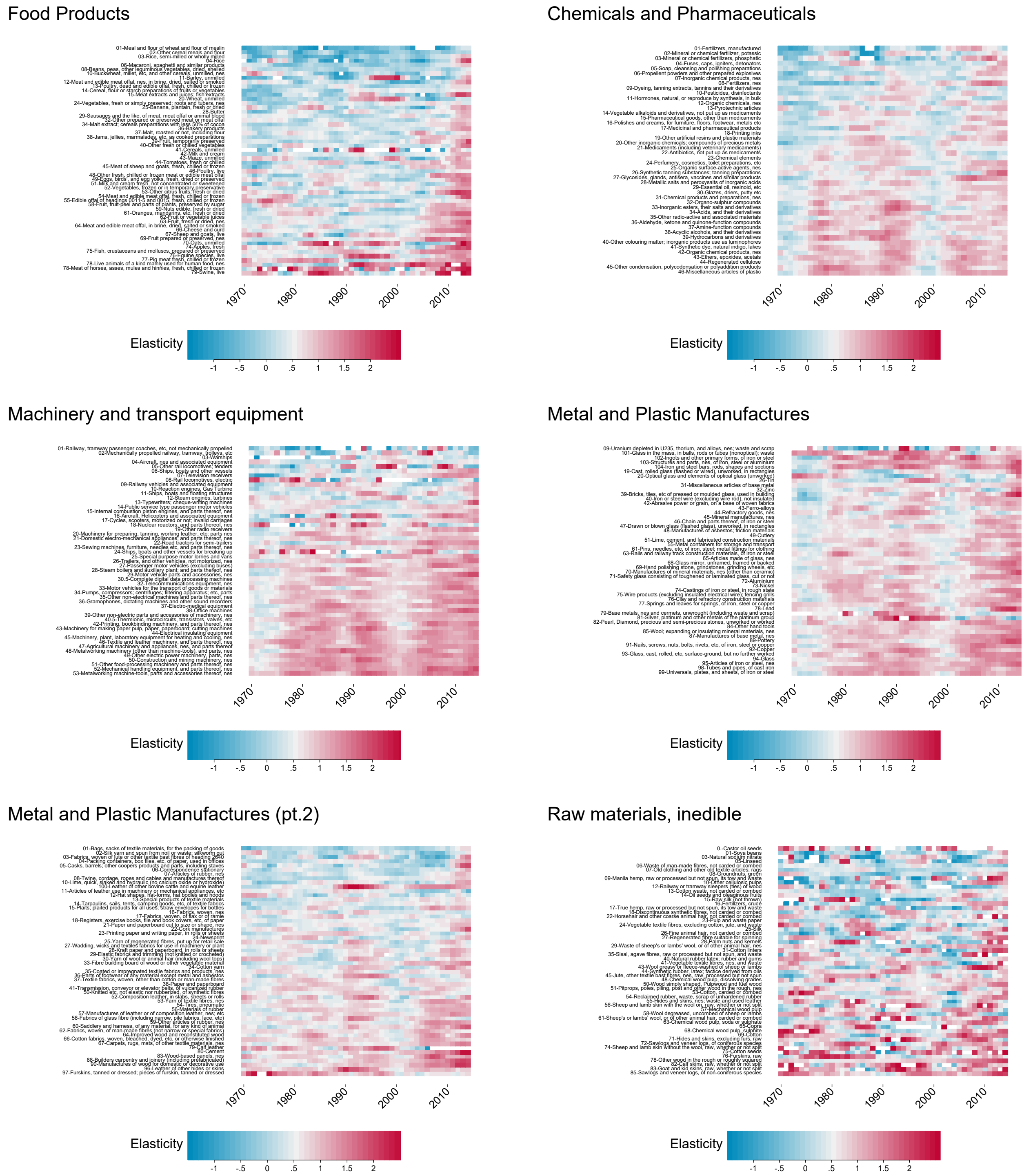

Fig. 5. Heat map. Time evolution of α_2 product-level coefficients estimated using eq. 5. We exclude from the analysis "Other commodities and transaction n.e." (1-digit SITC Rev. 2 code 9).

3.1 Specialization patterns, average growth and volatility

Let us now analyse the evolution of country-level indices of RCA-intensity and Keynesian and Schumpeterian efficiencies.

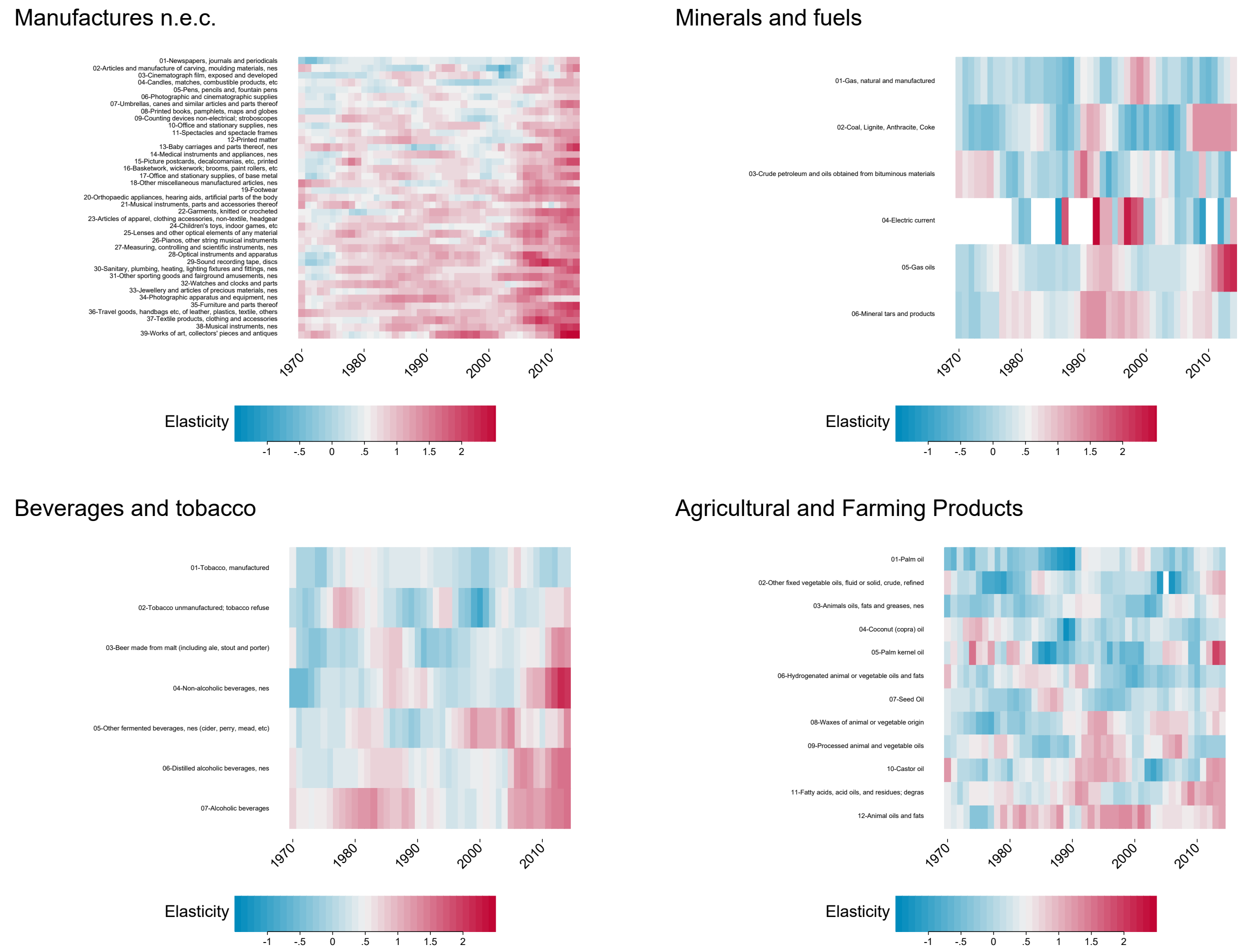

Fig. 6. Heat map. Time evolution of α_2 product-level coefficients estimated using eq. 5. We exclude from the analysis "Other commodities and transaction n.e.c." (1-digit SITC Rev. 2 code 9).

	RCA Intensity				**Schumpeterian Efficiency**				**Keynesian Efficiency**			
	1970s	*1980s*	*1990s*	*2000s*	*1970s*	*1980s*	*1990s*	*2000s*	*1970s*	*1980s*	*1990s*	*2000s*
North America	0.149	0.123	0.107	0.108	0.239	0.241	0.211	0.211	0.618	0.717	0.878	1.019
Europe	0.200	0.172	0.166	0.169	0.243	0.274	0.223	0.206	0.632	0.771	0.833	0.964
Japan & Asian Miracles	0.215	0.164	0.131	0.135	0.253	0.304	0.293	0.324	0.638	0.751	0.805	0.913
China	0.228	0.162	0.146	0.131	0.195	0.202	0.273	0.306	0.714	0.696	0.807	1.031
Asia	0.365	0.308	0.296	0.279	0.084	0.101	0.114	0.107	0.457	0.470	0.598	0.706
Latin America	0.358	0.336	0.316	0.318	0.138	0.147	0.140	0.129	0.433	0.424	0.553	0.642
North Africa	0.357	0.302	0.302	0.243	0.077	0.113	0.122	0.094	0.400	0.412	0.621	0.782
Sub-Saharan Africa	0.458	0.428	0.430	0.428	0.055	0.048	0.055	0.061	0.345	0.266	0.388	0.486

Table 1. Evolution of RCA intensity, Schumpeterian and Keynesian efficiency. Indexes are average across macro-regions and decades.

Table 1 shows the evolution of the three indices across 8 macro-regions. Starting from the RCA intensity, we notice three different patterns, inside an overall negative ordering among (above the mean) revealed comparative advantage and (low) GDP/c at the macro-regional level. First, Sub-Saharan Africa fails in reducing specialization, increasing its productive concentration in the period. Second, Asia and North Africa, starting from above average, slightly reduce their specialization intensities while Latin America, after a first declining specialization period, witnessed a reversal tendency toward specialization in the last two decades; finally, the more advanced regions Europe, North America and Japan together with China and the Asian Tigers, starting from already low levels, maintain their relatively low specialization status.

Moving to SE (Schumpeterian Efficiency) index, we observe a reversal ordering in the index, with higher values now characterizing the richest macro-regions and the successful development experiences (i.e. China and the Asian Tigers). Europe and North America display similar patterns experiencing the relative peak in production with above-average patenting intensities in the 80s. Interestingly, China shows the most successful performance with a steady increase. North Africa, Latin America and Asia present relative fluctuating performances but never exceed 10% of total export with RPA ≥ 1. Again, distant from all other regions, Sub-Saharan Africa displays the worst performance with only a negligible and declining part of export characterised by high technological intensities.

The third panel shows the Keynesian Efficiency (KE) index, which is not that different from the SE index in terms of ordering. In this case, China and Asian Tigers already start from a good position and steadily improve their relative status. While, from 1990 onward, Latin America worsens its performance relative to the other macro regions. Notably, regions with similar export structures present the same patterns, particularly true for Europe and North America among rich countries and Asia and North Africa among developing macro regions.

The next step concerns the relationship between specialization patterns, growth and its volatility. Indeed, any significant correlation between average growth and specialization efficiencies would suggest that trade structure impacts upon the average countries' performance. And likewise the links with the variability and length of growth spells.

As a first introductory exploration, Figure 7 divides observations into quartiles based on the distribution of decade average growth and decade volatility. The x-axis shows the average value of the quartile in ascending order, while the boxes present the main statistics of specialization indices' distributions (i.e. median - interquartile range and adjacent values). Growth is defined as the log-difference in GDP/c over 10 years, and volatility as the standard deviation of the yearly difference in the logarithm of income per capita computed for each decade. The top panel of Figure 7 shows a negative relationship between average growth and specialization intensity, and conversely a positive one for Keynesian and Schumpeterian efficiencies. This positive relationship is not always statistically significant comparing the first and the second quartiles, while it is significant at the 1% level when we compare the first with the last two groups. Moving to volatility, we detect two clear patterns between the first and last two volatility quartiles. The correlation pattern is positive with volatility in the RCA index and negative for Schumpeterian and Keynesian specialization efficiencies.[8]

[8] Appendix D presents the Kolmogorov-Smirnov tests assessing the null hypothesis of equality of the distributions. In all three cases, the distributions of the first two quartiles are statistically different from the last two. In contrast, only for RCA intensity and Keynesian efficiency, the first and the second quartiles reject the null hypothesis of equality of the distributions of the K-S test.

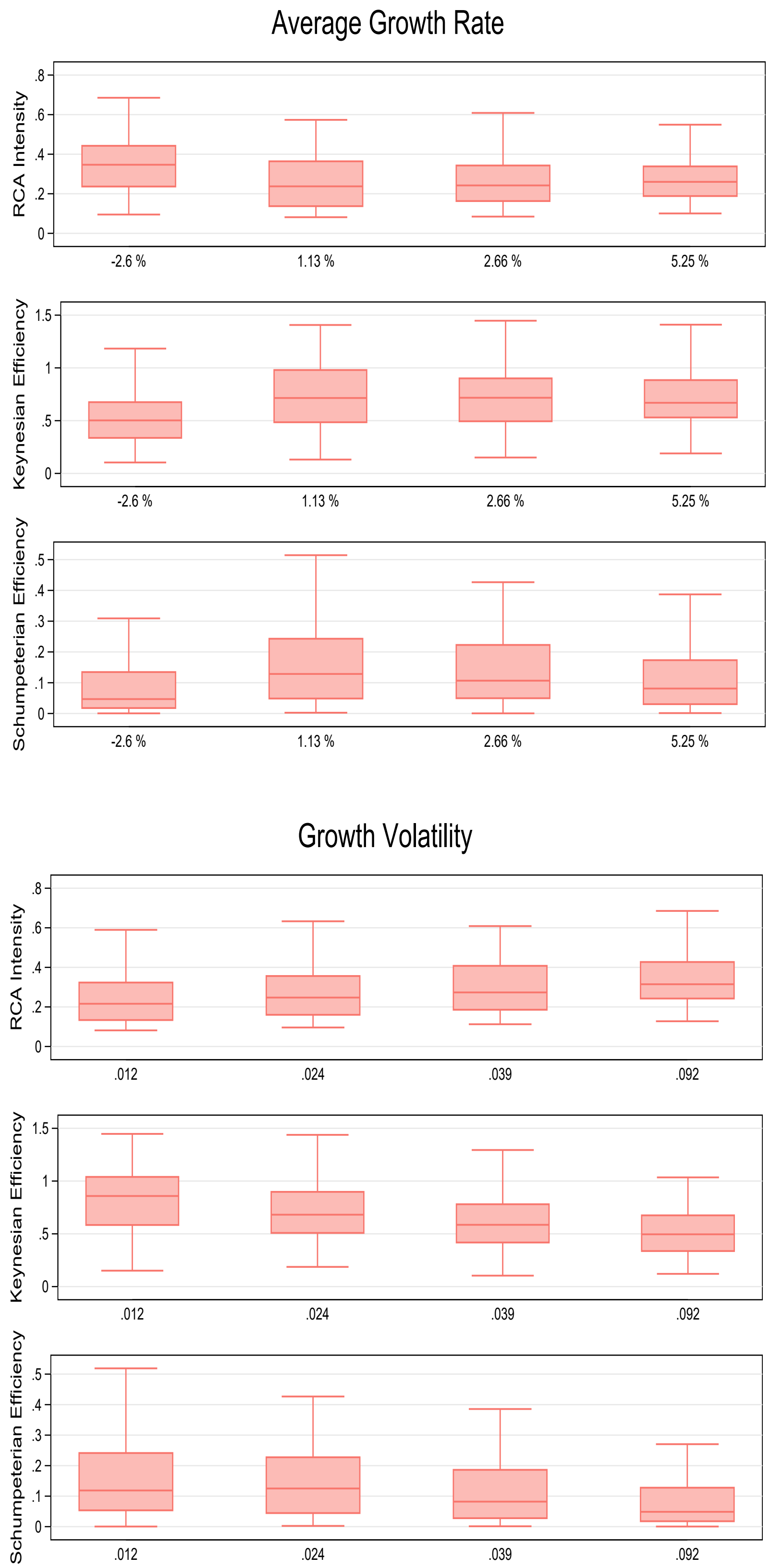

Fig. 7. Box plots by quartiles of ten-year output growth (top) and volatility (bottom).

As further evidence, we estimate the effect of trade structure on growth and volatility using the following equation and evaluating the impact of RCA intensity, and the Keynesian and the Schumpeterian efficiency indices:

$$Y_{i,p} = \alpha Y_{i,p-1} + \beta TradeStructureIndex_{i,p} + \delta X_{i,p} + \gamma_p + \epsilon_{i,p} \quad (8)$$

where Y stands for average growth or volatility of country i over p (= 5 or 10 years) periods, measured as the standard deviation of the yearly difference in log GDP/c computed for 5 and 10 years non-overlapping periods; trade structure indices stand for our three variables described above; X is a set of controls. All regressors are correspondingly computed as averages over the period p. Our controls include trade openness, inflation volatility, exchange rate volatility and the log of initial GDP/c. We estimate equation 8 using system GMM.

Tables 2 and 3 show the regression results. The trade structure coefficients are all significant. Starting with RCA intensity, it negatively affects, with non-negligible magnitudes, growth over both 5 and 10 years, while it positively affects volatility. Keynesian and Schumpeterian efficiencies are instead both positively correlated with average growth. However, Schumpeterian efficiency, as measured here, fails to be significant. This is probably due to the changing relationship between technology and growth.[9] Stronger and both statistically significant are instead the coefficients on volatility, reporting elasticities of -3% and -5% respectively. Such results hold for both 5 and 10 years time windows, therefore quite effective in the medium run.

4 Growth spells and their determinants

We now move to the inspection of the effects of our quality of specialization indices on growth episodes, expressed in terms of duration, also motivated by previous evidence on volatility.

4.1 Growth episodes identification

We implement the "*fit and filter*" methodology (Kar et al., 2013) for growth regime identification. The procedure involves two steps.[10] In the first one, the "optimal" number of structural breaks based on the length of the series is identified (Bai and Perron, 1998). The breaks can be up-breaks if followed by a growth period or down-breaks if followed by a collapse. In the second step, the authors propose three rules to identify breaks as "significant":

1. For the first candidate break of a series, any change of more than 2% (up or down) is considered a significant growth break since the previous history is unknown. Once the first significant break is identified, the subsequent thresholds depend on the previous history.
2. If an up-break follows a previous down-break or vice versa, then to qualify the break as significant, the absolute magnitude of the growth difference between the two regimes must be greater than 3%.
3. If a candidate up-break follows another up-break then an acceleration of only 1% is sufficient to be considered a significant growth break.

The number of growth spells identified and the duration are comparable with Kar et al. (2013). The main differences are due to the different raw data employed (PWT9.1 instead of

[9] For instance, Castaldi et al. (2009) finds that patenting activities is significantly correlated with growth only up to 1990 while this relationship fades away in the last decades.

[10] For a detailed explanation of the procedure see Kar et al. (2013); Pritchett et al. (2016).

	Dependent Variable: GDP/c Growth Rate					
	(1)	(2)	(3)	(4)	(5)	(6)
	5-years panel			*10-years panel*		
	RCA Int.	**KE**	**SE**	**RCA Int.**	**KE**	**SE**
Lag Growth Rate	0.118**	0.153***	0.162***	0.0455	0.0578	0.0667
	(0.013)	(0.002)	(0.002)	(0.412)	(0.339)	(0.261)
Init. GDP/c	-0.0209***	-0.00617**	-0.00238	-0.0160***	-0.00369	-0.00121
	(0.000)	(0.025)	(0.367)	(0.000)	(0.125)	(0.603)
Openness	0.00527	0.0147**	0.0135**	0.00821**	0.0127***	0.0141***
	(0.254)	(0.011)	(0.022)	(0.035)	(0.005)	(0.005)
SD Exchange Rate	0.000230	0.000639*	0.000508	-8.72e-06	0.000335	0.000256
	(0.563)	(0.076)	(0.188)	(0.975)	(0.250)	(0.477)
SD Inflation	-0.0950***	-0.107***	-0.0877***	-0.0234	-0.0108	-0.00907
	(0.000)	(0.000)	(0.001)	(0.269)	(0.612)	(0.660)
RCA intensity	-0.191***			-0.159***		
	(0.000)			(0.000)		
Keynesian E.		0.0313**			0.0367**	
		(0.014)			(0.018)	
Schumpeterian E.			0.00816			0.00492
			(0.677)			(0.789)
AR(2)	0.158	0.156	0.153	0.085	0.494	0.566
Hansen Test	0.176	0.207	0.153	0.221	0.139	0.097
Year FE	YES	YES	YES	YES	YES	YES
N of countries	144	144	144	144	144	144
N. of Instruments	139	139	139	126	126	126
Obs.	1,024	1,024	1,024	575	575	575

Table 2. Regression results of eq. 8. Dependent Variable: GDP/c growth rate. For GMM-SYS estimation we use up to 3 lags as instruments in the 5-year panel and up to 2 for the 10-year panel. P-value in parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

	Dependent Variable: GDP/c Volatility					
	(1)	(2)	(3)	(4)	(5)	(6)
	5-years panel			*10-years panel*		
	RCA Int.	**KE**	**SE**	**RCA Int.**	**KE**	**SE**
Lag Volatility	0.318***	0.317***	0.301***	0.290***	0.284***	0.285***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Openness	-0.00380	-0.00494	-0.00153	-0.00452	0.00108	0.000847
	(0.504)	(0.391)	(0.766)	(0.513)	(0.881)	(0.896)
Exchange Rate Volatility	0.000529**	0.000275	0.000309	0.000518***	0.000374	0.000382*
	(0.042)	(0.224)	(0.205)	(0.001)	(0.259)	(0.091)
Inflation Volatility	0.102**	0.0995**	0.0962**	0.0648	0.0847*	0.0715
	(0.030)	(0.037)	(0.020)	(0.139)	(0.083)	(0.128)
Log GDP/c	0.0115***	0.00242	0.00288	0.00956*	0.00154	0.00312
	(0.001)	(0.283)	(0.332)	(0.078)	(0.651)	(0.278)
RCA Intensity	0.121***			0.0894**		
	(0.002)			(0.020)		
Keynesian Efficiency		-0.0314**			-0.0290**	
		(0.039)			(0.023)	
Schumpeterian Efficiency			-0.0506**			-0.0418*
			(0.041)			(0.087)
AR(2)	0.237	0.234	0.235	0.851	0.949	0.958
Hansen Test	0.209	0.111	0.103	0.337	0.127	0.070
Year FE	YES	YES	YES	YES	YES	YES
N. of countries	144	144	144	144	144	144
N. of Instrument	105	105	105	48	48	48
Obs.	941	941	941	490	490	490

Table 3. Regression results of eq. 8. Dependent variable GDP/c volatility. For GMM-SYS estimation we use up to 3 lags as instruments in the 5-year panel and up to 2 for the 10-year panel. P-value in parenthesis. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

PWT7.1). Overall, we analyse the GDP/c time series of 143 countries in the period 1950-2010, finding 257 breaks. Of them, 136 are up-breaks and 121 down-breaks.

We then define as growth episodes every period between two growth breaks whose average growth rate is greater than 2%. Additionally, we define breaks characterised by positive average growth but lower than 2% as stagnation and periods with negative average growth as collapses. In the following, we will focus only on growth spells leaving stagnation and collapses for future analysis. After excluding countries with less than 1 million inhabitants and considering only spells ending after 1970, we are left with 189 growth episodes. Their average duration is 18.9 years, with a standard deviation of 13.2 years. Appendix B shows descriptive statistics and growth episodes' distribution.

4.2 Econometric model: survival analysis

Survival analysis is a useful tool to estimate the duration of a given phenomenon. Similarly to Berg et al. (2012), our event of interest is the end of a growth spell (i.e., the occurrence of a down-break). The duration of the growth episode is our variable of interest. Our purpose is to relate the expected duration of growth spells to the characteristics of countries' trade composition at the beginning of the period and its evolution within the growth regime.

We model duration by parametrizing the hazard rate (i.e., the conditional probability that the spell will end in the next period) and estimate the relevant parameters using maximum likelihood. We define the hazard function for T (duration of growth spells) as:

$$\lambda(t, X(t), z) = \lim_{h \to \infty} \frac{P(t \leq T < t + h | T \geq t, X(t + h), z)}{h} = \frac{f(t|x_t, z)}{1 - F(t|x_t, z)} \tag{9}$$

This definition allows both time-invariant and time-varying covariates. We use a "proportional hazard model" that assumes that the time dependence of λ is multiplicatively separable from its dependence on $X(t), z$ and that the relationship between λ and $X(t), z$ is log-linear. Therefore, the "baseline hazard" (λ(t)) takes the functional form:

$$\lambda(t) = g(X(t), z)\lambda_0(t) = exp(\beta[X(t), z]) \cdot \lambda_0(t) \tag{10}$$

To estimate the relevant parameter β, we need to assume a distribution for λ_0. Like Berg et al. (2012), we assume a Weibull distribution (i.e., $\lambda_0(t) = pt^{(p-1)}$) for variable duration allowing for both positive and negative duration dependence. The parameter p, which is contextually estimated (ancillary parameter), indicates whether duration dependence is positive (p>1) or negative (p<1). Results are similar to those derived from a Cox Proportional Hazard Model, a non-parametric method requiring no distributional assumption (see Appendix F).

Given the structure of the breaks, we have to deal with cases in which a growth episode follows another growth episode (i.e., growth acceleration). In those cases, we will treat the first spell as right-censored and the second as left-censored. For the second spell, we will set the episode starting year (origin) at the same year as the previous one while introducing the covariates only from the beginning of the second spell. When a spell begins before 1970, we set its notional start to the original year while we consider 1970 as the year in which the country enters the analysis since we do not have available data for the previous period.

4.3 Estimation results

We start by exploring the unconditional hazard of growth spells' duration. We then add one by one regressors that might affect duration dynamics to find the suitable baseline specification to test the effects of trade structures. After sequentially testing the significance of several covariates, we will present a concise summary model considering the most relevant factors.

In what follows, hazard ratio coefficients can be interpreted as the factor by which the probability that the spell ends in the next period is multiplied as a result of an increase by 1 of the correspondent regressor. For instance, a hazard rate of 0.9 means that an increase of 1 in the variable is linked with a 10% reduction in the probability that the spell will end in the next period. Therefore, the magnitude of the coefficients needs to be judged with reference to their distributions.[11]

Appendix E constructs step by step the baseline specification that we employ in the survival analysis. All regressions are estimated on the whole sample of growth episodes and on a restricted sample of extraordinary growth experiences, defined as spells with average growth greater than 5%. Robustness checks are presented in Appendix F.

We tackle the relationship between structural transformation in the export composition and persistent economic growth first through the lenses of the Pavitt taxonomy (Pavitt, 1984). Table 4 presents the first set of survival analysis results based on export baskets' composition.[12] With respect to the Pavitt taxonomy breakdown, the hazard rate correspondent to changes in supplier dominated industries export share is greater than one, meaning that increasing the share of traditional or agricultural-based manufacturing goods has negative consequences for the duration of development spells. Scale intensive exports do not have significant effects for the whole sample, while specialised supplier products increase the probability of growth spells continuation. Similarly, science-based production improves growth prospects (but its coefficient fails to be significant). Looking at exceptional growth spells (growth rates greater than 5%), the detrimental effect of increasing suppliers dominated export shares is reinforced, and science-based shares' impact becomes significant. The coefficients of scale intensive and specialised suppliers maintain the same signs but lose significance.

The changing specialization patterns in the development process are a possible confounding factor when pooling countries with different income levels. Therefore, let us split the sample into developing and developed countries and repeat the same analysis. Supplier dominated export shares confirm their negative relation with growth spell duration. Scale intensive exports have opposite effects in the two groups of countries, positive for developing and negative for developed countries. Specialised supplier exports are statistically significant only for developed countries, positively impacting growth episodes. Altogether, these results confirm that technologically "backward" manufacturing activities have a negative impact on growth duration. Scale intensive sectors have a positive impact only on developing countries. With respect to exceptional growth episodes, exporting goods in the specialised suppliers' category (production of machinery and capital goods) seems to represent an enabling condition for growth spells higher than 5% for developed countries. Science-based exports are strongly beneficial for duration of exceptional growth episodes, independently from country stage of development.

[11] When possible, we normalise the covariates to be constrained in the interval [0,1]. When normalisation is not viable, we refer to the distribution of the covariates. Appendix A offers descriptive statistics and sources for the covariates used.

[12] All regressions control for the baseline variables presented in column 4 of Tab A7.

	Supplier Dominated	Scale Intensive	Specialised Suppliers	Science Based
		Full Sample		
		All Countries		
Init. Export Share	1.008	0.999	0.972	1.014
	(0.195)	(0.976)	(0.322)	(0.489)
Δ Export Share	**1.030****	1.004	**0.925***	0.948
	(0.013)	(0.884)	**(0.060)**	(0.154)
Spells/Failure	*171/62*	*170/61*	*170/61*	*170/61*
		Developing Countries		
Init. Export Share	1.005	0.941	0.980	1.017
	(0.420)	(0.294)	(0.728)	(0.569)
Δ Export Share	**1.022***	**0.913****	0.917	0.963
	(0.069)	**(0.046)**	(0.186)	(0.414)
Spells/Failure	*128/44*	*127/43*	*127/43*	*127/43*
		Developed Countries		
Init. Export Share	**1.041****	1.054	0.941	1.040
	(0.035)	(0.254)	(0.247)	(0.578)
Δ Export Share	**1.130****	**1.077****	**0.866***	0.910
	(0.014)	**(0.046)**	**(0.072)**	(0.125)
Spells/Failure	*43/18*	*43/18*	*43/18*	*43/18*
		Exceptional Growth Episodes		
		All Countries		
Init. Export Share	**1.016****	0.979	0.992	1.024
	(0.028)	(0.482)	(0.886)	(0.268)
Δ Export Share	**1.050*****	1.001	0.933	**0.925***
	(0.003)	(0.977)	(0.242)	**(0.051)**
Spells/Failure	*82/32*	*82/32*	*82/32*	*82/32*
		Developing Countries		
Init. Export Share	1.009	0.937	1.030	1.024
	(0.163)	(0.176)	(0.459)	(0.470)
Δ Export Share	**1.041***	**0.871***	0.945	**0.913****
	(0.077)	**(0.073)**	(0.226)	**(0.011)**
Spells/Failure	*64/22*	*64/22*	*64/22*	*64/22*
		Developed Countries		
Init. Export Share	**1.098***	1.096	0.881	1.239
	(0.066)	(0.521)	(0.352)	(0.154)
Δ Export Share	**1.097*****	1.047	**0.525*****	**0.757*****
	(0.000)	(0.582)	**(0.000)**	**(0.007)**
Spells/Failure	*18/10*	*18/10*	*18/10*	*18/10*

Table 4. Regression results from semi-parametric survival analysis. All regressions control for initial GDP/c, US interest rate, exchange rate and price dynamics. Robust standard errors clustered at the country level. Hazard rate and P-value (in parenthesis) are presented. *** p<0.01, ** p<0.05, * p<0.1.

Table 5 extends the analysis to the RCA, KE and SE indices. The first column shows that specialization intensity negatively affects the probability that the growth spells continue. This result is confirmed in the split sample and holds both for developing and developed countries. Combining these results with the negative impact of supplier dominated exports, the growth reducing specializations are those in traditional activities and natural resources. The coefficients related to specialization are significant both in levels and in changes within the spell at the 1% level.

Turning to our proxy of Keynesian and Schumpeterian efficiencies, specifications 2 and 3 in Table 5 test the effects of international demand adjustments and technological upgrading in the development process. The coefficients of the diversification index augmented by demand elasticity are significant at the 1% level in both initial levels and changes. More specifically, an increase of 1 in the initial levels of Keynesian efficiency increases by more than 3% the probability that the spells will continue, while an increase of 1 within the spell spurs by 5% survival prospects. In the restricted sample, the coefficients almost double, signalling a positive relationship between improving Keynesian specialization efficiency and the intensity of the growth spell. Moving to Schumpeterian efficiency, we find significant and positive effects only in variations, while the variable in level fails to be significant. An increase in Schumpeterian efficiency of 1 corresponds to a higher survival probability of 4% in the whole sample. Exporting innovative products become more relevant in the restricted sample of exceptional growth episodes in which SE significance increases and its magnitude doubles.

	RCA Intensity	Keynesian Efficiency	Schumpeterian Efficiency	RCA Intensity	Keynesian Efficiency	Schumpeterian Efficiency
	Full Sample			**Exceptional Growth Period**		
Initial Level	1.028**	0.969***	0.991	1.033*	0.944***	0.989
	(0.014)	(0.000)	(0.629)	(0.059)	(0.000)	(0.654)
Delta within Spell	1.079***	0.947***	0.965*	1.094***	0.923***	0.932**
	(0.000)	(0.000)	(0.086)	(0.000)	(0.000)	(0.028)
LL	*-95.907*	*-72.878*	*-103.268*	*-43.321*	*-21.514*	*-44.052*
Spells/Failures	171/62	171/62	171/62	82/32	82/32	82/32

Table 5. Regression results from semi-parametric survival analysis. All regressions control for initial GDP/c, US interest rate, exchange rate and price dynamics. Robust standard errors clustered at the country level. Hazard rate and P-value (in parenthesis) are presented. *** p<0.01, ** p<0.05, * p<0.1.

We then test if these results are robust to the introduction of possibly omitted variables, usually considered in the growth literature, which we add one by one to the baseline specification (Table A6, col.5) and estimate a summary model presented in Table 6.[13]

First, we introduce variables related to countries' trade patterns as openness, measured in terms of the percentage over GDP of the sum of export and import flows, and participation in global value chains (GVC), computed in terms of the percentage of foreign value-added in total output (Pahl and Timmer, 2019). Both variables have positive and significant effects on the probability of spells' continuation, in line with the literature. However, we choose to introduce only overall openness in the summary specification due to the sparse coverage of

[13] Here, we limit our analysis to the usual suspects of the growth literature with particular attention to those variables measuring characteristics that are likely to be accelerating/complementary factors to trade structures. As a comparison, Appendix E shows the regression results for these control variables and motivates their choice.

the GVC variable that would make hard comparisons across results. Openness always exerts a positive effect on the probability of growth duration even if significant only in exceptional growth periods.

Since the 1990s, education has been at the centre of the growth literature (Romer, 1989, Aghion and Howitt, 1992 among the others), and it has been used to link growth and structural change, finding positive effects (Teixeira and Queirós, 2016). We measure education both as average primary and secondary years of schooling (Barro and Lee, 2013). The effects of education are significant and positive, especially their evolution within the spell, both in the case of primary and secondary education. Note that the magnitude of the coefficient is high, but the variables are expressed in years and not in percentages. On average, an increase of 1 year in primary schooling corresponds to an increase of 25% of the variable (as can be computed from the descriptive statistics in Appendix A). In this section, looking at the relative log-likelihood and sample coverage, we kept secondary schooling for the summary regressions. The positive role of education is confirmed in the full sample summary model while it loses significance in the exceptional growth case. This result comes as a surprise but is probably due to the smaller sample primarily composed of developing countries.

The role of investments is central in pushing structural transformations (Hirschman, 1958). Indeed, well-designed investments might induce further expenditure in related sectors and start the virtuous cycle at the heart of the development process. Moreover, investments are fundamental to adapt the industrial structure both to demand and supply stimulus. In Table A7 in the Appendix E we tested several possible proxies of investment. We introduce only capital per worker for brevity, but similar results are available for the other investment-related variables. The positive role of capital per worker in sustaining growth spells is confirmed both in the full sample and in exceptional growth episodes. Finally, we add regional dummies to account for common regional characteristics, like geography or culture.

The summary regression focuses on variations of KE and SE indicators within the spell. For the sake of brevity, we omit the RCA intensity index, however available upon request and confirming previous results. Remarkably, although the introduction of a wide set of control variables, both measures of efficiency remain significant in the full specification. Their effects are comparable to those estimated in the previous model without controls, and even stronger for SE (see Table 5). These results are confirmed in our restricted sample of exceptional growth episodes in column (4). Additionally, the effects of both indices increase in magnitude in affecting exceptional growth episodes when the interactiont term is taken into account (column (6)).

Concerning duration dependence, the Weibull specification implies monotonicity. The estimated ancillary parameter suggests that the hazard is a rising function of time in all model specifications, with a null of constant hazard ($p = 1$) rejected. These results lend support to a positive duration dependence meaning that the probability of ending the growth spell increases over time ($\frac{\delta h}{\delta t} > 0$).

Goodness of fit To conclude, we investigate the overall statistical performance of our summary model in Table 7 against a series of nested models, starting from pure duration to the baseline specification (i.e. full model without trade composition variables), presenting a wide set of indicators. The left panel considers the full model without regional dummies, while the right panel also includes regional fixed effects. According to the likelihood-ratio test, the full model fits the data significantly better. As indicated by the high values of the associated χ^2 statis-

	(1)	(2)	(3)	(4)	(5)	(6)
	Full Sample			**Exceptional Growth Ep.**		
Δ KE	0.968***	0.968***	0.968***	0.938***	0.911***	0.906***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Δ SE	0.949**	0.947**	0.947**	0.935	0.940	0.916**
	(0.044)	(0.024)	(0.025)	(0.113)	(0.209)	(0.029)
Δ KE # Δ SE			1.000			0.997**
			(0.949)			(0.040)
Δ opennes	0.990	0.993	0.993	0.973***	0.974***	0.972***
	(0.119)	(0.282)	(0.288)	(0.001)	(0.004)	(0.003)
Δ Yrs Secondary Sch.	0.245***	0.247***	0.245***	2.090	3.557*	4.500*
	(0.001)	(0.001)	(0.001)	(0.247)	(0.078)	(0.050)
Δ K per worker	0.988***	0.987**	0.987**	0.987**	0.988*	0.988*
	(0.008)	(0.035)	(0.038)	(0.037)	(0.074)	(0.094)
Avg. Growth Rate	1.183**	1.209***	1.209***	1.193	1.277	1.282
	(0.012)	(0.007)	(0.007)	(0.276)	(0.265)	(0.315)
Init. GDP/c	1.000***	1.000**	1.000***	1.000	1.000**	1.000**
	(0.006)	(0.010)	(0.010)	(0.415)	(0.019)	(0.029)
Δ Exchange rate	1.002	1.002	1.002	1.003	1.003	1.003
	(0.299)	(0.352)	(0.360)	(0.123)	(0.178)	(0.245)
Δ US int. rate	1.327***	1.274***	1.273***	1.475***	1.611***	1.703***
	(0.001)	(0.003)	(0.003)	(0.001)	(0.001)	(0.001)
Δ Inflation	0.993	0.987	0.987	1.019	1.016	1.023
	(0.889)	(0.782)	(0.781)	(0.683)	(0.812)	(0.692)
Region FE	No	Yes	Yes	No	Yes	Yes
Spells/Failures	135/47	135/47	135/47	61/24	61/24	61/24
Ancillary parameter	2.528	2.612	2.612	1.211	1.571	1.620
P-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LL	*-34.145*	*-31.379*	*-31.378*	*-7.193*	*-1.590*	*-0.512*

Table 6. Regression results from semi-parametric survival analysis. Robust standard errors clustered at the country level. Hazard rate and P-value (in parenthesis) are presented. *** p<0.01, ** p<0.05, * p<0.1.

tics, these tests reject the full set of zero restrictions implicit in the smaller models at extremely small p-values (less than 0.1%). Similarly, we can get a sense of the model's explanatory power by examining a likelihood-based pseudo-R^2 measuring the goodness-of-fit (Wooldridge, 2002). Overall, the inclusion of our indicators allows explaining 70% of the variation, largely increasing the variation explained in the baseline model (56%). To sum up, adding trade composition variables consistently improve the performance of all model specifications. This is particularly true when considering exceptional growth episodes.

	LL	LR Test χ^2	p-value	Pseudo R^2	LL	LR Test χ^2	p-value	pseudo-R^2
	Full Sample							
	Full Model				Full Model + Regional fe			
Full Model (Tab. 6; Col. 3)	*-34.08*	.	.	0,675	-31.38		.	0.700
Baseline Specification	*-45.55*	**21.97**	**0.000**	0.565	*-45.55*	**27.38**	**0.000**	0.565
Only init. GDP/c	*-104.77*	**141.37**	**0.000**	*0.000*	*-104.77*	**146.79**	**0.000**	0.013
Pure Duration Model	*-104.77*	**141.38**	**0.000**	.	*-104.77*	**146.79**	**0.000**	.
	Exceptional growth periods							
Full Model (Tab. 6; Col. 6)	*-6.35*	.	.	0.857	-0.51	.	.	0.988
Baseline Specification	*-20.34*	**27.98**	**0.000**	0.541	*-20.34*	**39.67**	**0.000**	0.542
Only init. GDP/c	*-41.73*	**70.69**	**0.000**	0.060	*-41.73*	**82.37**	**0.000**	0.060
Pure Duration Model	*-44.36*	**76.01**	**0.000**	.	*-44.36*	**87.69**	**0.000**	.

Table 7. Goodness of fit measures. Bold indicates the rejection of nested models at the 1% level. Pseudo R^2 defined as 1-$\frac{LL_1}{LL_0}$ where LL_1 is the log-likelihood of the full model and LL_0 of the pure duration model. The Baseline Specification is the full model without trade structure variables (i.e. Keynesian & Schumpeterian efficiency).

5 Conclusions

The impact of the structure of output upon the growth of the various countries, especially when they are open to international trade, has been one of the most tangled issues throughout the whole history of political economy. The conventional wisdom, at least since Ricardo, predicts that gains from specialization, stemming from revealed comparative advantage, at the very least increase international welfare – if all countries live in a General Equilibrium, as implicit in the Ricardian argument –, or, even more, that sheer specialization, independently of what is produced, fosters growth – as explicit in the so-called "Washington Consensus" prescriptions. However, the theory is weak and the evidence is absent. Rather, it is the *quality* of specialization that influences growth and, even more, persistent growth.

This paper, using a long-term, product-level cross-country dataset, analyzes the nexus between trade composition and growth, introducing two novel indicators able to capture such quality of specialization. First, an index, which we call of Keynesian efficiency, ranking exported products according to their dynamism measured in terms of elasticity of their demand in importing countries and weighted by the degree of export diversification. Second, an index, that we call of Schumpeterian efficiency, which tracks products technological content, proxied by their patent intensities. According to our results, diversification in products, whose international demand grows more than the income of importing countries, and present higher technological content, positively influences growth rates and growth episodes, identified as periods of 2% growth and, even more, exceptionally growth episodes identified as periods of 5% growth.

In turn, such patterns of "good" diversification hint at the underlying importance of country-wide capabilities of technological and organizational learning (Cimoli et al., 2009). The evidence suggests that it is a diversified, dynamic, and technologically advanced export composition which promotes stable GDP growth. Conversely, bad specialization in natural resources and manufacturing products, characterised by poor learning opportunities, lowers long-term rates of growth and increases the probability of growth spell endings, both in developing and developed nations.

The implications from a policy point of view are far-reaching. The standard recipe has been "Specialize exploiting your comparative advantages and will grow more". At the opposite, the policy prescription of our analysis is "Diversify into the activities which offer the greatest opportunities of learning and demand growth, irrespective of current comparative advantages". Indeed, climbing the ladder of development might imply "getting the prices wrong" as the late Alice H. Amsden provocatively put it (Amsden, 1989). That is purposely implementing policies which go against the incumbent patterns of comparative advantages as signalled by international markets.

One of the main limitations of our work is the use of export data, which represent only a fraction of country production. Additionally, the composition of what is traded internationally and what is produced domestically is not completely overlapping. Being exported by a tiny fraction of firms, traded goods might give a biased picture of actual capabilities of the various countries, potentially over-estimated. However, domestic product-level data are still lacking and sectoral level analysis conflates intra-sectoral heterogeneities. Second, in actual fact, whatever product is more often the outcome of international value chains of intermediate inputs. Hence, the relevance of participating or not into global value chains and the impact of different stages of production upon prospects of growth. The latter represents a future avenue of research.

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Appendix

A Descriptive Statistics

A.1 Trade indices

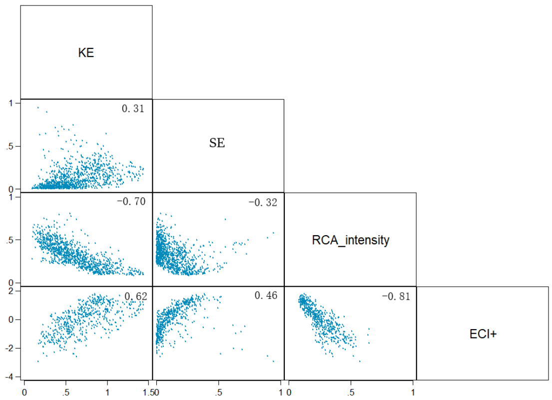

Fig. A1. Cross-correlations among RCA, SE, KE. Economic Complexity Index used as a benchmark.

	n	*mean*	*sd*	*n*	*mean*	*sd*
	Developing			**Developed**		
KE	6204	0.5	0.25	2171	0.79	0.29
SE	6210	0.1	0.13	2172	0.21	0.12
RCA	6210	0.37	0.13	2172	0.21	0.12
ECI	3239	-0.46	0.83	1610	0.96	0.46

Table A1. Descriptive statistics of trade specialization variables by development status. Economic Complexity Index used as a benchmark.

Figure A2 shows the country-level aggregation of the three indices presented in Section 3 with the mean RCA intensity values, Keynesian and Schumpeterian efficiency in the period under consideration.

A.2 Other variables

Variable	Obs	Mean	Std.Dev.	Primary Source
Real GDP/c	3748	471.56	12079.18	*PWT 9.1*
Openness	2879	72	52	*PWT 9.1*
Terms of Trade	3748	102	3	*PWT 9.1*
US interest rate	3149	5.61	3.03	*World Bank*
Exchange Rate	3748	294.48	1403.93	*PWT 9.1*
Consumer Price Level	3748	35	25	*PWT 9.1*
Telephonic Subscription (100 persons)	2589	16.31	18.64	*World Bank*
Years of Primary Schooling	3500	3.97	1.69	*Barro Lee*
Years of Secondary Schooling	3500	2.32	1.45	*Barro Lee*
Real Capital per worker	3714	88438	118278	*PWT 9.1*
Real Investment per worker	3775	8604	13.493	*PWT 9.1*
Foreign Value Added in Output	3631	0.24	0.12	*Pahl and Timmer, 2019*

Table A2. Summary statistics and source of the variables used in the survival analysis.

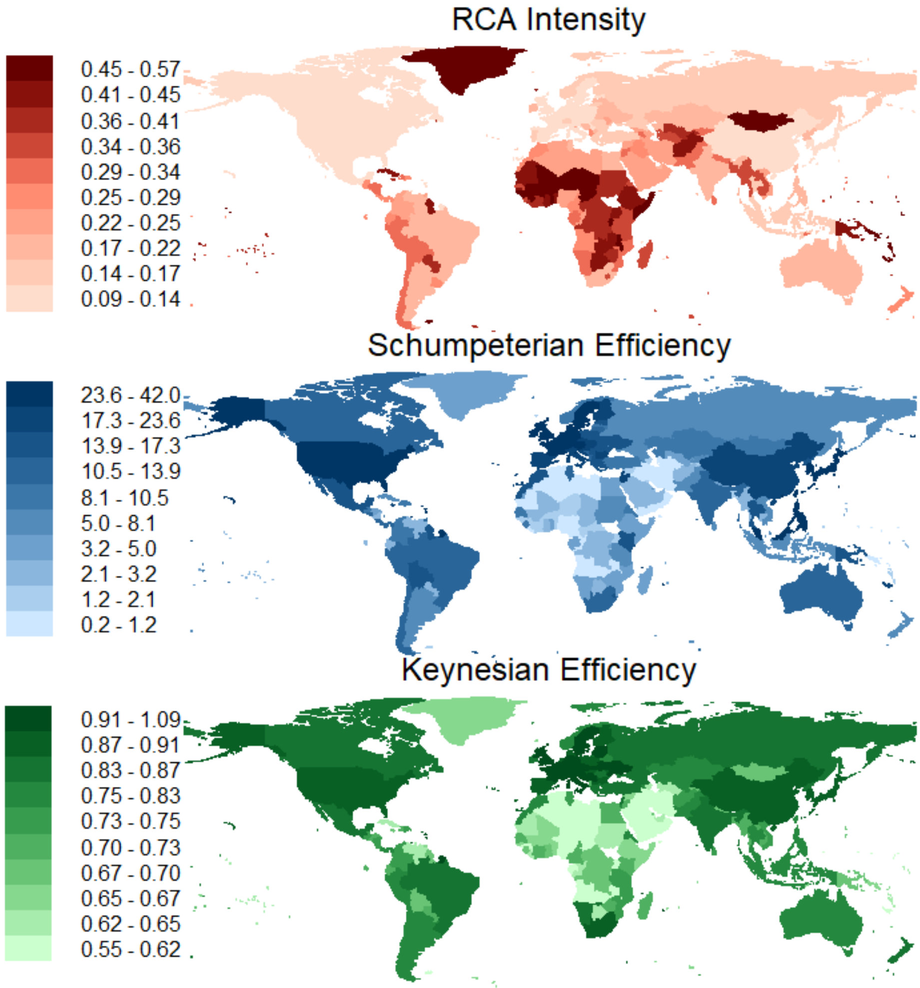

Fig. A2. Average values of the three specialization indices in the period 1970-2010. Thresholds are endogenously generated through k-means clustering.

B Growth spells descriptive statistics

	n. of spells	mean	sd
Asia	61		
Duration		19.72	12.75
Growth Rate		5.81	2.69
Europe	41		
Duration		25.1	16.31
Growth Rate		4.45	1.85
Latin America	40		
Duration		14.13	8.57
Growth Rate		4.87	2.36
North Africa	10		
Duration		20.2	13.97
Growth Rate		5.04	2.41
North America	2		
Duration		61	0
Growth Rate		2.06	.06
Sub-Saharan Africa	41		
Duration		13.68	5.88
Growth Rate		5.31	3.72

Table A3. Descriptive statistics of breaks identified using Kar et al., 2013.

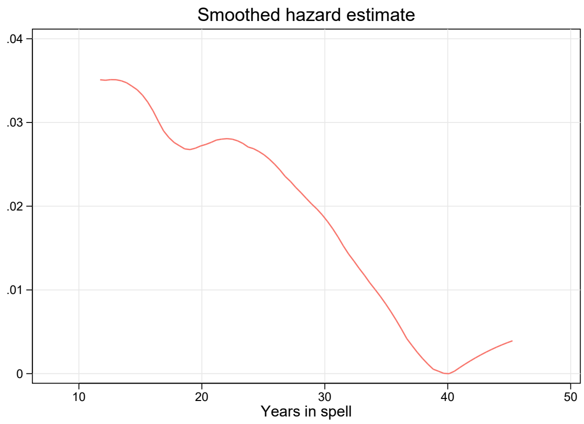

Fig. A3. Unconditional hazard computed by analysing all spells that have endured at least a given length and estimating how many end in the next year. Since the hazard declines with duration spells, it suggests that the longer the spell, the lower the hazard of ending.

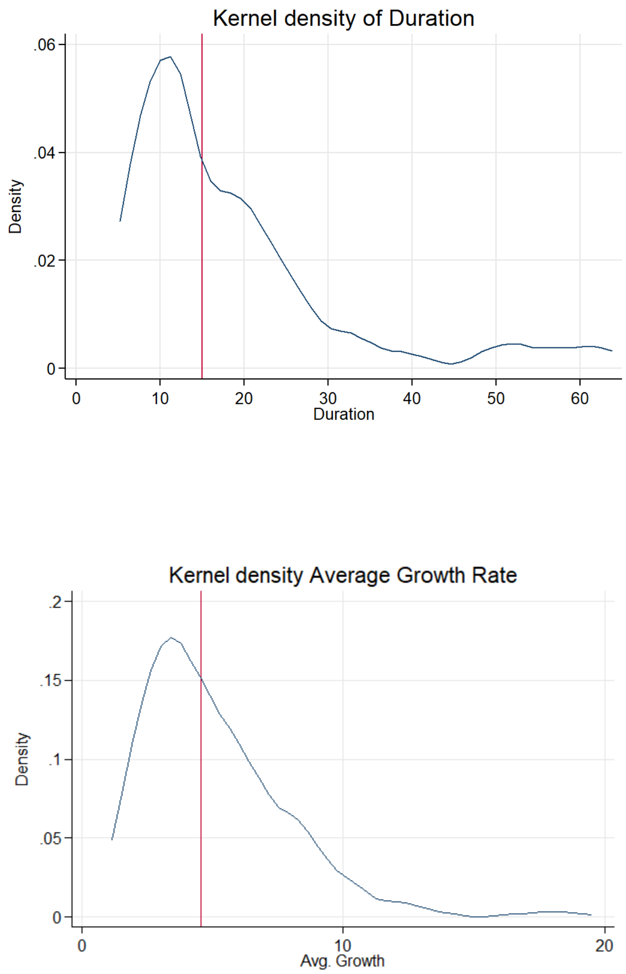

Fig. A4. Kernel density distribution of duration episodes (top) and average growth rate (bottom). The vertical red line shows the median.

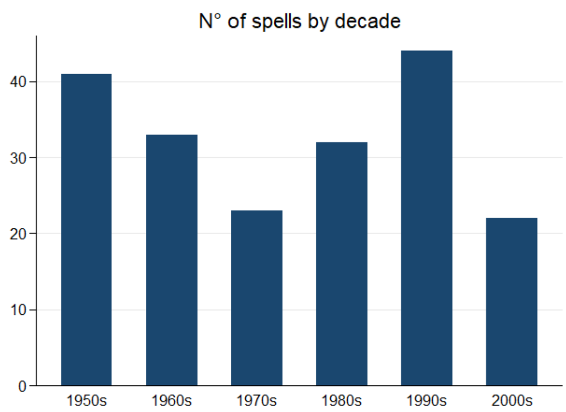

Fig. A5. Growth spells initial decade distribution.

C Import demand elasticity

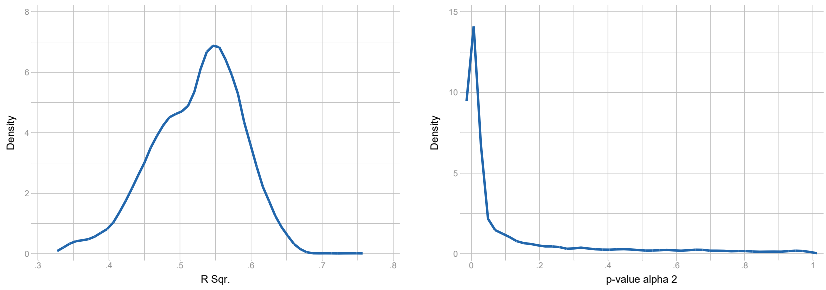

Fig. A6. The left panel presents the R^2 from the estimation of eq. 5; the right panel the p-values distribution of α_2.

D Trade structure, average growth and volatility

Kolmogorv-Smirnov Tests

	Volatility			Growth		
	KE	SE	RCA int.	KE	SE	RCA int.
1q vs 2q	**0.220**	0.092	0.111	**0.314**	**0.308**	**0.266**
	0.001	0.467	0.240	**0.000**	**0.000**	**0.000**
1q vs 3q	**0.351**	**0.183**	**0.214**	**0.3412**	**0.274**	**0.299**
	0.000	**0.008**	**0.001**	**0.000**	**0.000**	**0.000**
1q vs 4q	**0.439**	**0.3151**	**0.326**	**0.342**	**0.180**	**0.275**
	0.000	**0.000**	**0.000**	**0.000**	**0.009**	**0.000**
2q vs 3q	**0.169**	**0.171**	0.134	0.094	0.092	0.101
	0.020	**0.018**	0.114	0.468	0.496	0.375
2q vs 4q	**0.298**	**0.308**	**0.249**	**0.126**	**0.168**	**0.204**
	0.000	**0.000**	**0.000**	**0.143**	**0.018**	**0.002**
3q vs 4 q	**0.169**	**0.180**	**0.161**	0.092	0.123	0.1143
	0.027	**0.015**	**0.040**	0.499	0.169	0.240

Table A4. Kolmogorov-Smirnov test of the equality of distributions relative to Fig. 7. Null Hp. of equality of distributions. P-value are presented (bold if significance>5%).

E Survival Analysis: Baseline Specification

Controls Given the econometric setup described in the methodological section, the principal concern is the possibility of reverse causation. The right-hand side variables of eq. 10 might depend on whether a spell has ended or is still ongoing. Hazard model estimates are consistent if we assume that the hazard at time t conditional on the covariates at t, neither depends on covariates' future realizations nor unobserved factors (Wooldridge, 2002). Thus we need two major assumptions. First, we preclude contemporaneous feed-backs from the end of the regime to the covariates. That is possible either if information available in $t-1$ contains all relevant information to predict the end of the spell in the next period or if realizations at time t are not affected by the contemporaneous end of the spell. Second, we should carefully treat omitted variables. Given the large sample under analysis (both in terms of years and countries), it is the hardest assumption to satisfy. Indeed, using all covariates that are considered relevant in the literature would shrink our final sample just to developed countries. We reduce the incidence of this problem by controlling for the usual suspects of the growth literature (e.g., external shocks, economics fundamentals etc.).

Table A7 starts by analysing the role of initial income per capita. Contrarily to Berg et al. (2012), we find neither negative correlations nor a significant coefficient between the probability that the spell continues and GDP/c meaning no preliminary support for the convergence hypothesis. In model (2), we add the average growth rate within the spell. It seems that a higher average growth reduces the probability that the spell lasts longer. Further, in model (3) we use regional dummies to account for common regional dynamics. All regional dummies are expressed relatively to the Asian dummy. We see that North America (i.e., Canada and the US) are associated with much higher continuation probabilities. While Latin America and Sub-Saharan countries have hazard coefficients significant at 1% and consistently higher than 1, i.e. those regions undergo shorter growth periods.

Considering only exceptional growth periods (i.e. spells with average growth greater than 5%), we notice that average growth during the spell is no more significant and that the only region in which the continuation probabilities are higher is Asia (the reference dummy), meaning that exceptional growth experiences tend to last more in Asian countries.

	(1)	(2)	(3)	(4)	(5)	(6)
	Full Sample			Exceptional Growth Episodes		
Init. GDP/c	0.966	0.979	1.019	1.000	1.000	1.000**
	(0.134)	(0.379)	(0.614)	(0.151)	(0.180)	(0.022)
Avg. Growth		1.132***	1.142***		0.989	0.982
		(0.002)	(0.001)		(0.916)	(0.858)
Europe			1.235			4.124**
			(0.697)			(0.013)
Latin America			4.672***			10.39***
			(0.000)			(0.000)
North Africa			0.546			4.137*
			(0.563)			(0.063)
Sub-Saharan Africa			3.886***			8.932***
			(0.001)			(0.003)
North America			3.16e-07***			
			(0.000)			
Spells/Failure	189/67	189/67	189/67	86/33	86/33	86/33

Table A5. Baseline regression results from semi-parametric survival analysis. Robust standard errors clustered at the country level. Hazard rate and P-value (in parenthesis) are presented. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Macroeconomic variables and international shocks Further, we account for macroeconomic shocks or more general internal or international turmoils that might affect the duration of the growth spell. Similarly to Berg et al. (2012), we check the role of global macroeconomic instability by evaluating yearly changes in the US interest rate at the end of the spells (model (1)). In line with expectations (Mauro and Becker, 2006), the US interest rate is always significant, and a 1% increase is associated with the reduction of the probability that the episode will continue of 56%. Inflation has a significant negative impact on duration (model (2)). Indeed, excessive inflation might generate instability and loss of confidence. The role of inflation spirals is particularly relevant in developing countries that constitute the lion share of our growth spells. We test the role of the exchange rate in model (3), considered a competitiveness index in international markets (Rodríguez and Rodrik, 2001) and a synthetic indicator for a country's perceived stability. In line with expectations, the exchange rate yearly percentage change exerts a positive and significant effect on growth duration. Similarly, and related, also the terms of trade variation has a positive impact on growth duration (model (4)), but its effect is not significant when we account for all factors together. The last column (model (5)) presents the final baseline specification. Considering only exceptional growth episodes, the only two covariates remaining significant are the US interest rate and the exchange rate variation.

	(1)	(2)	(3)	(4)	(5)
	Full Sample				
Init. GDP/c	0.999	0.999	0.999	0.999	0.999
	(0.487)	(0.510)	(0.372)	(0.241)	(0.325)
US Interest Rate	1.560***	1.437***	1.425***	1.423***	1.435***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Inflation		1.090**	1.082**	1.082**	1.090**
		(0.016)	(0.038)	(0.032)	(0.014)
Terms of Trade			0.998	0.990	
			(0.283)	(0.340)	
Exchange Rate				0.996***	0.996***
				(0.002)	(0.002)
Spells/Failure	187/65	186/64	186/64	186/64	186/64
	Exceptional Growth Episodes				
Init. GDP/c	1.000	1.000	1.000	1.000	1.000
	(0.345)	(0.213)	(0.193)	(0.230)	(0.249)
US Interest Rate	1.385***	1.322***	1.338***	1.320***	1.306***
	(0.000)	(0.006)	(0.002)	(0.003)	(0.008)
Inflation		1.045	1.042	1.045	1.048
		(0.237)	(0.247)	(0.200)	(0.193)
Terms of Trade			0.965	0.960	
			(0.562)	(0.505)	
Exchange Rate				0.998*	0.998*
				(0.051)	(0.098)
Spells/Failure	86/33	85/32	85/32	85/32	85/32

Table A6. Baseline regression results from semi-parametric survival analysis. Robust standard errors clustered at the country level. Hazard rate and P-value (in parenthesis) are presented. *** p<0.01, ** p<0.05, * p<0.1.

Growth literature controls Table A7 controls for variables that since the beginning of the growth literature have been associated with countries growth performances. We evaluate those effects either as initial level and change within the spell, to distinguish between initial conditions and evolution, or as average throughout the episodes. The regressors chosen in this section are particularly relevant for the analysis in Section 4.3 since they measure characteristics that are complementary to trade performances in the development process.

	Full Model			Exceptional Growth Episodes		
	h.r	P-value	Spells/Failure	h.r.	P-value	Spells/Failure
			Capital & Investment			
Init. Invest./w	0.971	0.628	159/52	0.845*	0.057	85/32
Δ Invest./w	0.896***	0.000		0.805***	0.000	
Init. Cap./w	0.982***	0.001	173/57	0.982**	0.024	82/31
Δ Cap./w	0.967***	0.000		0.963***	0.000	
Init. Tel. Subs./c	1.012	0.422	148/42	1.033*	0.061	67/18
Δ Tel. Subs./c	0.927***	0.004		0.911*	0.097	
			Education			
Init. Yrs. Primary Sch.	0.733***	0.002	169/60	0.771**	0.045	76/30
Δ Yrs. Primary Sch.	0.281***	0.000		0.0880***	0.000	
Init. Yrs. Secondary Sch.	0.749	0.111	169/60	0.587**	0.042	76/30
Δ Yrs. Secondary Sch.	0.136***	0.000		0.185***	0.000	
			International Integration			
Init. Openness	0.996	0.251	154/54	0.990**	0.035	69/26
Δ Openness	0.988**	0.037		0.984**	0.018	
Init. GVC Participation	0.964*	0.052	115/42	0.944***	0.003	55/23
Δ GVC Participation	0.939**	0.013		0.935**	0.016	

Table A7. Regression results from semi-parametric survival analysis. All regressions control for initial GDP/c, US interest rate, exchange rate and price dynamics. Robust standard errors clustered at the country level. Hazard rate and P-value (in parenthesis) are presented. *** p<0.01, ** p<0.05, * p<0.1.

F Robustness checks

As a first robustness check, we test the role of distributional assumptions on the baseline hazard (λ_0). In Table A8 we report results using non-parametric Cox regression. Results are largely identical. Further, we test different distributional assumptions as Log-Logit and Log-Normal baseline hazard distributions, confirming the original results (regressions' results available upon request).

	(1)	(2)	(3)	(4)	(5)	(6)
	Full Sample			Exceptional Growth Ep.		
Δ KE	0.966***	0.971***	0.971***	0.934***	0.920***	0.904***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Δ SE	0.966	0.965*	0.965*	0.947	0.949	0.895**
	(0.155)	(0.087)	(0.087)	(0.109)	(0.135)	(0.015)
Δ KE # Δ SE			1.000			0.996***
			(0.966)			(0.007)
Δ opennes	0.991	0.994	0.994	0.977***	0.978***	0.972***
	(0.165)	(0.347)	(0.357)	(0.003)	(0.009)	(0.008)
Δ yrs Secondary Sch.	0.222***	0.241***	0.242***	1.140	1.701	2.107
	(0.001)	(0.001)	(0.001)	(0.826)	(0.406)	(0.362)
Δ K per worker	0.993*	0.987**	0.987**	0.989*	0.991	0.987*
	(0.086)	(0.030)	(0.028)	(0.056)	(0.107)	(0.076)
Avg. Growth Rate	1.102	1.120	1.120	1.083	1.151	1.165
	(0.116)	(0.139)	(0.140)	(0.648)	(0.442)	(0.477)
Init. GDP/c	1.000**	1.000	1.000	1.000	1.000*	1.000**
	(0.029)	(0.149)	(0.144)	(0.584)	(0.063)	(0.050)
Δ Exchange rate	1.000	1.000	1.000	1.001	1.001	1.001
	(0.812)	(0.799)	(0.807)	(0.417)	(0.518)	(0.639)
Δ US int. rate	1.242***	1.208***	1.208***	1.385***	1.429***	1.505***
	(0.001)	(0.006)	(0.006)	(0.001)	(0.002)	(0.001)
Δ Inflation	0.988	0.993	0.993	1.003	1.004	1.007
	(0.716)	(0.855)	(0.858)	(0.917)	(0.927)	(0.867)
Region FE	No	Yes	Yes	No	Yes	Yes
Spells/Failures	135/47	135/47	135/47	61/24	61/24	61/24
LL	*-138.613*	*-135.276*	*-135.275*	*-51.596*	*-49.703*	*-48.414*

Table A8. Results from Cox- regressions. Robust standard errors clustered at the country level. Hazard rate and P-value (in parenthesis) are presented. *** p<0.01, ** p<0.05, * p<0.1.

To evaluate the role of omitted variables, one possibility is to control for the presence of unobserved heterogeneity (also referred to as "frailty" in the context of survival analysis) in the form of a multiplicative stochastic term (v_i) which is added to the proportional baseline hazard (Eq. 10). This multiplicative stochastic term can be interpreted as specific to sets of observations ("shared frailty"), for instance, common to all observations belonging to a specific country. In this case, v_i is analogous to a random effect term in a panel regression context. Table A9 shows the effect of adding the random effect, largely confirming our estimation results.

	(1)	(2)	(3)	(4)
	Full Sample		**Exceptional Growth Ep.**	
Δ KE	0.968***	0.968***	0.938***	0.919***
	(0.000)	(0.001)	(0.000)	(0.000)
Δ SE	0.948*	0.947*	0.920**	0.905**
	(0.068)	(0.054)	(0.048)	(0.023)
Δ KE # Δ SE	1.000	1.000	0.997	0.996*
	(0.729)	(0.963)	(0.169)	(0.057)
Δ opennes	0.990	0.993	0.971**	0.974*
	(0.103)	(0.268)	(0.031)	(0.051)
Δ Yrs. Secondary Sch.	0.235***	0.245***	2.424	3.779
	(0.002)	(0.005)	(0.348)	(0.182)
Δ K per worker	0.988*	0.987*	0.987*	0.988
	(0.053)	(0.079)	(0.086)	(0.110)
Avg. Growth Rate	1.183**	1.209**	1.175	1.209
	(0.031)	(0.025)	(0.305)	(0.237)
Init. GDP/c	1.000**	1.000*	1.000	1.000**
	(0.036)	(0.080)	(0.422)	(0.045)
Δ Exchange rate	1.002	1.002	1.002	1.003
	(0.502)	(0.528)	(0.488)	(0.422)
Δ US int. rate	1.326***	1.273***	1.510***	1.603***
	(0.001)	(0.004)	(0.000)	(0.000)
Δ Inflation	0.992	0.987	1.024	1.037
	(0.862)	(0.767)	(0.659)	(0.476)
Region FE	No	Yes	No	Yes
N of groups	90	90	51	51
Spells/Failures	135/47	135/47	61/24	61/24
Ancillary parameter	2.542	2.612	4.671	3.472
P-value	(0.000)	(0.000)	(0.000)	(0.000)
LL	*-34.08*	*-31.378*	*-6.35*	*-1.72*

Table A9. Regression results from semi-parametric survival analysis with shared frailty. Robust standard errors clustered at the country level. Hazard rate and P-value (in parenthesis) are presented. *** p<0.01, ** p<0.05, * p<0.1.

Sample Perturbation Table A10 presents perturbed coverage of the sample, evaluating different country configurations. In models (1) and (2), we exclude Asian countries, while in models (3) and (4), we consider only developing countries. The main results are robust, however reducing the sample size impacts upon the significance of the SE coefficients.

	(1)	**(2)**	**(3)**	**(4)**
	Without Asia		**Only Developing**	
	Full Sample	Exceptional Growth Ep.	Full Sample	Exceptional Growth Ep.
Δ KE	0.973***	0.925***	0.981*	0.922***
	(0.003)	(0.000)	(0.063)	(0.001)
Δ SE	0.950**	0.954	0.949	0.915*
	(0.045)	(0.545)	(0.119)	(0.084)
Δ Openness	1.016	0.996	1.022*	0.972
	(0.355)	(0.927)	(0.091)	(0.269)
Δ Yrs. Secondary Sch.	0.091***	12.53	0.043***	1.45
	(0.000)	(0.112)	(0.000)	(0.809)
Δ K per worker	0.993	0.976**	0.996	1.003
	(0.348)	(0.034)	(0.760)	(0.894)
Avg. Growth Rate	1.241***	1.401	1.186**	1.044
	(0.007)	(0.202)	(0.013)	(0.846)
Init. GDP/c	1.000	1.000	1.000*	1.000
	(0.152)	(0.442)	(0.081)	(0.126)
Δ Exchange rate	1.000	1.000	1.004**	1.003
	(0.990)	(0.897)	(0.034)	(0.252)
Δ US int. rate	1.326***	1.501**	1.290**	1.304
	(0.001)	(0.013)	(0.013)	(0.129)
Δ Inflation	0.975	1.008	1.086	1.039
	(0.651)	(0.902)	(0.265)	(0.505)
Spells/Failures	93/36	34/16	98/32	47/16
LL	*-23.437*	*-2.098*	*-28.910*	*-9.468*

Table A10. Robustness check on semi-parametric survival analysis. All regressions control for initial GDP/c, US interest rate, exchange rate and price dynamics. Robust standard errors clustered at the country level. Hazard rate and P-value (in parenthesis) are presented. *** p<0.01, ** p<0.05, * p<0.1.