Export structure upgrading and economic growth in the Western Balkan countries

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ABSTRACT

In this paper, we seek to analyze the impact that the ability to produce more sophisticated goods has on the economic performance of the Western Balkan region and to determine the factors fostering this process. To do so, we elaborate an export sophistication index, *à la* Hausmann. The outcomes obtained show that export sophistication has a positive and significant effect on growth in these economies. Additionally, we found that this process is driven more by the sophistication in medium-skill and technology-intensive manufactures goods rather than through sophistication in high-skill goods. Our findings also confirm that a greater participation in international production networks and a better institutional environment stimulates the upgrading of exports, and the subsequent economic growth of these economies.

JEL classifications: F14; F63; O4

Key words: Export sophistication, Economic growth, International production networks, FDI, Western Balkan countries, Panel data models

I. INTRODUCTION

The last two decades have been one of the most favorable periods in terms of economic performance for many Eastern European nations. During this transition period, they opened up their economies, and followed an export-led growth model, resulting in higher growth rates, which in turn contributed to a convergence trend in per capita incomes with high-income countries (IMF 2014, 2015; Shimbov et al. 2016). Recent literature has related this process to the ability of transition countries to produce goods that are more sophisticated and more competitive in international markets (Lall et al., 2006; Hausmann et al., 2007; Jarreau and Poncet, 2012; Lederman and Maloney, 2012). According to these studies, successful developing and transition economies have progressively changed their productive structure, replacing low-value-added activities and unsophisticated goods with higher value-added activities and more sophisticated products, thus increasing the competitiveness of their production and trade.

Over the last few decades, with the increasing globalization and integration of the world's markets, parts of the production process or even entire production processes are being shifted progressively to transition and developing countries. Accordingly, these countries produce goods that have been transferred from more developed economies, thus becoming part of the international production networks (IPNs)[1]. As is well known, this process of participation in IPNs may yield greater knowledge spillovers, encouraging backward and forward linkages with other products and industries present in the country. In that sense, the more sophisticated these products are, the higher the benefit for the country will be, considering that they are associated with higher productivity levels and knowledge spillovers (Hausmann et al., 2007). The level of sophistication of production and exports is thus correlated with economic performance. In general, countries exporting more sophisticated products are those advancing faster up the technological ladder, and therefore achieving higher rates of economic growth (UNCTAD 2013). A country's production structure may become more sophisticated either through an increase in the quality of previously produced goods, or by creating new and more sophisticated ones. According to a recent report (UNCTAD 2013), since 2006 the degree of export sophistication has risen more in high-income countries and

[1] For more detail on the phenomenon of delocalization of the production process (or international fragmentation of production as it is also known) refer to Jones and Kierzkowski (1990), Deardorff, (2001), Baldone et al. (2007), Jones et al. (2005), Kaminski and Ng (2005), OECD (2013) and Shimbov et al. (2013).

middle-income developing countries than in low-income ones. Moreover, export sophistication in most transition economies is higher than the expected level at their stage of development. In this regard, the relevance of identifying the factors fostering the sophistication of the exports of these economies seems clear. Given that improvements in the export structure may play a key role in the economic performance of these countries, policies aimed at fostering the modernization of their economies should stimulate this greater sophistication of the production process.

Nevertheless, little attention has been paid in the literature to the question of what motivates the recent increase in the sophistication of exports in transition economies. Some of the few examples include: (i) the work of Zhu and Fu (2013), which looks at different determinants of export upgrading, like the level of GDP per capita, human and physical capital, and foreign direct investment (FDI); and (ii) the studies by Xu and Lu (2009), and Wang and Wei (2010), which analyze the case of China's rising export sophistication, relating it to the presence of multinational firms and processing trade.

In this paper, we seek to contribute to this strand of the literature by examining two issues: first, the role of export sophistication in economic growth in the Western Balkan countries (WBC) [2]; and, second, the factors influencing the level of export sophistication in these countries. We pay particular attention to two questions that have been highlighted recently in the literature as crucial in the structural upgrading of these economies: (i) the relevance of openness in this process through FDI and a greater participation in IPNs (with a significant increase in trade in parts and components); and (ii) the shift from low- to medium-skill and technology-intensive products in the export structure of these countries.

The recent behavior of the Western Balkan countries (WBC) makes the case of this region particularly relevant for the study of the current structural changes in exports. During the transition period, the WBC embarked on a process of far-reaching reforms aimed at transforming the economic structure from a socialist to a market-based one. This helped the WBC to expand the role of the private sector by dismantling the previously state-controlled industries through privatization and building the institutions needed to support a market economy. These measures

[2] The Western Balkan countries in this paper comprise Albania, Bosnia and Herzegovina, Croatia, Republic of Macedonia, Montenegro, and Serbia. Kosovo is also geographically part of the Western Balkans group, but it is not included in this study because of data limitations.

allowed them to achieve a greater degree of external liberalization, as well as macroeconomic stability. In addition to these underlying early goals, the WBC also aimed to create a business-friendly environment enhancing productivity and exports and hence their output and income. This structural transformation was accompanied by a process of integration. Currently, five of the six countries are either in negotiations to join the European Union (EU) or are candidate countries, a situation that has led to a significant improvement in their legal and regulatory frameworks[3]. This combined economic and political transformation resulted in a substantial shift in the productive and export structure of the WBC which helped them to quickly integrate into the world economy through IPNs, especially the EU, which accounts for more than 80 percent of the overall processing trade exports of the region and around 70 percent of the overall exports (Shimbov et al. 2013 and 2016).

Empirically, we contribute to the literature in several ways. First, we elaborate for the first time an export sophistication index, as proposed by Hausmann, Hwang and Rodrik (2007) (from now on referred to as HHR) for the Balkan region. Second, we analyze the connections between export sophistication and growth and the factors fostering the recent changes in the structure of exports in the Balkan region through instrumental variables techniques and simultaneous equations estimation methods that correct for both simultaneity and endogeneity bias. The results obtained are in line with previous works confirming the positive and significant effect on economic growth in these countries of a shift towards more sophisticated goods. However, in this paper, we go a step further by demonstrating that it is not the sophistication in high-skill goods, but rather the increased sophistication in medium-skill and technology-intensive manufactures goods, which is driving this process. As an additional contribution, our estimates support the beneficial influence on the level of export upgrading of a higher participation in the world economy and particularly of an increase in the share of parts and components (P&C)[4] trade and the flows of FDI in the WBC[5]. In addition to this, we observe that domestic investment and a better business environment, in terms of higher institutional quality and macroeconomic stability, are crucial factors in stimulating

[3] Albania, Bosnia and Herzegovina, Rep. of Macedonia, Montenegro and Serbia are either negotiating or candidate countries, while Croatia joined the EU in 2013.
[4] For further details on the products included, see the table on data sources and definitions or refer to Shimbov et al. (2013).
[5] Some authors have also looked at the relevance of the overall balance of payments, such as Soukiazis et al. (2017).

the sophistication of the export basket of these transition economies and hence their economic performance.

The rest of the paper is organized as follows. Section 2 explains the structural transformation of the WBC, revealing similarities and differences across the countries. The next section provides an overview of the literature analyzing the links between upgrading the productive and export structure and the related impact on economic growth. Section 4 outlines the methodology applied in calculating the export sophistication index, and also contains some relevant stylized facts on this ongoing process of increasing export sophistication in the WBC. The econometric specification and estimation results are presented in Section 5. The final section concludes with a policy discussion on the topic.

II. THE EVOLUTION OF THE EXPORT STRUCTURE OF THE WESTERN BALKAN COUNTRIES

In this section, we look at relevant facts concerning the process of opening up and change in the export structure of the WBC. We highlight several patterns common to most of the WBC, but also point out some differences among these countries in terms of the intensity of their respective structural transformations.

As shown in Figure 1, over the period analyzed, from 1996 to 2015, all of the WBC increased their export orientation, i.e., the share of exports in GDP, even in the years after the 2008/2009 trade collapse. In some countries, such as Serbia and Montenegro, the share of exports with respect to GDP more than tripled. In Albania and Bosnia and Herzegovina, the share of exports in GDP rose more than two and a half times, while Rep. of Macedonia experienced a twofold increase. This increasing trade openness suggests a positive correlation between exports and economic growth in those countries. But more importantly, the WBC not only increased their exports, but also managed to change the composition of exported goods. Except for Albania, which is the only oil exporter, the share of manufactures in overall exports increased in all the countries (see Figure 1b), thereby allowing them to reinforce know-how, productivity and output, as indicated by Stehrer and Wörz (2009). The share in the WBC is more than double compared to that of other transition economies,

but is still lower compared to developed ones, although it is catching up fast[6]. Finally, this increased share of manufactures products occurred with respect to both the intensive margin (the WBC exported more products of the same product category) and the extensive margin (the WBC exported new product varieties), which is an important prerequisite for sustainable export growth[7].

INSERT FIGURE 1 HERE

By examining the exports of manufactures in more depth, we observe that the WBC not only increased the share of manufactures exports, but also succeeded in improving the skill and technology structure of their exports. As can be seen in Figure 2, the WBC managed to increase the share of medium-skill and technology-intensive manufactures mostly at the expense of low-skill and technology-intensive ones. Croatia, Rep. of Macedonia, and Serbia and Montenegro have seen significant improvements along these lines, with Albania being the only exception, largely because of increased oil exports.

INSERT FIGURE 2 HERE

The quantitative approach outlined above clearly shows three important outcomes in the structural transformation of the production process in the Western Balkan countries. First, it reveals that they became increasingly export-oriented, as indicated by the growing share of exports in GDP. Second, this transformation has been largely due to an increasing share of the manufactures sector in overall exports, a process which has been accompanied by a greater participation in IPNs (Shimbov et al., 2013, 2016) (see Figure 3). Finally, we observe a positive shift from low- to medium-skill and technology-intensive manufactures goods, giving the WBC the potential for increased productivity and output in the future.

INSERT FIGURE 3 HERE

[6] The share in the WBC increased from 37 to 48 percent between 1996 and 2015 while it declined in the developed economies from 67 to 64 percent. The share in other transition economies stands at 20 percent and has also been decreasing.

[7] For growth to be sustained for decades it must involve a continued introduction of new goods, not merely continued learning on a fixed set of goods. Feenstra et al. (2005) and Hidalgo and Hausmann (2011) argue that rich countries or countries that have grown faster appear to have introduced more goods than poor countries. For an analysis of extensive vs. intensive margins in international trade, see Hummels and Klenow (2005).

III. RELATED LITERATURE

The export performance of a country has long been highlighted in the economic literature as one of the key driving forces for development, even going as far back as Adam Smith and David Ricardo. Primary attention has been paid to the role of exports in economic performance (Cuadros et al., 2004) and practical proof has been seen in the case of the East Asia growth miracle, which lifted millions of people out of poverty (World Bank 1993). Nevertheless, a rise in the amount of exports is not enough to sustain the development process that was started some decades ago by many transition economies. Recent trade literature highlights the relevance of a structural transformation of exports in replacing low-value-added activities and basic goods with higher value-added activities and more sophisticated products, thus increasing competitiveness (Hausmann et al. 2007)[8].

The changing patterns of export structures across countries since 1970 were analyzed by Lee (2011), who argues that changes in the world's export structures account for much of the observed effect of economic integration on the global economy. Furthermore, the geographical distribution of high-technology industries has shifted from developed to developing countries, particularly the emerging markets. A significant part of this change in export structure and export patterns can be explained by the recent rise in international production networks and global value chains (GVCs) which are a defining feature of 21st century trade (Baldwin, 2014)[9]. This phenomenon has enabled countries to undertake more in-depth specialization in niche parts of the production chain, either through FDI or arms-length transactions, with important implications for a country's trade pattern and economic behavior[10]. For firms in developing countries, integration into GVCs does not only represent a new market for their products, but also plays a growing and crucial role in accessing knowledge and enhancing learning and innovation. For this reason, both researchers (Gereffi and Sturgeon, 2013) and policy-makers (European Commission, 2014) have started to consider

[8] The idea of export diversification strategies appeared with the new trade and endogenous growth theories developed by Krugman (1979) and expanded by Romer (1990), Grossman and Helpman (1991), Krugman (1995) and Barro and Sala-i-Martin (1997), which explained the importance of trade flows like intra-industry trade by taking into account factors such as externalities and scale economies, the demands and tastes of consumers, and the product cycle. In these models, exports open up opportunities for increased specialization, which in turn leads to higher productivity growth through learning-by-doing (Grossman and Helpman, 1991).

[9] Theoretical models developed by Jones and Kierzkowski (1990), Feenstra and Hanson (1996) and Grossman and Rossi-Hansberg (2008) capture trade relations that result from the international fragmentation of production.

[10] See, for example, Baldone et al. (2007), Foster et al. (2013), Baldwin (2014), Shimbov et al. (2016).

participation in GVCs as a part of the industrial policy toolkit with a high potential to facilitate faster development through structural upgrading (Whittaker et al., 2010). Recent empirical studies by Kowalski et al. (2015) and Stöllinger (2016, 2017) show that participation in GVCs has a beneficial effect on structural upgrading and trade for developing and transition economies, particularly in Europe, in their role as offshoring destinations[11]. Nevertheless, while the above studies offer empirical support for the endogenous growth theory, it is unclear whether the particular mix of goods has any implication for structural change and economic growth.

The seminal contribution to this literature comes from HHR, who developed a model describing economic growth as a result of transferring resources from lower-productivity activities to higher-productivity activities through the entrepreneurial process of product discovery or accelerated technological development, as set out in Hausmann and Rodrik (2003)[12]. In doing so, HHR presented an index that captures the sophistication of a country's productive structure by measuring the "quality" of its export basket, which they call EXPY. They show that there are meaningful differences in the specialization patterns of otherwise similar countries, arguing that countries that acquire the capability to export more sophisticated goods grow faster, and emphasizing the idea that what a country produces and exports matters[13]. This approach by HHR received justified attention because it offered a theoretical structure to explain export sophistication along with an adequate empirical treatment.

Several empirical papers have tested the hypothesis that increased export sophistication leads to higher future growth and income. Rodrik (2006) illustrates a cross-country relationship between the level of sophistication of exports and the per capita income, using the HHR sophistication index. He finds that China is an outlier in terms of the overall sophistication of its exports, i.e., its

[11] For a broader overview of the subject see "Making Global Value Chains Work for Development" – Taglioni, Daria, and Deborah Winkler; The World Bank 2016.

[12] Hausmann and Rodrik (2003) argue that in a setting of significant cost uncertainty for private investors in developing countries, the range of goods that an economy ends up producing and exporting is determined not just by the usual fundamentals, but also by the number of entrepreneurs that can be stimulated to engage in cost discovery in the modern sectors of the economy, which leads to higher productivity and growth. This structural change is an integral component of models of economic development, such as the dual economy model, first developed by Lewis (1954), who shows that resource shifts entail a 'structural change bonus' which is essential to achieve high and sustained aggregate productivity growth (McMillan and Rodrik 2011).

[13] Lall et al. (2006) develop a similar measure for calculating export sophistication, which they call the "normalized export sophistication index". Nevertheless, while they present a series of indicators showing the evolution of export sophistication over time, they do not develop an explicit link between their export sophistication measure and growth.

export bundle would correspond to a country with a per capita income level three times higher than its actual level. Jarreau and Poncet (2012) also test the prediction that regions, which develop more sophisticated goods, measured by their EXPY index, subsequently grow faster, using regional variations within a single country (China) that enable them to control for different institutional capacity. They find that there is considerable variation in export sophistication, controlling for the level of development, and that this variation in turn matters for growth. Mishra et al. (2011) and Anand et al. (2012) broaden the scope of the analysis by looking not only at goods, but also at services. Mishra et al. (2011) argue that services can provide developing countries with an alternative channel for growth that goes beyond the limits of traditional industrialization.

More recently, Fortunato and Razo (2014) expand the analysis by looking at a wide variety of countries, including high incomes ones. They look at both the dynamics and the composition of the export structure and its effects on growth and also on the likelihood of countries being trapped at intermediate levels of income. Their analysis confirms HHR's results, showing that indeed a country's relative level of export sophistication has significant consequences for subsequent growth.

These previous papers confirm the growth-enhancing effect of export sophistication. If this proposition – countries become what they export – is indeed true, then identifying factors that determine the country's level of export sophistication should be an important research target for academics and should have important implications for policy-makers in developing countries. HHR presented an early brief overview of potential determining factors of export sophistication, and identified GDP per capita, human capital, and the rule of law as potential determinants for the explanation of export sophistication variation across countries. Anand et al. (2012) also indicate that the positive relationship between GDP growth and export sophistication, and add that external liberalization and good information flows are also significantly associated with a high level of export sophistication.

An important contribution to the research on the determinants of export sophistication is the study by Zhu and Fu (2013). Their results suggest that the export sophistication of countries is enhanced by capital accumulation, engagement in knowledge creation and transfers via investment in

education, and foreign direct investment. In addition, they indicate that institutional quality also facilitates the export upgrading of countries[14].

Finally, Xu and Lu (2009) and Wang and Wei (2010) investigate the importance that processing trade and participation in GVCs have on export sophistication. They use the example of China to show that processing trade moves China into the production and exports of more sophisticated varieties within a given product category. Furthermore, they point out that the level of export sophistication is positively related to the level of FDIs. For an overview of the literature related to the process of export sophistication and its determinants, please see Table 1 below.

INSERT TABLE 1 HERE

IV. THE EXPORT SOPHISTICATION OF THE WESTERN BALKAN COUNTRIES

a) Measuring export sophistication (EXPY)

To measure the quality of exports and how it varies over time, as well as to determine its importance in the process of development, we focus on what is known as its sophistication. Ideally, one would take the research and development (R&D) content of an exported product as a measure of its level of sophistication, but product-level R&D data is rarely available. To overcome this limitation, in this paper we adopt HHR's export sophistication index, widely used in previous literature.

This index is a measure of the sophistication of a country's export basket. It attempts to capture the productivity level associated with a country's exports, which is also considered a proxy of the most productive set of goods that a country can produce at a given time (based on the idea that these goods reveal the production frontier, assuming that countries export those products in which they are most productive[15]). Thus, the export sophistication index reflects the competitive characteristics of the exported products on the basis of the degree of development of the exporting countries of each good, and hence it is a proxy for the productivity of a country's exports. In that

[14] Similar findings are also presented by Weldemicael (2014).
[15] According to Melitz (2003), exporting firms are on average more productive than non-exporting ones.

sense, products exported by rich countries will have features that allow high-wage-earning producers to compete in world markets (such as technological content, high level of quality, marketing, institutions, skill level of the labor force or capacity for management and coordination of the production process).

The construction of the export sophistication index entails two stages. First, an index called PRODY is developed for each product, which is used to calculate the EXPY index for each country. Specifically, the PRODY index is calculated in the following way. First, we construct a weight that can be used further on in the process. The numerator of this weight is the value-share of a product *k* in the exports of country *j*. The denominator aggregates the value-shares over all countries exporting product *k* (HHR):

$$Weight_k = \frac{x_{jk}/X_j}{\sum_j (x_{jk}/X_j)}$$

These weights can be used to calculate an index called PRODY, by multiplying the obtained weights with GDP per capita of each country:

$$PRODY_k = \sum_j Weight_{jk} Y_j$$

Hence, the index is a weighted average of GDP per capita, where the weights correspond to the revealed comparative advantage (RCA) of each country in product *k*. The rationale for using RCA as a weight is to ensure that country size does not distort the ranking of products. Thus, PRODY associates the sophistication level of a product with the income levels of the countries exporting it. A product exported intensively by high-income countries is considered to have high sophistication (i.e., a "rich country" export), and a product exported intensively by low-income countries is considered to have low sophistication (i.e., a "poor country" export).

Next, the PRODY index is used to construct the export sophistication level of country *j* at time *t* ($EXPY_{jt}$). This is calculated as the weighted average of the PRODY of the goods exported by a country, with the weights being their relative export shares. Accordingly, EXPY is an estimate of

the degree of sophistication of a country's export basket, which is a proxy for the productivity level associated with that country's exports (HHR).

$$EXPY_{jt} = \sum_{k} \frac{x_{jkt}}{X_{jt}} PRODY_k$$

The EXPY index as constructed above shows a positive correlation with technological intensity. Nevertheless, this correlation is not perfect, as noted by Lall et al. (2006). According to these authors, among the production characteristics that PRODY integrates there are cases where high-technology products have low levels of sophistication (PRODY values). This might be a result of the growing globalization and international fragmentation of production, whereby previously integrated productive activities are now segmented and parts of the process are relocated to lower-wage countries[16]. On the other hand, there are low-technology products with high sophistication as measured by the index, suggesting that the products have specific requirements for natural resources, logistics or other needs that are beyond the reach of poor countries. For example, some high-income economies are exporters of scarce natural resources such as oil or other products requiring advanced logistic infrastructures, which results in high PRODY values that are not necessarily representative of the capabilities associated with the production stage.

b) Data availability and main PRODY and EXPY statistics

We combine two data sources to calculate the PRODY and EXPY indexes for the WBC. For trade statistics, we take UNCTAD data on 255 products, using the Standard International Trade Classification (SITC) Rev.3 at the 3-digit level. For GDP per capita data, we rely on the World Development Indicators from the World Bank and we use GDP per capita in constant 2011 international US dollars, which allows us to control for increases in real terms.

Following the original work by HHR and the practice established in subsequent literature such as Mishra et al. (2011), Jarreau and Poncet (2012), Anand (2012), and Zhu and Fu (2013), the EXPYs are constructed here using static PRODY for a consistent set of countries that reported trade and GDP per capita data for the period 2002-2004. We do so because of the following reasons. First,

[16] Srholec (2007) shows that the specialization of some developing countries in high-tech exports can be attributed to the effect on trade statistics of international fragmentation of electronics production.

in order to avoid the so-called "omitted country bias", as discussed in HHR, it is essential to use a consistent sample of countries, since non-reporting is likely to be correlated with income, and thus constructing PRODY for different countries over different years could introduce serious bias into the index. The choice to use the years in question is driven by the intention of maximizing the sample of countries, i.e., that these are the years in which most of the countries reported both trade and GDP per capita data (179 countries from an initial sample of 213 countries). In addition to this, the PRODY index can change over time when the GDP per capita of the exporting countries changes, even with the same number of exporting countries. This raises the concern that an increase in EXPY could not only be due to a change in the share of exports of an existing export bundle or the addition of new sophisticated commodity, but may also be a result of an increase in the GDP per capita of other exporting countries, which would lead to misleading conclusions in a given country. Thus, over time EXPY can either increase through the addition of new sectors of high PRODY to the export basket, or simply by increasing the export share of current high PRODY sectors (i.e., extensive vs. intensive upgrading), both of which are consistent with the notion of structural change in the economy, which is analyzed in this paper though the proxy of increased sophistication.[17]

INSERT TABLE 2 HERE

Table 2 shows some descriptive statistics related to the export sophistication index. As we can see, there is a high variation in EXPY among countries as evidenced by the high standard deviation. Nevertheless, during the period analyzed the EXPY value increased by 10 percent overall, or 0.5 percent per year, calculated by geometric mean. On the other hand, the range of values of EXPY also increased, from 23,543 US dollars in 1996 to 24,370 US dollars in 2015. Using data from columns 4 and 5 of Table 2, we calculate that the minimum value of EXPY increased on average by 1.6 percent per year, while the maximum value of EXPY increased on average by 0.4 percent (both calculated by geometric mean). This is an indication that the EXPY value for some low-income countries grew during 1996–2015 more rapidly than in high- and middle-income countries. This is a positive observation as it suggests that some countries with a low level of export

[17] When looking at the main statistics referring to average PRODY for the period 2002-2004, we observe that there is a great variability in the degree of sophistication across products. In general, higher value-added goods that require a higher level of skill and technology intensity have higher recorded PRODY values (due to space limitation the results are available as supplementary material, table S.1.,at Emerging Markets Finance and Trade Journal webpage).

sophistication continually increased their production and export diversification, and as a result their export sophistication steadily increased as well. Looking at the country performance of the WBC, we observe that average growth of export sophistication had been equal to or higher than the world average, pointing to a more dynamic structural change taking place in these countries. For example, Rep. of Macedonia and Serbia and Montenegro clearly lead the field in terms of increased export sophistication, with an average growth per year of 1.6 and 4.2 percent, respectively. The other three countries also experienced increases in their sophistication, but at a more moderate level.

c) Evolution of export sophistication in the WBC

In this section, we examine some stylized facts about the sophistication of exports in the WBC. We first focus on the evolution of the export sophistication of the WBC relative to other countries before going on to analyze the potential determinants of this process.

INSERT FIGURE 4 HERE

As can be observed from Figure 4.a, the WBC have been gradually improving their overall export sophistication over time, although moderately. This process has been largely driven by manufactured goods, as can be seen in Figure 4.b. Throughout the period analyzed, the export sophistication of manufactures in high-income countries has been in constant decline, while the opposite is true for the WBC, which show a clear upward trend. In fact, at the beginning of the sample period (1996) the level of export sophistication in manufactures goods in the WBC was 62 percent of that of high-income countries. However, as the WBC underwent structural transformation, their export sophistication in manufactures rapidly converged to that of high-income countries, reaching 86 percent in 2015.

INSERT FIGURE 5 HERE

Disaggregating the export sophistication index for manufactures by the level of skill and technological intensity reveals a distinct behavior of its components. The sophistication of low-skill and technology-intensive products increased until 2008, changing since then into sharp decline (Figure 5a), and converging with the level of high-income countries. By contrast, export sophistication in high-skill and technology-intensive products was in decline until 2008, after

which it increased moderately (Figure 5c). However, consistent with the observation made in Section 2, the WBC have significantly increased their export sophistication in medium-skill and technology-intensive products (Figure 5b). This points to the fact that the WBC have been expanding their production frontier over time and acquiring new skills and technologies, among other things through the process of increased FDIs and higher participation in IPNs (as also indicated in Section 2)[18].

INSERT FIGURE 6 HERE

Next, Figure 6 displays a scatterplot of EXPY and GDP per capita to reflect how export sophistication varies across countries. We observe that in these countries the level of export sophistication is positively related to the level of income per capita, as has been highlighted in previously reviewed literature (Rodrik 2006, HHR).

To summarize, some important observations can be drawn from the above discussion. First, a structural transformation of the WBC production from low- to medium-skill and technology-intensive manufactures (and in some countries to high-skill and technology-intensive manufactures) has resulted in an increased level of export sophistication. Second, this process seems to be largely driven by manufactures goods, and in particular by medium-skill and technology goods, indicating that the WBC had been expanding their production frontier and acquiring new capabilities at this level of specialization. This process of acquiring new capabilities appears to be influenced by the increased participation of the WBC in IPNs. Finally, in line with related theoretical and empirical literature, we also confirm a positive correlation between this increasing export sophistication and the level of income in the WBC. Nevertheless, despite this evidence, to the best of our knowledge, the effects of structural transformation and increased export sophistication on growth and in particular the factors that drive the variation in export sophistication have never been empirically tested for the economies of the Balkan region.

[18] This process was accompanied by an increase in: (i) human capital, as on average the six countries increased their gross tertiary enrolment ratio by 3.2 times between 1996 and 2015, with the average enrolment being 55 percent; (ii) the stock of FDI increased on average by 13 times between 1996 and 2015, averaging 50 percent of GDP in 2015; (iii) trade in parts and components as a percentage of GDP has increased on average by 3.2 percentage points, averaging 8.5 percent of GDP in 2015.

V. ECONOMETRIC METHODOLOGY AND RESULTS

In this section, we describe the econometric approach, define the data, and detail the empirical results. As previously mentioned, the aim of this paper is to test the effects that the structural changes in exports have on the economic performance of the WBC and, equally important, to identify the factors driving this structural change. To do so, we use panel data and the export sophistication index described in Section 4, for both total goods (EXPY) and manufactures goods only (EXPY in manuf.). For comparison purposes and to obtain a broader view of this phenomenon (thereby overcoming the limitations of using the EXPY index indicated by some authors), we also incorporate the share of high-skill and technology-intensive manufactures with respect to total exports (HS manuf. exports) as a measure of export sophistication, as in the paper by Fortunato and Razo (2014)[19]. A novel contribution of this paper is that we further consider the share of medium-skill and technology-intensive manufactures (MS manuf. exports). By doing so, we attempt to verify our hypothesis that the increasing export sophistication in the WBC has been more a consequence of an increase from low- to medium-skill and technology-intensive goods than the result of an increased weight of highly technology-intensive products.

First, following the traditional literature on economic growth, and according to specifications by HHS and Jarreau and Poncet (2012), we estimate the baseline model for growth including the natural log of real GDP per capita in the previous period (thus capturing the convergence effect), the investment rate (*INV*), to control for physical capital accumulation, and a measure of export sophistication (*EXP_SOPH*) as our regressor of major interest[20]. Next, we extend this model by introducing other control variables, such as human capital (*HK*) and openness (*OPEN*). Human capital has also been included as a control variable in the studies by HHR, Anand et al. (2012), and Jarreau and Poncet (2012)[21]. Similarly, trade openness is widely conceived in the literature as a driver of economic growth (e.g., Rodriguez and Rodrik, 2000; Billmeier and Nannicini, 2013).

[19] In their regressions, Jarreau and Poncet (2012) also use the variable highly technology-intensive goods with respect to total exports as a proxy of sophistication. Furthermore, Fortunato and Razo (2014) use this variable as an additional explanatory variable.

[20] As appropriately pointed out by an anonymous reviewer, in the conventional well-known model of economic growth by Barro and Sala-i-Martin (1992), population is also included as a measure of scale. However, the low variability of this variable in the period analyzed prevents us from including it in a regression with country-specific effects.

[21] According to the new growth theory, human capital is the engine and stimulus driving economic growth in the long run (Romer, 1990).

Related to our research, we can find regressors that capture the openness of the economy in the estimations shown by Anand et al. (2012) and in Fortunato and Razo (2014).[22]

More specifically, the equation for estimating growth takes the following form:

$$\ln(y_{i,t}) - \ln(y_{i,t-1}) = \alpha_0 + \alpha_1 \ln(y_{i,t-1}) + \alpha_2 \ln(EXP\_SOPH^k_{i,t}) + \alpha_3 \ln(INV_{i,t}) + \alpha_4 \ln(HK_{i,t}) + \alpha_5 \ln(OPEN_{i,t}) + \delta_i + \mu_t + \varepsilon_{1i,t} \quad (1)$$

where y denotes the natural log of real GDP per capita, and *i* and *t* index our five countries and the twenty periods, respectively. δ_i represents time-invariant permanent differences across countries and μ_t denotes the time effects that affect the countries identically in each period. The error term ε_{it} is assumed to be independent across countries and over time.

Nevertheless, while there seems to be a consensus in the literature on the determinants of economic growth, this is not the case for the fundamentals behind the sophistication in exports. Indeed, this phenomenon is an issue that has scarcely been explored in theoretical and empirical works, as previously mentioned in Section 3 (Literature review). Given the lack of empirical studies on this topic and the difficulty in obtaining detailed data for an extended period for the WBC, modeling the variations in the export sophistication has not been an easy task.

In line with the previous literature, we have considered the influence of the following covariates in the regression for EXPY: the GDP per capita, the investment rate, the stock of FDI, trade in P&C, and openness. The relevance of GDP per capita in the export sophistication of countries is a robust result that remains stable through different model specifications and methodologies (see, for instance, HHR, and Lin et al., 2017). However, as pointed out by Zhu and Fu (2013), rather than the role of per capita income itself, this result might mask the influence of those fundamentals of export sophistication that determine per capita income such as human capital, FDI, trade or institutional quality. For these authors, the capital-labor ratio, the rate of FDI, and openness are also key determinants in explaining export sophistication. According to these authors, export sophistication in these economies has risen considerably due to the global nature of production. Likewise, Cuadros and Alguacil (2014) show that FDI and imports are the main channels through

[22] Definitions and data sources for all variables are provided in Table A.1 in the Appendix.

which developing countries obtain knowledge from foreign sources. In this line, participation in IPNs is considered by many authors as having high potential for structural upgrading through export sophistication (Kowalski et al. 2015, Stöllinger 2016, 2017). The role of foreign investment and processing trade in the sophistication of the export structure has been analyzed by Xu and Lu (2009) and Wang and Wei (2010) for China. In the case of the WBC, Shimbov et al. (2016) show how the greater participation of these countries in IPNs has had important implications for their economic behavior. In fact, in their work, the positive effect of processing trade is present beyond the beneficial influence of traditional trade.

In addition to this, we have extended the baseline with other relevant factors, which have recently been pointed out by the literature as essential in the structural transformation of developing or transition economies. This is the case of the quality of institutions (*INST*) and macroeconomic stability (*STAB*). The quality of institutions is measured here by two alternative variables: the control of corruption index, which focuses more on political institutions, and the EBRD index, capturing the business environment or the quality of institutions from an economic perspective. Macroeconomic instability is proxied by the inflation rate. As demonstrated by Morrissey and Udomkerdmongkol (2012) and Cuadros and Alguacil (2014), the institutional framework is particularly relevant for technology upgrading, especially in the context of developing countries. Furthermore, according to Alguacil et al. (2011), instability at the macro level that increases uncertainty may lead to a shrinking in the ability of these countries to absorb foreign technologies.

Therefore, the equation for estimating the factors that drive the variation in export sophistication can be expressed as:

$$\ln(EXPY_{i,t}) = \beta_0 + \beta_1 \ln(y_{i,t}) + \beta_2 \ln(INV_{i,t}) + \beta_3 \ln(FDI_{i,t}) + \beta_4 \ln(P\&C\_TRADE_{i,t}) + \beta_5 \ln(OPEN_{i,t}) + \beta_6 INST_{i,t} + \beta_7 STAB_{i,t} + \delta_i + \mu_t + \varepsilon_{2i,t} \quad (2)$$

where *y* denotes real GDP per capita, *i* stands for each of the WBC, and *t* denotes time. The terms μ_t and δ_i represent the time effect, and the time-invariant and unobserved bilateral effects,

respectively. The remaining error ε_{it} is assumed to be independent across countries and over time.[23]

To estimate the above equations, we have employed a panel data setting using several estimation techniques, which allows us to account for time effects and unobserved individual heterogeneity, and also to deal with endogeneity problems[24]. For comparative purposes, we first estimate our equations using the fixed-effects (FE) methodology. Most empirical works that analyze the effects and/or the cause of export sophistication with panel data use an FE estimation (see for instance Xu and Lu, 2009; Zhu and Fu, 2013). To mitigate the simultaneity problem and to account for a dynamic effect, in these initial regressions we add the explanatory variables from one year before. Robust standard errors are calculated to eliminate potential heteroscedasticity and autocorrelation of the panel data. As mentioned above, we employ different measures of the export sophistication: EXPY, EXPY in manufactures, and exports of high-skill manufactures and of medium-skill manufactures. The period analyzed runs from 1996 to 2015.

Next, to overcome the problem of endogeneity and reverse causality, on the one hand, we estimate the coefficients of the extended model of Eq. (1) using two-stage least squares (TSLS) and generalized method of moments (GMM) instrumental variable (IV) techniques[25]. As mentioned previously, the likelihood of both the potential positive impact of an increase in the sophistication of exports on GDP per capita growth and the possibility of an export upgrading being enhanced by a higher rate of economic growth is well documented in the literature (see, for instance, Hausmann et al., 2007). On the other hand, the simultaneity bias in Eq. (2) is solved here through the system GMM estimation methodology proposed by Arellano and Bond (1991). The difficulty to find an appropriate instrument for the GDP per capita in the EXPY equation has prevented us from estimating this last equation using the 2SLS regression. Finally, as a novelty in the literature

[23] Given the high correlation between the variables that represent the quality of institutions, the EBRD index and the control of corruption, to avoid the inefficiency that multicolinearity entails, we have included these variables separately in the regression. The correlation matrix is available as supplementary material, table S.2., on the Emerging Markets Finance and Trade Journal website.

[24] All regressions include time effects and the decision as to whether to consider unobserved country-specific effects as fixed or random is made based on the Hausmann test. Rejection of the null hypothesis in this test implies that fixed model estimation is preferred, and vice versa. See Greene (2012) for more details.

[25] The GMM method provides more consistent estimations in the presence of arbitrary heteroscedasticity, but at a cost of possibly poor finite sample performance. Thus, if heteroscedasticity is not present, then the standard IV technique will be preferable (Baum et al. 2003). In addition, with a long time dimension and small number of individuals GMM estimation may cause problems due to the presence of many instrumental variables.

on export sophistication, we estimate all the coefficients of both equations (EXPY and GDP per capita growth) simultaneously by the three-stage least square (3SLS) methodology. By jointly estimating the system of equations using the optimal instruments computed in the previous stages, this method provides asymptotically more efficient estimations than 2SLS, thereby yielding the most reliable results[26].

The estimation results of GDP per capita growth obtained through fixed effects (FE) are depicted in Table 3.[27] The coefficients in this table are shown sequentially for the four alternative measures of export sophistication. In the first four columns, we present the estimates of the basic model, taking the investment rate as a control variable, and the past value of GDP per capita in order to capture the convergence effect. In the following four columns, we extend this basic model by introducing human capital and openness as explanatory variables that mitigate the omitted-variable concerns.

INSERT TABLE 3

In line with previous empirical studies, our results confirm, the positive influence of export sophistication on real GDP per capita growth[28]. In all specifications, the initial EXPY index (for all goods, as well as for manufactures goods only) is positive and significant. Consequently, as expected, an improvement in a country's export sophistication will lead to subsequent growth in its income. Specifically, the estimated coefficients imply that on average a 10 percent increase in the EXPY index is associated with a rise of 0.8 percentage points in GDP per capita growth in the next period. This effect, however, is slightly smaller if we look at the EXPY index for manufactures goods, with an estimate coefficient not greater than 0.031 (thus indicating a growth of 0.31 percentage points for every increase of 10 percent in the EXPY index). On the other hand, consistent with Fortunato and Razo (2014), the share of high technology-intensive manufactures in exports does not seem to significantly influence the economic performance of a country. However, if we go a step further and examine the impact of medium-skill and technology-intensive

[26] Wooldridge, J. M. (2010).

[27] As can be seen at the bottom of this table, the Hausmann test statistic suggests that in all cases the fixed effects model is preferred to the random effects model. In addition, from the Wooldridge test for autocorrelation, we can conclude that the data does not have first-order autocorrelation.

[28] See Hausmann et al. (2007), Anand et al. (2012), Jarreau and Porcet (2012), and Fortunato and Razo (2014), among others.

manufactures, our results show that they have a positive and significant influence in both the basic and the extended models. This effect is slightly higher than the influence of an increase in the EXPY index for manufactures goods. This confirms our intuition that the observed transition from specializing in low-skill and technology-intensive products to medium-skill and technology-intensive products has significant consequences for economic growth in the WBC.

In all cases we also obtain the predicted negative and significant coefficient on the lag of real GDP per capita, with a coefficient between 0 and -1, indicating the existence of a convergence effect (see Anand et al. 2012, Jarreau and Porcet, 2012). The empirical evidence also confirms the expected positive influence of human capital on economic growth. This variable appears strongly significant in all specifications. Similarly, and in line with previous literature, a greater openness of these economies seems to have a positive effect on their potential growth (Anand et al., 2012, and Jarreau and Porcet, 2012). However, results on the investment rate are uncertain. On the one hand, they show highly significant and positive coefficients in the basic regressions, providing evidence of the positive relationship between domestic investment and economic growth, as shown in Jarreau and Porcet (2012) and Fortunato and Razo (2014). This result, on the other hand, does not hold in the extended model. The explanation for this probably lies in both a positive and significant correlation of this variable with openness and the endogeneity problems that this equation may suffer, as previously pointed out.

Thus, to eliminate simultaneity and the reverse causality biases, we next estimate the GDP per capita growth by IV and GMM. As an instrument for export sophistication, we employ the share of information and communication technology (ICT) goods as a percentage of total trade. We analyze the adequacy of this instrument by testing the two criteria necessary for an instrument to be valid: relevance and exogeneity. Particularly, following the procedure suggested by Wooldridge (2015), we use the OLS estimates of the effect of ICT on both EXPY and EXPY in manufactures in order to verify the instrument's relevance. The results obtained confirm that ICT is significant and correlated with the sophistication of exports. Additionally, we verify the exogeneity of this

instrument by showing that ICT does not cause any significant effect on GDP per capita growth beyond its influence through EXPY[29].

Subsequently, Table 4 illustrates the 2SLS and GMM estimations of the different specifications of GDP per capita growth. As can be appreciated, the positive influence of EXPY and EXPY in manufactures on GDP per capita growth is robust across different methods and model specifications. However, the estimated coefficients on export sophistication are lower than in the FE estimation, which is not surprising if we consider the upward biases derived from a positive reverse causality coming from GDP per capita growth to EXPY in the within-group estimator. An increase of 10 percent in the EXPY index now entails a rise in GDP per capita growth of between 0.07 and 0.1 percentage points. Likewise, as in the FE estimation, the beneficial impact of domestic capital accumulation and openness are highly significant regardless of the methodology employed, while the share of high technology-intensive manufactures in exports is not significant in any case. Additionally, the relevance of the share of medium technology-intensive manufactures is confirmed in the IV estimation. However, contrary to our previous results, human capital now appears to be insignificant in all but two models, where it is significant only at the 10 percent level. This can be accounted for by both the high correlation of this variable with per capita income and openness, and the endogenous character of this variable[30]. Finally, given that with weak instruments the conventional IV inference is misleading[31], we test this fact for ICT. Hence, at the bottom of the table, we report the Cragg–Donald statistic (1993) and the critical values of Stock and Yogo statistic (2005) to test the null hypothesis that instruments are weak. We also test for over-identifying restrictions using Hansen's J chi-squared statistic. The results confirm that the choice of ICT as an instrument for export sophistication is reasonable. Moreover, the results of the Sargan test for endogeneity in the GMM estimation show that the regressors in our model are not exogenous[32].

INSERT TABLE 4 HERE

[29] Due to space limitations, the tables showing the estimates of the above-mentioned procedures are only available as a supplementary material, tables S.3. to S.5., on the web-page of the Emerging Markets Finance and Trade Journal.
[30] Ciccone and Papaioannou (2009).
[31] Stock et al. (2002).
[32] Even though the instrumental variables estimator removes the inconsistency of the FE estimations, it causes a loss of efficiency that needs to be taken into account if we suspect that the predictor in the model is not endogenous.

We now turn to the second aim of this paper, which is to analyze the factors influencing the level of export sophistication in the WBC. Table 5 summarizes the regression of EXPY with respect to its fundamentals using the fixed effects estimation method (as derived by the Hausmann test results shown at the bottom of the table). As previously, all explanatory variables are observed one year prior to the dependent variable. Then, in Table 6, in order to solve the potential endogeneity problem of this regression, we use the system GMM methodology proposed by Arellano and Bond (1991).

INSERT TABLE 5 HERE

As can be seen in Tables 5 and 6, our estimates reflect a clear positive influence of the stock of FDI and P&C trade on EXPY. The coefficients on these variables are strongly significant in all regressions and do not depend on the estimation method. More precisely, we can conclude that, according to the GMM estimations, an increase of 10 percent in the rate of the stock of FDI or of trade in parts and components is accompanied by an improvement in the EXPY index of more than 1.6 percentage points. Thus, a higher openness to foreign markets through foreign investments or through an increased participation in international production chains should be considered as a priority objective to ensure improvements in the productive structure of these countries[33].

INSERT TABLE 6 HERE

In addition, and in line with HHR and Anand (2012), we find a positive influence of the lagged value of GDP per capita on the current value of EXPY. Furthermore, similarly to the findings of Zhu and Fu (2013), the positive and statistically significant coefficients of investment indicate that higher accumulation of physical capital leads to an increase in the sophistication of exports. An increase in the investment rate of 1 percent leads to an increase of around 0.3 percentage points in the EXPY index, other variables being kept constant. Finally, we observe that a better business environment in terms of a higher quality of institutions and macroeconomic stability are also crucial factors in stimulating the sophistication of the export basket of these transition economies and hence their subsequent growth. Both EBRD and the control of corruption indexes exert a

[33] This in turn is a powerful contributor to growth, complementing the impacts generated by other determining factors, as shown by Shimbov et al. (2016). Similar results in terms of the growth-enhancing effects of the processing trade are obtained by Baldone et al. (2007) for the EU countries, and by Foster et al. (2013) for four advanced and emerging economies.

positive and significant influence on the sophistication of exports, regardless of the specifications and methodologies. Conversely, as expected, a higher macroeconomic uncertainty is negatively associated with EXPY. All the estimations include period fixed effects. The autocorrelation tests of the residual in the system GMM show that there is no significant first-order autocorrelation. Similarly, the results of the Sargan test confirm that the over-identifying restrictions are valid.

Finally, we report more results from the tests conducted to check the robustness of both the growth-enhancing effect of EXPY and the drivers of export sophistication through the simultaneous estimation of equations (1) and (2) by the three-stage least squares (3SLS) methodology. Under general conditions, this estimation method provides asymptotically more efficient estimations that those obtained by 2SLS as, in addition to endogeneity and simultaneity, it also controls for the cross-correlations in the residuals of the equations (Wooldridge, 2010).

Table 7 depicts the results from the 3SLS estimations of our system of equations. The outcomes in this table confirm that EXPY is positively correlated with GDP per capita and vice versa. Thus, these findings confirm a mutually reinforcing effect between export sophistication and economic performance, and the importance of carrying out a simultaneous estimation of both variables, such as the one conducted in this paper through the 3SLS method, for a proper inference. Our results in these regressions also show the relevant role of domestic investment for economic growth and the convergence effect.

INSERT TABLE 7 HERE

Additionally, as shown in the second part of this table, the positive and significant coefficients on FDI, P&C trade, and openness in the EXPY equation corroborate our hypothesis that a higher participation of these economies in the international production networks stimulates the upgrading or sophistication of exports directly and therefore, indirectly, their economic behavior. The influence of human capital on GDP per capita growth and the effect of the EBRD index on the EXPY are also found to be robust results, as shown in columns (3) and (4).

VI. CONCLUSIONS

The Eastern European countries have been undergoing intense reforms and significant structural transformation over the past two decades, resulting in a new export structure and an improvement

in their economic performance. In this process, the Western Balkan countries have not been an exception. In recent decades, they have progressively opened up and become increasingly export-oriented. This transformation has been largely fueled by the increased share of manufactures in their export structure and a shift from low- to medium-skill and technology-intensive products. This process has also been linked to the increased participation in IPNs and the rise in FDI inflows. It is therefore of particular interest to analyze both the impact of this structural transformation on the economic performance of these countries and the factors that drive the variations in the level of export sophistication.

In line with recent literature, to capture the effect of this structural transformation on economic growth in the WBC we have elaborated an export sophistication index, *à la* Hausmann (HHR). This is a measure of the sophistication of a country's export basket comparing the income level of countries with similar export structures. A descriptive analysis of this index reveals two important facts. First, the WBC have been successful in improving their process of productive specialization, by incorporating and expanding to goods with higher value-added. Second, this process of structural transformation has been relatively more concentrated in the expansion of sectors producing medium-skill and technology-intensive goods, where the WBC have converged significantly to the level of high-income countries.

Our econometric analysis confirms the positive influence of the structural transformation of production on economic growth in the WBC. Through the estimation of a set of panel data models, the results reveal that increased export sophistication leads to subsequent income growth in these economies. Moreover, according to our initial hypothesis based on the descriptive analysis, we can confirm that it is not the rise in the level of sophistication in high-skill and technology-intensive goods that is driving this improvement in income, but instead the increased sophistication in medium-skill products. In addition, we ratify the positive influence of greater levels of domestic investment on economic growth.

Concerning the determinants fostering increased export sophistication, we observe that a greater involvement in the world market, either through a higher participation in the IPNs or by foreign investments, plays an important role in the increased sophistication of exports in these countries.

We also confirm that domestic investment, a better business environment, and macroeconomic stability seem to be crucial factors in stimulating the quality of their export basket.

Overall, our findings support the notion that structural reforms aimed at improving the production structure in the WBC have increased their export sophistication and it can be considered an important stimulus for income growth. Promoting policies specifically aimed at increasing sophistication in manufactures products, particularly in medium-skill and technology-intensive products, has a significant potential to improve the future economic performance of these countries.

APPENDIX

Table A1. Definitions and data sources

Abbreviation	Definition	Data source
GDP per capita	GDP per capita, PPP (constant 2011 international US$).	World Development Indicators
EXPY	Export Sophistication Index *à la* Hausmann et al. (2007) for all products	Author's calculations based on UNCTAD database
EXPY manuf.	Export Sophistication Index *à la* Hausmann et al. (2007) in manufactures	Author's calculations based on UNCTAD database
HS manuf. exports	High-skill and technology-intensive manufactures exports (as % of total exports)	Author's calculations based on UNCTAD database
MS manuf. exports	Medium-skill and technology-intensive manufactures exports (as % of total exports)	Author's calculations based on UNCTAD database
Investment rate	Gross investment as % of GDP	World Development Indicators
Human capital	Individuals using the internet (per 100 people)	World Development Indicators
Openness	Sum of exports and imports of goods and services measured as a share of GDP	World Development Indicators
FDI	FDI stock as % of GDP (inward)	UNCTAD database
P&C trade	Parts and components trade (as defined in Shimbov et al. 2013) as % of GDP	Author's calculations based on UN Comtrade database
Macroecon. stability	Changes in average consumer prices (year-on-year)	WEO database
Institutions	Control of corruption index	World Governance Indicators
EBRD	EBRD Transition index	EBRD
ICT	Share of information and communication technology goods as % of total trade	UNCTAD database

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SUPPLEMENTARY MATERIAL - TABLES

Table S.1. Main statistics of the PRODY indicator (2002-2004).

PRODY 2002-2004	No. of observations	Average (across products)	Standard deviation	Lowest value	Highest value
	112484	17224	7759	1827	36618
	SITC Rev. 3 code	**Product description**		**PRODY value**	
Products with highest values	677	Rails & railway track construction mat., iron, steel		36618	
	342	Liquefied propane and butane		35681	
	343	Natural gas, whether or not liquefied		33716	
	515	Organo-inorg., heterocycl. compounds, nucl. acids		33112	
	571	Polymers of ethylene, in primary forms		33004	
	885	Watches & clocks		31761	
	749	Non-electric parts & accessor. of machinery, n.e.s.		31658	
	516	Other organic chemicals		31461	
	882	Cinematographic & photographic supplies		30648	
	774	Electro-diagnostic appa. for medical sciences, etc.		30369	
Products with lowest values	261	Silk		3965	
	75	Spices		3580	
	277	Natural abrasives, n.e.s. (incl. industri. diamonds)		3385	
	72	Cocoa		3179	
	74	Tea and mate		3162	
	121	Tobacco, unmanufactured; tobacco refuse		2942	
	223	Oil seeds & oleaginous fruits (incl. flour, n.e.s.)		2820	
	71	Coffee and coffee substitutes		2566	
	263	Cotton		2194	

286	Ores and concentrates of uranium or thorium	1827

Source: author’s calculations based on UNCTAD data and World Development Indicators

Table S.2. Correlation matrix: 1996-2015.

	GDP per capita	GDP pc growth	EXPY	P&C trade	Investments	Openness	Human capital	EBRD	CC	Inflation	FDI
GDP per capita	1.000										
GDP pc growth	-0.317 (0.001)	1.000									
EXPY	0.237 (0.015)	-0.110 (0.263)	1.000								
P&C trade	0.474 (0.000)	-0.161 (0.124)	0.111 (0.291)	1.000							
Investments	-0.103 (0.297)	0.316 (0.001)	-0.301 (0.002)	-0.266 (0.010)	1.000						
Openness	0.164 (0.094)	0.171 (0.081)	0.021 (0.834)	0.282 (0.006)	0.168 (0.086)	1.000					
Human capital	0.547 (0.000)	-0.307 (0.003)	0.307 (0.003)	0.337 (0.002)	-0.201 (0.051)	0.365 (0.000)	1.000				
EBRD	0.606 (0.000)	-0.393 (0.000)	-0.112 (0.268)	0.093 (0.390)	0.304 (0.002)	0.267 (0.007)	0.546 (0.000)	1.000			
CC	0.677 (0.000)	-0.120 (0.273)	0.177 (0.106)	0.533 (0.000)	-0.103 (0.348)	0.656 (0.000)	0.619 (0.000)	0.476 (0.000)	1.000		
Inflation	-0.184 (0.068)	-0.083 (0.412)	0.148 (0.142)	-0.172 (0.104)	-0.291 (0.003)	-0.487 (0.000)	-0.261 (0.011)	-0.575 (0.000)	-0.425 (0.000)	1.000	
FDI	0.829 (0.000)	-0.234 (0.019)	0.224 (0.025)	0.490 (0.000)	-0.065 (0.522)	0.222 (0.026)	0.688 (0.000)	0.527 (0.000)	0.665 (0.000)	-0.200 (0.049)	1.000

Significance levels are in parentheses

Table S.3. Estimation results of EXPY on ICT: 1996-2015.

Dependent variable	ln(EXPY)	ln(EXPY)	ln(EXPY)	ln(EXPY)	ln(EXPY manuf.)	ln(EXPY manuf.)	ln(EXPY manuf.)	ln(EXPY manuf.)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\ln(ICT)_t$	0.455***	0.229***	0.489***	0.116***	0.417***	0.455***	0.2323**	0.315***
	(0.0790)	(0.0486)	(0.0776)	(0.0362)	(0.0660)	(0.0790)	(0.1114)	(0.1148)
$\ln(\text{GDP per capita})_t$			-1.3231***	0.463			0.522	0.1433
			(0.3328)	(0.3124)			(0.4779)	(0.9914)
$\ln(\text{Investment})_t$			-1.134***	0.068			-1.133**	1.482***
			(0.2118)	(0.1331)			(0.3042)	(0.4222)
$\ln(FDI)_t$			0.1459	0.569			0.265	0.173
			(0.1191)	(0.0649)			(0.1711)	(0.2059)
$\ln(\text{Human capital})_t$			0.093	-0.0311			-0.268**	-0.096
			(0.0701)	(0.0304)			(0.1006)	(0.0965)
$\ln(OPEN)_t$			-0.051	0.2026*			0.915*	0.595*
			(0.3335)	(0.1078)			(0.4789)	(0.3420)
Constant	7.324***	9.518***	8.622***	8.731***	8.008***	7.324***	1.502	-2.5050
	(0.149)	(0.0954)	(1.339)	(0.446)	(0.0598)	(0.149)	(4.8573)	(7.596)
Observations	77	77	73	73	77	77	73	73
R-squared	0.865	0.955	0.252	0.976	0.305	0.865	0.417	0.890
Country FE	NO	YES	NO	YES	NO	YES	NO	YES
Year FE	NO	YES	NO	YES	NO	YES	NO	YES

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table S.4. Estimation results of Real GDP per capita growth on ICT: 1996-2015.

Dependent variable	Real GDP per capita growth			
	(1)	(2)	(3)	(4)
$\ln(\text{GDP per capita})_{t-1}$	-0.0497**	-0.0521**	-0.229***	-0.231***
	(0.0219)	(0.0206)	(0.0501)	(0.0463)
$\ln(\text{EXPY})_t$	0.000836		0.0106	
	(0.00927)		(0.0271)	
$\ln(\text{EXPY manuf.})_t$		0.00151		0.0135
		(0.00641)		(0.00832)
$\ln(\text{Investments})_t$	0.0374*	0.0382**	0.0731***	0.0555**
	(0.0192)	(0.0177)	(0.0221)	(0.0241)
$\ln(\text{Human capital})_t$	-0.00447	-0.00410	0.0229***	0.0241***
	(0.00428)	(0.00419)	(0.00562)	(0.00548)
$\ln(\text{Openness})_t$	0.0731***	0.0716***	0.0558***	0.0506**
	(0.0254)	(0.0261)	(0.0203)	(0.0197)
$\ln(\text{ICT})_t$	0.0119	0.0120	-0.00670	-0.0102
	(0.00737)	(0.00604)	(0.00684)	(0.00650)
Constant	0.0615	0.0831	1.493***	1.597***
	(0.319)	(0.236)	(0.417)	(0.400)
Observations	73	73	73	73
R-squared	0.397	0.397	0.842	0.850
Country FE	NO	YES	NO	YES
Year FE	NO	YES	NO	YES

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table S.5. Correlation between ICT and GDP per capita growth: 1996-2015.

Dependent variable	Real GDP per capita growth	
	(1)	(2)
$\ln(ICT)_t$	-0.00328	0.00146
	(0.00406)	(0.00494)
Constant	0.0307***	0.0786***
	(0.00411)	(0.0110)
Observations	77	77
R-squared	0.010	0.714
Country FE	NO	YES
Year FE	NO	YES

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1