Real Effective Exchange Rates and deindustrialization: Evidence from 25 Post-Communist Eastern European countries

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Abstract

For the past three decades, Eastern European countries have exhibited a noticeable decline in their share of the industrial production sector overall, but not uniformly. Simultaneously, trade liberalization and integration in international production networks were intensified, bringing different export sophistication levels and economic development to countries in this region. This paper aims to examine the real effective exchange rate (REER) impact on the deindustrialization or reindustrialization process in 25 post-communist Eastern European countries. The paper employs a heterogeneous panel common factor approach for the period 1995-2018 to exploit the effect of diverse levels of export complexity, stage of economic development, and intensity of participation in global value chains on REER- industrial production relationship. The results establish a heterogeneous yet significant negative relationship between currency strengthening and industrial production. Our findings also indicate that this negative effect of appreciation is less pronounced with the country`s higher economic complexity and its broader participation in global value chains.

Keywords: Global Value Chain, Economic Complexity Index, Eastern Europe, Post-Communist Economies, Real Effective Exchange Rate

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1. Introduction

Economic theory indicates that the industrial sector and its productivity are the main engines of nations' economic growth (Solow, 1956; Abramovitz, 1956; Solow, 1957; Jorgenson and Griliches, 1967; Arrow, 1971; Acemoglu et al., 2014). Concurrent with the degree of a country's development, industrial production has the potential to absorb the labor force with a wide range of skills. This phenomenon is particularly evident as the World population has increased, demanding more skilled labor for both developed and developing countries. (Berman et al., 1994; Machin and Van Reenen, 1998). Coupled with natural advantages such as: economies of scale (Bain, 1954; Stigler, 1958), learning by doing (Arrow, 1971; Romer, 1986), optimal knowledge growth and allocation of time (Lucas and Moll, 2014), the industrial sector represents a fundamental driver of technological progress. These characteristics make the manufacturing sector a paramount factor for developing countries in their efforts to catch up with the developed countries' growth rates and income levels (Abramovitz, 1986; Broadberry, 1993; Bernard and Jones, 1996; Hultberg et al., 2004).

Despite the importance of the industrial sector for economic growth, economies have exhibited a decline in the share of industrial production in GDP, measured at both current and constant prices (Kuznets, 1966; Herrendorf et al., 2014; Timmer et al., 2015; Rodrick, 2016). Both advanced and developed economies have exhibited this deindustrialization trend in the last few decades (Cornwall, 1980; Rowthorn and Ramaswamy, 1997; Rodrick, 2016; Felipe et al., 2019). The problematic aspect of this trend of deindustrialization is that, in developing countries, it started to occur even before the manufacturing sector reached a ripe stage. This "premature deindustrialization" (Romer, 2016) implies that a decrease in industrial productivity occurs before reaching the levels of the industrial capacity of developed countries (Dasgupta and Singh, 2006; McMillan and Rodrik, 2011; Rodrik, 2016). Two explanations for this premature deindustrialization of developing countries are at the forefront, namely: trade and globalization (Rodrik, 2016). By reducing import prices, the impact of globalization implies that developing countries have to counterbalance globalization by increasing technological progress in the export sector. To achieve this goal, developing countries need to implement active monetary and exchange rate policies since even short-term volatility of exchange rates impacts the terms of trade (Kenen and Rodrik, 1986). Utilizing relative price channels, a dynamic real exchange rate policy, such as this, stimulates technological processes in the trade sector and represents a significant factor in the country's reindustrialization.

The literature examining premature deindustrialization, its causes, and its consequences is still evolving. A less developed part of that literature attempts to understand the causes, size, and the nature of deindustrialization experienced in many post-Communist countries of Eastern Europe (EE). These countries represent markedly different settings for the analysis due to their unique institutional history. Since 1990 and the following three decades, the countries of Eastern Europe have exhibited a noticeable decline in their share of the industrial production sector overall, but not uniformly. However, this decline was not uniform across all countries and for specific countries is better described by a U-shaped curve, where the initial deindustrialization trend is followed by reindustrialization. Suitable explanations as to why the industrial sector decreased in the 1990s lie in the process of transformation from the "old" to the "new" economic systems (communism vs. market economies), as well as in breaking the old international and regional relations while simultaneously opening to trade and increasing financial inflows.

Furthermore, most of these countries' industrial sectors were non-competitive in the global markets during the “old” regime (Blanchard, 1997; Fidrmuc, 2003). Additional reasons for the decline of the industrial sector in this region lie in the high initial share of the industrial sector in the pre-transition period and the rigidity of the business structures that could not quickly adapt to new market conditions (Damiani and Uvalić, 2014; Bartlett, 2014; Bruno et al., 2014). After the year 2000 and the implementation of institutional and market reforms in transition countries, some of the countries geographically located in Central Europe (CE) exhibited an opposite trend and a slight increase in industrial production. For the remaining transition countries, the declining industrialization trend or stagnation persisted. One of the crucial characteristics of industrial and trade development, most pronounced in CE countries, is a gradual increase of participation in global value chains (GVCs) starting in the 1990s, which resulted in extensive involvement in global value chains through the end of the observed period (Gunnella et al., 2019).

In the settings of the Mundell-Fleming model (Mundell 1963, Fleming 1962), the undervalued exchange rate causes domestic goods to be more competitive in foreign markets. Consequently, the higher competitiveness in global markets stimulates investment and industrial production. However, if the economy largely depends on imported capital goods, the domestic currency's strengthening leads to an increase in investment and industrial production (Diaz Alejandro, 1963). These disparate effects could eventually reflect different levels of economic development and complexity (Hausmann and Hidalgo, 2011) and the extent of participation in international trade.

Post-communist countries have distinct industrial sector features such as the heritage of an over-industrialization and frequent institutional and market failures. All of these countries liberalized trade and capital account at the beginning of the transition period, and REER had an essential role in the industry sector's structural change. Against this background, we found that these countries are important laboratory to study the comprehensive REER-industrial production relationship. We wanted to ascertain the role of REER in the re(de)industrialization process in this specific institutional framework and show how REER policy has to change conditional on the development level, implemented reforms, and international integration of these countries. To address all these aspects of the REER-industrial production relationship, we fill this gap in deindustrialization literature relating to EE by utilizing panel time-series data with annual frequency on a sample of 25 countries of the EE region over the period 1995-2018.[4] That is the primary goal of this study.

Building on these explanations, the objective of this research is to examine the following dilemmas empirically. First, we examine the long-term relationship between (REER) and industrial production for twenty-five (25), post-Communist countries of Eastern Europe. Second, we analyze the magnitude of this relationship for different levels of export diversification and complexity, as well as the countries' level of development and production capacity for future growth. Third, we analyze the effect of intensity of the countries' participation in global value chains on the type (positive or negative) and the magnitude of the relationship between REER and industrial production. In this context, we also examine variations in the REER-industrial production relationship depending on the countries' upstream or downstream position in the global value chains.

Our approach contributes to this line of research by employing the panel data methodology. When dealing with emerging countries, a common problem is the lack of long and reliable time-series data, which prevents empirical investigation at the individual country's

[4] Albania, Armenia, Azerbaijan, Belarus, Bulgaria, Croatia, Czechia, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Poland, Republic of North Macedonia, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan. For the other post-communist countries in Eastern European region, needed data were not available for observed period.

level. To choose the most suitable methodology, we consider the sample characteristics and issues that result in bias in the estimates. Due to the close and mutual economic, trade, and social relations between the countries in our sample, we can expect cross-sectional dependency for most of their macroeconomic and fundamental indicators. Even though countries in this region have had a similar "transition path," they comprise an economically heterogeneous group. Furthermore, these countries are more or less globally integrated, such that global economic changes and shocks (called "strong" factors) have simultaneously impacted their industrial sectors. We utilize more efficient and recent panel data estimators to resolve these issues of heterogeneity, cross-sectional dependence, and the presence of unobservable effects (such as external economic shocks). We use augmented mean group (AMG) methodology (Ebehardt and Bond, 2009; Eberhardt and Teal, 2010) that is consistent for small samples and can be applied to heterogeneous, cross-sectionally dependent, dynamic and cointegrated panels when endogeneity and unobserved common factors are present.

As our baseline result, we report a negative relation between the REER and industrial production share. The main result stands when we employ alternative measures for the REER, relating to deviations from equilibrium levels and groups of countries with different development levels. Furthermore, we establish that the relationship between the REER and industrial production is weaker in countries with a higher potential for future growth, which exhibits lower negative consequences when REER appreciates. Similarly, the relationship's magnitude is less pronounced for countries with extensive involvement in global production chains. Finally, there is heterogeneity among countries related to their position in global value chains (GVC), precisely the implication that REER's impact on industrial production depends on the degree of a country's backward and forward linkages. REER appreciation's negative consequences are less pronounced for countries with higher percentages of backward linkages due to the lower cost of imported intermediate goods. For most of the developed countries in the sample with a significant percentage of foreign value-added in their export, REER's appreciation can be beneficial for overall industrial production. We conduct a set of tests to assess our results' robustness and address issues of endogeneity. The results remain significant in all specifications.

Following the above introduction, we proceed as follows. Part Two reviews the literature. Part Three describes the data. Part Four outlines the empirical strategies, presents the results and robustness tests. Part Five concludes.

2. Literature Review

Trade liberalization and globalization affect deindustrialization mainly through industrial products' prices, which are exogenously determined for small, developing countries. A reduction in the relative price of industrial products negatively affects their industrial sector's productivity and reduces industrial production. To offset this negative exogenous impact of relative prices for developing countries, it is necessary to increase technological progress in the industrial sector. Consequently, the degree of the impact of global prices and technological progress on the country determines the deindustrialization rate (Rodrik, 2015).

One of the most important factors influencing the change in the industrial sector's size and productivity is the change in the real exchange rate (REER). The empirical relationship between the real exchange rate and industrial production is established in many papers (Goldberg, 1993; Campa and Goldberg, 1995; Burgess and Knetter,1998; Goldberg, Tracy and Aaronson, 1999; Campa and Goldberg, 2001; Servén, 2003; Campbell and Lapham, 2004; Ekholm et al., 2012; Berman et al., 2012).

Specifically, as REER is the relative price of tradable and non-tradable products, exchange rate depreciation should increase the industrial sector's profitability and size (Rodrik 2008). Hausmann et al. (2005) posit that the real exchange rate depreciation accelerates growth.

A strand of literature recognizes the impact of the real exchange rate on economic growth precisely through its effect on structural changes in the industrial sector and economy and the reallocation of capital and other production factors. These researches stress the importance of export growth for economic development and the important role of REER in that process. Thus, Barbosa -Filho (2006) show that the level of the real exchange rate affects the relative prices of both tradable and non-tradable goods in the country, and consequently, the structure and growth rate of the economy. Similarly, Guzman et al. (2018) state that a stable and competitive real exchange rate policy may promote economic development.

Similarly, Rodrik (2008) points out that the reallocation of resources in the economy, caused by the depreciation of the real exchange rate, stimulates the development of the industrial export sector and creates a new economic structure, impacting the long-term economic growth. Kamin and Klau (1998) point out that the continuous depreciation of the nominal exchange rate, in order to keep the level of real exchange rate below the initial level, has an expansionary effect in the long run. This effect is sufficient to show a positive impact from lower export prices and induce structural changes in manufacturing production for export. Rajan and Subramanian (2011) and Berg et al. (2012) also point to the positive effects of REER depreciation on the industrial sector. Mallick and Sousa (2012), studying large emerging economies, report that contractionary monetary policy has a strong and negative effect on output.

Another strand of literature (Diaz-Alejandro, 1963; Krugman and Taylor, 1978; Wijnbergen, 1986; Edwards, 1989; Bird and Rajan, 2004; Blecker and Razmi, 2008; Bleaney and Vargas 2009) emphasizes the potential contraction effects of devaluation and its benefits for cheaper import.

Opposing effects of REER on export and industry production, documented in these two strands of literature, could reflect different levels of economic complexity and development as well as the extent of the country`s industry exposure to international trade. As the production process become increasingly fragmented across numerous countries, the nature of trade (or country`s participation in the global value chain) also became important for the relationship between REER and the development of the export and industry sector (Brito, Magud, and Sosa, 2018; Ahmed, Appendino and Ruta, 2017). Freund and Pierola (2012) found that currency depreciation in developing countries stimulates manufacturing export growth, but has no important influence in developed countries. Subsequently, Freund and Pierola (2015), after examining the firm-level data from 32 countries, demonstrate that exporters being the top one percent in trade volume critically shape trade patterns. Ahmed et al. 2017 show that higher participation in global value chains reduces the sensitivity of export on REER changes. If the country largely depends on the import of intermediate products, then REER depreciation will improve the competitiveness of only the domestic part of the final export value-added. In that case, appreciation can be more beneficial for export and industry development by lowering imported products' cost. Mattoo, Mishra, and Subramanian (2014) and Amiti, Itskhoki, and Konings (2014) show similar results confirming a lower effect of depreciation on the export value if reliance on imported products is higher. Studies that address Central and Eastern European countries' participation in global value chains (Olczyk – Kordalska, 2017; Hagemejer – Ghodsi, 2017) emphasize Central European countries' high participation and their position closer to the final consumer.

Literature that examines the issue of REER-industrial production relationships in Eastern European countries is not extensive. Mostly, researches are focused on the connection between REER and economic growth (Haddad and Pancaro, 2010; Rapetti, Skott and Razmi 2012; Comunalle 2017). In all these papers, empirical evidence suggests that undervaluation is beneficial for the development of these and other transition countries, although Haddad and Pancaro (2010) suggest short term benefits. Several studies consider as the important problem of deindustrialization in this region. Bartlett (2014) examines the form of industrial development, indicating that the difference in country`s growth potential is a consequence of the different level of sophistication of industrial products among countries in this region. Other studies (Cerović, Nojković and Uvalić, 2014; Damiani and Uvalić, 2014; Stojčić and Aralica, 2018) investigate the importance of different factors of deindustrialization, where not enough attention has been paid to the real effective exchange rate. A literature review showed a lack of research that comprehensively examine the relationship between REER and deindustrialization, taking into account changes in the country`s development and position in international production networks.

3. **Sample and formation of variables**

3.1. ***Sample sources***

The data come from various sources. Overall, the basis of the sample consists of the set of economic indicators capturing the impact of REER on the industry value-added share in GDP for twenty-five (25) Eastern European mostly post-Communist countries. We closely follow the model of Rodrick (2008) as a baseline.

The United Nations Statistics Division is the source for the following variables:

- industry value added share in GDP - the share of mining, manufacturing and utility sector in the income of the country (*industry*);
- the proportion of exports of goods and services in annual income;
- the proportion of imports of goods and services in annual income;
- the annual level of income/gross domestic product per capita (*GDP pc*);
- gross fixed capital formation as a share of GDP (*GFCF*) and
- general government final consumption expenditure as a share of GDP.

All of these variables are normalized to constant 2015 USD$ values, or 2015 year as a base if the variables are indices or percentages.

The REER statistics used to measure the relationship between the real value of a country's currency versus a basket of its trading partners' currencies are drawn from Darvas, Zolt's web page.[5] The statistics are updated monthly and represent an extension of the statistics used in Zsolt (2012) paper. The statistics for real exchange rates (RER) are drawn from the Penn World Table statistics and cross-checked with the World Bank statistics.

The World Bank Governance Indicators database is the source for the political stability index and the rule of law variables, while Global Adaptation Index database is the source for level of Information Communication Technology (ICT) infrastructure.

The United Nations Conference on Trade and Development (UNCTAD) is the source of the following variables related to cross-border production processes: value-added embedded in foreign inputs (FVA); domestic value-added embedded in exported intermediates that are further re-exported by a third country (DVX); and the domestic value-added (DVA), which measures the value of exports created using domestic inputs and captures export contribution to GDP. All three variables (FVA, DVX, and DVA) are expressed as percentages of the country's gross exports.

The variable inflation/consumer price index (CPI) is normalized to the base year of 2015 and extracted from the International Monetary Fund (IMF) and its World Economic Outlook database. The United Nations Development Programme (UNDP) statistics are the source for the human development index (HDI). The Observatory of Economic Complexity (OEC) is the source for the economic complexity index (ECI) variable.

[5] https://www.bruegel.org/publications/datasets/real-effective-exchange-rates-for-178-countries-a-new-database/

3.2. ***Formation of variables***

We modify the raw variables to align our variables with the literature and normalize them for empirical procedures. All adjustments, as well as the reasons for their inclusion, are discussed below.

Our main independent variable controlling for the REER is extracted from the Zsolt (2012) database. This real effective exchange rate measure of a particular country $REER_i$ is calculated as:

$$\boldsymbol{REER_i} = \frac{\boldsymbol{CPI_i * NEER_i}}{\boldsymbol{CPI_i^f}} \tag{1}$$

The value $NEER_i$ is the nominal effective exchange rate of a country *i* under the study calculated as a geometrically weighted average of the nominal bilateral exchange rates between a particular country and its trading partners. CPI_i^f is a geometrically weighted average of CPI indices of trading partners, while CPI_i is a consumer price index of country *i*. The trade weights used for calculation of the $NEER_i$ and CPI_i^f are detailed in Bayoumi, Lee, and Jayanthi (2006) weight matrix for 184 countries. These weights consider not just the bilateral export and import shares, but also competition between the two countries in all other third markets. A decrease in the REER index represents currency depreciation and vice versa.

To check for the robustness of the tests, we use two REER proxies. The first is the bilateral real exchange rate between the national currency and the USD, obtained from the World Bank and Penn World Table database (RER). The second is the variable capturing the real effective exchange rate's misalignment from the long-term level aligned with productivity growth (REERM).

The theoretical framework for assessing misalignment of the real exchange rate from the long-term level aligned with productivity growth is provided in papers written by Dollar

(1992), Rodrik (2008), and Holzner (2006). A similar approach in assessing under/overvaluation of the real exchange rate is used in Orszaghova, Savelina, and Schund (2013), as part of the analysis of the application of Behavioral Equilibrium Exchange Rate model for transitional European countries. Similar to the mentioned papers, the approach applied herein takes into account the assumption that the Balassa - Samuelson's effect is present in observed countries, by regressing REER on GDP per employee (*GDPpe*) as a proxy for productivity:

$$\boldsymbol{ln\, REER_{it} = \alpha + \beta\, ln\, GDPpe_{it} + u_{it}} \tag{2}$$

where u_{it} are unobservable inputs, representing all external shocks. Despite the simplicity of its predictions, this method has the advantage that the resulting real exchange rate misalignment variable is comparable between countries and over time. Furthermore, this is the optimal way to construct REER equilibrium value and misalignment data for these transitioning countries since the data are usually incomplete with very short horizons and poor quality, limiting the use of other methods. The use of this measure for real exchange rate misalignment is to test whether the estimates, with different measures for REER are biased downward, as could be the case when Balassa - Samuelson's effect is ignored. To deal with several problems in estimating real effective exchange rate misalignment such as: possible endogeneity, cross-sectional dependency, heterogeneity, and small sample bias-- we apply the augmented mean group (AMG) methodology.[6]

- Insert Table 1-

[6] As suggested by Pedroni (2007), to deal with possible reverse causality, we estimated Eq. 2 augmented with a common dynamic process variable using Group-Mean Fully-Modified Ordinary Least Square (GM-FMOLS) methodology. We obtain similar results as in AMG estimation, confirming that productivity estimate is not misspecified.

The results in Table 1 indicate a positive and statistically significant relationship between REER and GDP per employee (GDPpe). According to the Balassa-Samuelson effect, an increase in productivity means appreciation of the REER, so a positive sign was expected. The obtained result is in line with studies done on developing countries' sample, where the estimated coefficient of productivity ranges from 0.2 to 1 (Egert, Halpern and MacDonald, 2006; Roudet, Saxegaard, and Tsangarides, 2007; Fidora, Giordano and Schmitz, 2017). Coefficients estimated in regression in Table 1 are used to determine the long-term REER level aligned with productivity growth.

Final data for the misalignment of the real effective exchange rate are calculated as a difference between the logarithm of the actual level of the real effective exchange rate ($ln\, R\, EER_{it}$) and the estimated equilibrium long-term level of real effective exchange rate aligned with productivity growth ($ln\, R\, \hat{E}ER_{it}$). For calculating the long-term equilibrium value for real effective exchange rate, we applied estimated coefficients from Table 1 on the permanent component of the independent variable, which is obtained by using the Hodrick-Prescot (HP) filter.

$$\boldsymbol{ln\, R\, EERM_{it} = ln\, R\, EER_{it} - ln\, R\, \hat{E}ER_{it}} \qquad (3)$$

Value of REERM greater than one indicates overvaluation while a value less than one indicates undervaluation.

To separately assess the impact of undervaluation and overvaluation changes on industrial production, we replaced variable REERM with two variables. The first variable (*overvaluation*) is calculated as a product of the original REERM values and a dummy variable, with a value of one for the periods of the undervalued exchange rate (when the REERM values are higher than one) and zero for other periods. The second variable (*undervaluation*) is calculated as a product of REERM and the differences between one and the specified dummy variables.

In addition to the REER as our main independent variable, we introduce the economic complexity index (ECI) and different measures of participation in global value chains to estimate their impact on the REER-industrial production relationship in the second part of the research.

The economic complexity index indicates the overall level of economic diversification and production capabilities of a country and is a measure to predict its future economic growth. Economic complexity index provides information about the country's industrial structure and productive capabilities, based on relative comparisons across various countries' export baskets (Hidalgo and Hausmann, 2011, Hausmann et al., 2014). That a country's economy is more complex (indicated by a higher economic complexity index), implies that its industrial production sector is more sophisticated and, consequently, the country is more developed.

Export data are used in calculating the economic complexity index, specifically information on the diversity and similarity of export products. Diversity, as a number of competitive export products, and similarity, as a number of countries that can export the same product competitively, are approximations of the variety of capabilities available to a country. Thus, countries at the top of the economic complexity index rank have diversified export baskets as well as export products produced in none or only a few other countries. These less similar (or, more unique) products are more likely to require a variety of skills and embedded knowledge and are usually produced in developed countries (Hidalgo and Hausmann, 2009). In the context of premature deindustrialization, it can be hypothesized that "transition" economies that do not develop an industrial sector as they grow are more likely to have diminished prospects for future growth, as the industrial sector is typically the main driver of productivity growth.

Aside from the complexity and diversification of products, we consider participation in global value chains (GVCs) to be an important feature of modern industrial sectors. In recent decades, the defining features of economic globalization include increasing trade integration, fragmentation of production process, and increased specialization. The proliferation of global value chains started in the 1980s and currently many developing and developed countries are extensively involved in the international production process (Gereffi et al., 2001; Baldwin, 2012; OECD, 2013). This is particularly true for the countries of Central Europe and the Baltic region, whose participation in global value chains is higher relative to both the world average and most of the developed economies. (Gunnella, et al. 2019).

We use Global Value Chain indexes as they are defined in Koopman, Powers, Wang and Wei (2010). Gross export is decomposed into two main components: foreign value added (FVA), and domestic value-added (DVA) share in gross export. FVA is a measure of foreign inputs used in the process of production of exported goods, while DVA measures the value of exports created using domestic inputs. DVX consists of exports of final and intermediate goods absorbed in the destination country, exports of intermediates re-exported to a third country, and those that return to the home country.

Using this value-added accounting, we further define indicators related to a country's involvement in global value chains. Above defined term, FVA represents a measure for downstream participation in global value chains (or backward linkages). The variable DVX represents upstream participation in global value chains (or forward linkages) and is defined as that part of domestic value-added exported as an intermediate product to trade partners, which is further processed and re-exported. As an indication of the extent of the country's involvement in global value chains, the global value chains participation is defined as the sum of FVA and DVX, expressed as a share of gross export.

Two countries may have the same global value chains participation, but they may participate in global value chains by specializing in different parts of the production process (upstream or downstream). To measure the relative relation between backward and forward linkages, we calculate the global value chains position indicator as follows:

$$GVCposition_i = \ln\left(1 + \frac{DVX_i}{EX_i}\right) - \ln\left(1 + \frac{FV_i}{EX_i}\right) \tag{4}$$

were EX_i is the gross export of a country. High backward linkages relative to forward linkages indicate the downstream position of country such that its global value chains (GVC) position index has a negative value. This result means that foreign value-added from imported intermediate input is relatively higher compared with the value-added from exported intermediate products to trading partners. A positive value of this index means that a country has more forward linkages compared to backward and takes the upstream position in global value chains.

Other independent variables employed are macroeconomic and fundamental indicators commonly used in industrial production regressions, namely: GDP per capita; government expenditure and gross fixed capital formation as a share of GDP; the openness of the country; and CPI. The variable used to reflect the openness of the country is a composite variable. It is calculated as the summation of the country`s export and import, divided by the gross domestic product level for a given country. Increased openness of the country should result in lower levels of trade protections. Thus, trade openness should positively impact economic performance and, through increasing productivity, is expected to result in an appreciation of the domestic currency (Kim and Korhonen, 2002; Gantman and Dabos, 2017).

The inflation variable, CPI, with a base year of 2015, has three missing observations over the entire panel. We apply linear interpolation to input their values. In extended regressions, we also introduced the following governance indicators for a given country: political stability, the rule of law, the level of human development, and the level of information and technology. In some of our analysis specifications, we conduct a log transformation and normalization of the independent variables when warranted.

The final sample extends from the years 1995 until 2018. The basic statistics of the main independent variables are presented in Table 2.

- Insert Table 2-

4. Empirical procedure and results

This paper analyses the relationship between real effective exchange rate (REER) movements and industrial production for Eastern Europe countries. In this part, we first present empirical specifications, then we present the advantages and verification of the suitability of the applied methodology for the research's objectives. Next, we present and discuss econometric results regarding the relationship between different measures of REER and industrial production, as well as the influence of development and economic complexity and international production process integration on the magnitude of the relationships mentioned above.

4.1. *Empirical specification and methodology*

Our primary empirical model captures the relationship between the share of industrial production in GDP and the REER. The model used follows Rodrik (2008). This model is adjusted to capture potential heterogeneity between countries, as well as common dynamic factors. Equation (4) presents the baseline specification:

$$\boldsymbol{lnindustry_{it} = \beta_i lnREER_{it} + \psi_{mi} x_{mit} + e_{it} \qquad e_{it} = \alpha_i + \gamma_i' f_t + \varepsilon_{it}} \quad (4)$$

for i = 1. . .N, t = 1. . .T, and m = 1…K, where K = 5 is the number of independent control variables.

The first part of Equation (1) presents the observable part of the model, where *lnREER* is the log-transformed real effective exchange rate index, and x_{mit} represents a vector of control independent variables. Control variables consist of a productivity measure proxied by GDP per capita, trade openness of the country, government expenditures share of GDP, gross fixed capital formation share of GDP, as a proxy for investments, and a consumer price index. The model allows for the slope coefficients β_i and ψ_{mi} not being homogeneous for the whole panel, allowing these coefficients to vary between countries.

The second part of Equation (1) includes unobservable inputs, e_{it}. This unobservable part of the model combines the influence of time-invariant heterogeneity and time-variant common factors. The time-invariant effect is captured through α_i intercepts specific for each country. Time-variant factors $\gamma_i' f_t$ represent unobserved common factors, f_t, multiplied with their country-specific loadings, γ_i'. With this part the model accounts for the common dynamic process, which represents the development and level of country-specific weighted common factors that affect industrial production for all countries in the panel. These common factors drive not only industrial production share in GDP, but also all dependent variables. Observable input variables can be modelled as linear functions of the unobserved common factors with country-specific factor loadings, respectively.

Several estimation problems could emerge in the process of identification of parameters β_i and ψ_{mi}. First, a heterogeneous influence of observable and unobservable variables across countries may exist. Second, there is a possibility that these factors are nonstationary and endogenous. Consequently, standard stationary framework estimation procedures, such us

Arellano and Bond, 1991; Blundell and Bond, 1998, could not be applied. Instead, we use the Augmented Mean Group (AMG) estimation technique developed by Eberhardt and Teal (2013), which is a dynamic panel multifactor modeling approach that implies the identification of heterogeneous slope coefficients. This methodology provides consistent estimates in cointegrated and small panels, incorporates endogeneity and cross-sectional dependence, and is appropriate for use in panels with a mixture of panel members with nonstationary and stationary variables (Eberhardt and Teal, 2008). Unlike other estimation techniques in common factor framework, such as Pesaran (2006) Common Correlated-effects Estimator – CCE, AMG explicitly accounts for cross-sectional dependence by estimating a common dynamic process that can be extracted and separately analyzed.

The AMG procedure is implemented in two steps (Eberhardt, 2012). The first step represents a pooled regression in the first differenced model, augmented with year dummies. Coefficients on the (differenced) year dummies represent estimated cross-country average of the evolution of unobservable factors over time (named "common dynamic process"). In the second step, an estimate for the unobserved common factors from the first step is included as an explicit variable in the group-specific regression model.[7] Estimates are averaged across countries using the Pesaran and Smith (1995) mean-group (MG) approach.

Our approach is in line with the findings of Bond and Eberhardt (2009). This approach uses Monte Carlo simulations to show that the inclusion of a common dynamic process variable allows separate identification of heterogeneous slope coefficients and the unobserved common factors that drive output and inputs.

[7] Alternatively, a common dynamic process can be subtracted from the dependent variable, which means that the common process is imposed on each panel cross-section with a unit coefficient.

Later, in the robustness part, we test for the results' sensitivity using several other methods. We use Pesaran (2006) common correlated effects mean group (CCE) estimator and the Chudik and Pesaran (2015) extension of this model to allow for a dynamic specification (DCCE). The literature recognizes that the CCE estimator is robust to nonstationarity, cointegration, breaks, and serial correlation (Pesaran, 2006; Kapetanios et al., 2011). At the same time, it is not necessarily a consistent estimator in the dynamic panel, as the lagged dependent variables are no longer strictly exogenous (Chudik and Pesaran, 2015). To remove potential bias in the estimation with endogenous and weak exogenous regressors, we use CEE/DCCE-2SLS and CEE/DCCE-GMM estimation approaches, and replace the Ordinary Least Squares (OLS) approach in individual regressions with Generalized Method of Moments (GMM) and Two Stage Least Square (2SLS). Monte Carlo simulations show that using 2SLS and GMM, instead of OLS, allows CCE to be robust in static and dynamic panel data with endogenous regressors and, importantly, that small sample properties of dynamic panel data estimator are significantly improved.

We conducted several pre-estimation tests to confirm the common factor and AMG estimation procedure's applicability in our research. We examined the cross-sectional dependence between countries, order of integration of variables and data poolability.

- Insert Table 3-

Cross-sectional dependence across countries was examined using the Pesaran (2015) test for weak cross-sectional dependence (CD), for which the test statistic is the sum of the correlation coefficients between the time-series for each panel member. We also estimate the exponent of cross-sectional dependency in a panel, for each variable, to determine the type of dependence (semi-weak, semi-strong or strong), following the Bailey, Kapetanios, Pesaran (2016) method. If semi-strong or strong dependence is ignored, then estimates could be inconsistent due to omitted variable bias. Based on the CD test result and all alpha values higher than 0.5, reported in Table 2, we conclude that the dependent and all independent variables have strong cross-sectional dependence. Consequently, we need to account for it in the further analysis.

- Insert Table 4 -

The REER, as well as most of the macroeconomic variables used in the analysis, are usually nonstationary. The AMG method can be used in mixed panels considering stationarity, so it is not necessary for model to be applied that all time series are nonstationary at the levels of the variables. However, we tested stationarity to see which variables may have a long-term cointegration relationship.

- Insert Table 5 --

We examine stationarity or nonstationarity of variables using the second-generation panel unit root tests. This is done by considering reported deficiency of the first generation of unit root tests that assume cross-sectional independence. We conducted a covariate augmented Dickey-Fuller (CADF) test and a cross-sectionally augmented panel unit root test (CIPS by Pesaran (2007). The latter test removes the cross-section dependence by augmenting the Dickey-Fuller regression with the dependent variable's first difference. Westerlund et al. (2016) document the wide usage and importance of both panel unit root tests. We also check test results for some variables, using the ADF test for the individual country's time-series. Moreover, based on tests results reported in Tables 4 and 5, we can conclude that nonstationarity cannot be ruled out in this dataset, while, after first differencing, the series are stationary. Based on these results, we can check the existence of a cointegration relationship between variables in our sample.

- Insert Table 6-

Aside from economic reasons, parameter heterogeneity may also be a consequence of sampling variation and the relatively limited number of time-series observations for each individual country (Pedroni, 2007). To check poolability of data, we use the analysis of variance (ANOVA) F-test and Welch F-test statistics and conducted formal Swamy (1970) S-statistic and Roy-Zellner (Roy, 1957; Zellner, 1962) test for poolability, as in Baltagi, 2005. All tests confirmed that heterogeneity is present in this sample and rejected null hypotheses of poolability.

Finally, following the estimation of coefficients in Equation (4), we check model residuals for the presence of potential nonstationarity and cross-sectional dependency. We test the stationarity of residuals to determine the presence of a cointegrating relationship between the dependent and set of independent variables, where a common dynamic process is a part of the cointegration relationship.

4.2. *Real effective exchange rate and de(re) industrialization*

Table 7 presents the results for the basic model, described in Equation (4). The table documents the relationship between the REER and the share of the industrial production in the income of the country. The baseline results, reported in column I of Table 6, confirm the expected relationship for developing countries showing the negative impact of the increase of REER on the share of industrial production in total income for the set of Eastern European countries observed from the year 1995 until 2018. Specifically, a one percent increase in the REER results in a decrease of the share of industrial production in the GDP of the country by 0.229%. The result is statistically significant and supports a strand of literature which documents that increases in REER lead to deindustrialization on average. These results are in line with findings of studies conducted using samples for developing countries and countries in transition (Hausmann, Pritchett and Rodrik, 2005; Rodrik, 2008; Freund and Pierola, 2012; Vaz and Baer, 2014). According to Rodrik`s (2008) research that we used as a baseline for our study, undervaluation stimulates economic growth, while overvaluation has a negative effect. He defines the industry sector as an operative channel for this effect. He also shows that results are robust to using different real exchange rate measures, such as different measures of the real effective exchange rate and misalignment of the real exchange rate from the equilibrium level. Hausmann, Pritchett and Rodrik (2005) and Freund and Pierola (2012) found similar results of the positive effect of depreciation or the negative effect of undervaluation, on industrial production. Examining many manufacturing export and growth surges in developing countries, they found that export and growth accelerations are usually preceded by a period of undervaluation.

The estimated negative coefficient of REER indicates that the relative size of the industrial sector depends negatively (positively) on the degree of REER appreciation (depreciation). The results show that decreasing appreciation or increasing depreciation can boost economic activity and move resources toward the industrial sector, through positive impact on share of trade in the developing countries.

Columns II and III of Table 6 extrapolate the observed panel, based on the difference in income level according to World Bank classification. Using this classification, we grouped countries in our sample into two categories, either high-income countries[8] or upper- and lower-middle income countries[9]. Geographically, high-income countries are Central European (CE) and Baltic countries, which are usually labeled as leaders among transition. The second group of the countries consists of the remainder of the sample, namely the Former Soviet Union (FSU) and Southeast European (SEE) countries.

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[8]Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia,

[9] Albania, Armenia, Azerbaijan, Belarus, Bulgaria, Georgia, Kazakhstan, Kyrgyzstan, Republic of North Macedonia, Romania, Russian Federation, Serbia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan

The results in column II, confirm a statistically significant and negative relationship between REER and the share of industrial production for countries of the less developed region. On average, there is a negative, but not statistically significant, relationship between incrase in REER and the industrial share in CE and Baltic countries (column III of Table 6). For some individual countries, however, significant relationships do exist. These results shows that REER depreciation is the „second best solution" for dealing with weak institutions and market failures, mostly pronounced in developing countries. Along with countries development, REER depreciation as incentive for growth should be replaced with direct effect of economic policy instruments. These results are in line with previous studies that show less or no importance of REER for export and industry development in developed countries (Rodrik, 2008; Freund and Pierola, 2012)).

Column IV of Table 6 reports the above relationship when the control variables describing institutional environment, efficiency of information and human development are present. The reported results are almost identical to the baseline result in column 1. A one-percent (1%) increase in REER results in a 0.227% decline in the share of industrial production in annual GDP. Columns V and VI report regression results when the original measure of the real effective exchange rate (REER) is replaced with a bilateral exchange rate with U.S (column V) and misalignment from long-term productivity growth (column VI). Both regressions show statistically significant negative relationships. confirming the baseline with a lower magnitude in the former case.

Finally, columns VII and VIII of Table 6 report the results when REER is replaced with variables representing overvaluation or undervaluation, constructed by extrapolating REER misalignment. The results are in line with the baseline findings confirming that REER appreciation leads to deindustrialization and vice versa. Results in column VIII are negative, but not statistically significant, which was expected in these transition countries with long periods of overvalued exchange rate. The results indicate that on average for these countries, lowering overvaluation is more beneficial than increasing undervaluation over the observed period. This asymmetric effect of under and overvaluation is also found in Razin and Collins (1997) and Cuestas et al. (2020) studies. Razin and Collins (1997) using panel data from 93 developed and developing countries, observed that high overvaluation of the real exchange rate has a significant negative effect on growth, while in the case of undervaluation, this effect was not significant. Cuestas et al. (2020), using a sample of 9 CEEC, showed that the effect of overvaluation on economic growth is much stronger than that of an undervaluation. According to their results, undervaluation has had only partial impact on economic activity in CEE countries.

In the control variables group, the significant, negative sign of the gross fixed capital formation as a share of GDP (GFCF) coefficient is noticeable in almost all specifications. The effect of GFCF on industrial and economic growth depends on the relative factor concentrations between sectors (Roudet, Saxegaard, and Tsangarides, (2007). Capital inflows are the largest share in the formation of fixed capital, mainly foreign direct investments, which in the majority of observed countries is driven by rent-seeking motivations, and directed at non-tradable sectors (Stojcic and Aralica, 2018).

The significant coefficients for the Common Dynamic Factor (CDF) indicate an important role of unobservable inputs, such us common global shocks and price of industrial products, in variations of industrial production's share in GDP in all observed countries, albeit with different importance for each country. This factor is a proxy for openness and financial and economic integration of the country (Felicio, Rossi, 2014; Chen, MacDonald, 2015). Over the observed period, common dynamic factors (CDF) show a downward trend, indicating an increasingly negative impact of external factors in determining industrial production.

-Insert Figure 1-

4.3. Economic complexity index ***(ECI) and global value chains (GVC) impact on REER and industrial production relationship***

The next set of tests examines the impact of economic diversification, production capabilities, and participation in global value chains on REER - industrial production relationship. To incorporate these factors, we first utilize the economic complexity index index statistics. If a country has a higher economic complexity index rank, then export basket products are more complex, requiring more sophisticated technology. Such a country should have higher GDP per capita as well as a better prospect for higher future growth rates. (Mealy, Farmer, Teytelboym, 2019). Also, suppose a country's economic complexity index rank is higher than the expected one according to the current level of GDP per capita. In that case, that country can be expected to experience faster growth in the future.

Previous studies indicate that, as a country becomes more developed, a weakened exchange rate is less important for developing its industrial sector and the country's growth (Rodrik, 2008; Egert, 2005, Razmi et al., 2012). Rodrik emphasizes the positive roles of strong institutions and the absence of market failures for industrial production and the country's economic growth. Instead of separately analyzing those fundamental economic growth factors, the economic complexity index serves as a composite measure to proxy the level of development and product sophistication. The literature shows that the economic complexity index is successful in explaining the cross-country differences in economic growth and productivity measured as GDP per capita (Hausmann et al., 2014; Ertan-Özgüzer and Oğuş-Binatlı, 2016; Mealy et al., 2018). Consequently, the hypothesis is that higher values for the economic complexity index (ECI)-- as a proxy for higher economic potential, better institutions, and higher level of embedded knowledge--should diminish the impact of REER on industry share in GDP.

The first column in Table 8 reports the results for this additional test. The results of the specification confirm our hypothesis and show that the higher economic complexity index reduces negative impact of REER increase on the industrial sectors share in GDP. For economic complexity index values higher than 0.92 (cases for the most developed countries with diversified industries and better positioned for higher future economic growth), REER appreciation can have a positive effect on the industrial structure of a country. Conversely, for less developed countries with less diversified industries and less sophisticated exports, REER depreciation is more important for developing the industrial sector and the country's growth.

The second indicator of interest is a variable that estimates the level of inclusion of the country in global value production. Patel et al. 2019 formally model the inclusion of global value chains (GVC) shares into the REER calculation. Such calculation of REER for countries in our sample is unachievable due to the lack of necessary data. Thus, this paper controls for global value chains influence on industrial production by the inclusion of related indicators in regression. A study by the European Central Bank (ECB) shows that global value chains (GVC)-REERs exhibit a similar effect on price competitiveness compared with conventional REER measures (Gunnella et al. 2019).

Over the observed period, trade in intermediates for countries in the Eastern European region have become successively more important, with noticeable differences in global value chains position among them. On average, for all observed region, countries are more integrated through backward linkages. The left panel of Figure 2 shows that an increase in the participation index is accompanied with a decrease in global value chains position.

-Insert figure 2-

Exporters from Central Europe (CE) and Baltic countries are generally located further downstream in global value chains compared to their partners, importing mostly higher value-added components and industrial equipment used for the production of intermediate or final goods[10] (Gunnella et al. 2019). Other countries from the sample are mostly located upstream in global value chains, as exports of commodities from these countries are inputs in the production of other countries' industrial sectors (Figure 2). On a global level, countries that are upstream in global value chains are not only commodity exporters. They are mostly developed countries that usually have high percentages of forward linkages due to large export or industry-related R&D, financial services, and high-tech intermediate products (IMF working paper, 2019). Differences between types of export products are an important consideration when analyzing the development implications of a country's global value chains position.

Larger participation in global value chains and a high percentage of backward linkages is an important channel for technology transfer across countries. Usual gains from global value chains participation (and backward linkages) for developing countries include higher productivity from the application of foreign technology, technological learning, and acquisition of new skills (Grossman and Rossi-Hansberg, 2008). For the CE countries, the main channel for knowledge acquisition and technology transfer are intermediate inputs, their variety and embedded technology. Companies involved in the global value chains benefit directly from new technology, while other companies that are not a part of the global value chains can acquire indirectly benefits from knowledge spillover through production networks in a country. Kummritz (2016) shows that an increase in global value chain participation has a significant positive effect on the domestic value-added share of export in a sample that includes middle- and high-income countries.

Participation in global value chains can affect the REER elasticity of export. When a country`s production is more integrated into global value chains, REER depreciation improves

[10] Poland has upstream position relative to the other CEE countries due to specialization in intermediate goods and industrial equipment, and partially due to export of natural resources.

the competitiveness of only a domestic value-added embodied in a final goods' export. Empirical evidence shows that larger global value chain participation decreases REER elasticity of manufacturing exports (Ahmed et al. 2017).

The global value chains (GVC) participation is an important feature of modern trade and industrial sectors that significantly impact investment, productivity, and REER export elasticity. As such, we proceed by testing its effect on the REER – industrial production relationship. When a country`s participation in global value chains changes, REER elasticity of export also changes, consequently, changing its effects on the country's industrial structure. First, we add the interaction of the REER with the global value chains participation to the industrial production regression to test this relation. Next, we test the influence of different countries' positions in global value chains by separately adding two more interactions of REER with FVA share and REER with DVX share.

Column II, in Table 8, reports the impact of the interactive effect of REER and global value chain participation. The impact is statistically significant, showing that the higher global value chains reduce the negative impact of REER increase on the industrial sector share in GDP, with a threshold value of global value chains participation of 65 percent. Specifically, up to this value, an increase of REER has a negative marginal effect on the industrial production, but then a positive one above this value. One explanation of this positive relationship is that higher participation in global value chains may be the benefits channel of cheaper imports of intermediate products for the involved industries in case of REER appreciation. Additionally, REER depreciation can be less effective for industry promotion as it only impacts the domestic value-added share of the gross exports, whose share is decreasing when the global value chain participation increases. Our results are in line with the results of studies that show the dampening effect of global value chains' participation on REER export elasticities. Ahmed et al. (2017) find in cross-section analysis that REER's impact on industry export is lower in a more involved country in global production. Similar results are found in Ollivaud et al. (2015) and Cheng et al. (2016).

Countries in the sample that have a higher level of global value chain participation are, at the same time, the most developed ones (from CE and Baltic region). This can be observed in Figure 3. This figure shows the correlation between the economic complexity index, as approximation of country`s development and export sophistication, and global value chains participation. Thus, regression results, in column II of Table 8, also support the hypothesis that when the economy is strengthening through global value chains knowledge transfer then REER depreciation is increasingly a less important aspect of growth promotion.

-Insert Figure 3-

Decomposing global value chains participation share into FVA and DVX share, indicates that backward linkages are the ones that have contributed to the explanation of lower sensitivity of industrial production to changes in the REER. The third column of Table 8 reports the results of the impact of the interactive effect of REER and FVA share. Increasing FVA shares in gross export reduces the negative impact of appreciation on industrial production. If the share of backward linkages is higher (more than 33% of gross export), a REER appreciation reduces the cost of imported intermediate inputs. This has a positive impact on overall industrial growth through the multiplicative effect of skills and knowledge acquisition. Similarly, Riad et al. (2012) and Ahmed et al. (2017) find that in a country with a downstream position in a global value chains, REER's impact on industry exports is lower. Ahmed et al. (2017) also show that backward linkages have a larger effect on the elasticity of industry exports to REER changes than forward linkages.

The fourth column of Table 8 neither shows any statistically significant impact of REER on the share of industrial production in GDP, nor does it show any statistically significant impact for the interaction term that controls for DVX share of gross export. The low variation in the forward participation across countries may be one of the reasons for the lack of statistical significance. Moreover, the relationship between economic development and upstream position of a country is not straightforward. While the positive linkage between these two indicators is clearer in cases of upstream positioned countries with developed business and financial services, it is not clear for countries that have upstream positions due to exports of commodities and manufacturing products (Guzman et al.2018, Ignatenko et al. 2019).

4.4 *Cointegration tests and robustness*

We left to perform cointegration tests as a post-estimation procedure to assess whether unobservable variables are part of a cointegration equation. As an informal cointegration test, we utilize the stationarity CIPS test for residuals of the AMG model (Banerjee and Carrion-i-Silvestre, 2011). When the regression residuals are stationary, the cointegration establishes a proper channel for empirical analysis, while the nonstationary property of residuals indicates potentially spurious regression. We test for cointegration existence using the test advocated by Gengenbach et al. 2009). This test is based on an error correction model and takes into account dependency between cross-section data using the residual bootstrapping technique (with 400 bootstrap replications). Additionally, we use alternative panel cointegration tests, suggested by Pedroni (1999, 2004) and Kao and Chiang (2001). All tests, reported in Table 9, confirmed the presence of cointegration.

After cointegration checks, we conduct further tests of robustness. Table 10 presents the results of our first set of checks, in which we use the Pesaran (2006) common correlated effects mean group (CCE) estimator. By its properties, and similar to the class of AMG estimators, CCE accounts for the presence of unobserved common factors by including cross-sectional averages of both dependent and the set of independent variables in the regression. In the CEE approach, we use 2SLS and GMM for individual regressions, In all specifications, REER shows a statistically significant negative relationship.

Table 11 presents the second set of robustness tests that address potential shortcomings of the common correlated effects mean group (CCE) estimator for dynamic panels. For this purpose, we employ the dynamic common correlated effects estimator (DCCE), initially derived in Chudik and Pesaran (2015), which is extended by Neal (2015). Consequently, we estimate the regression equations with 2SLS or GMM to account for endogenous regressors and improve the efficiency of the DCCE estimator using further lags of the variables to form the instrument set. For all regressions, the results are consistent with previous conclusions.

5. Conclusion

Premature deindustrialization started three decades ago in Eastern European countries. Globalization, trade, and financial account liberalization accompanied by the rigidity of the business structures and its non-competitiveness in the global markets led to industrial production deterioration. The decline of industry value-added, however, was not uniform across all countries. For part of them, mostly from CE and Baltic region, it is better described by a U-shaped curve. Since, year 2000 and the implementation of institutional and market reforms in these countries, the initial deindustrialization trend is followed by reindustrialization. For the remaining countries in the region, the declining industrialization trend or stagnation persisted. Trade internationalization exposed industrial products of these countries to world competition, so REER had a significant role in de(re)industrialization process influencing industry sector size and productivity.

Throughout the transformation process, one of the main modifying features of countries' economic landscape in these regions, especially in CE, was the broader integration of their industries in global value chains and moving up the export sophistication ladder. New industries emerged, and the relation between the share of the country's export and import of intermediate products has been changed. All these changed conventional analysis of REER influence on industrial production, and the role of depreciation in growth promotion. Accordingly, the main contribution of our analysis was a comprehensive examination of the relationship between REER and de(re)industrialization process, taking into account these modified characteristics of industry sectors. We utilize a sample of 25 post-communist Eastern European countries by applying a methodology that considers mutual trade and economic connection between countries, their heterogeneity, and the influence of common global shocks.

The paper had three objectives. First, as a baseline, we assess the relation between REER changes and share of industrial production in GDP without incorporating the effects of product sophistication or participation in global value chains. Second, we evaluate the hypothesis that higher values for the economic complexity index (ECI)-- as a proxy for higher economic potential, better institutions, and higher export sophistication--should diminish the impact of REER on the share of industrial production in GDP. Finally, we analyze how a change in the country`s integration in global value chains influence REER impact on industrial production.

Our baseline result reports a negative relation between the REER - industrial production relationship and is robust when we employ alternative measures for the REER. These results confirm one of the main concepts of export-led growth theories that depreciation is beneficial for growth promotion. Results also point out, that due to large periods of the overvalued exchange rates in this region, lowering overvaluation is more beneficial over the observed period, then increasing undervaluation.

In the second part of the analysis, we examine how this relation changes if we account for modification in economic complexity and participation in international production networks. We establish that the relationship between the REER and industrial production is weaker in countries with a higher economic complexity and export sophistication, which exhibits lower negative consequences when REER appreciates. Finally, a deeper integration of industries into global value chains lessens the negative effect of appreciation on industrial production. When percentages of this integration are high (above 65%), then appreciation can be beneficial for industry development. This is mostly due to cheaper intermediated imports that benefit a majority of countries in the region that are downstream located in global value chains. Our findings confirm that REER impact on industrial production depends on the country's global value chains position, indicating that the negative consequences of REER appreciation are less pronounced for countries with higher percentages of backward linkages.

These results may have important policy-relevant implications, especially when using undervaluation as a policy tool. Even though we cannot consider the real exchange rate as a strict policy variable, governments often use various instruments to influence its level. Undervaluation can be achieved through currency interventions, fiscal policy to achieve structural surpluses, income redistribution, and similar policies that result in higher savings than investment. Evidence shows that policies that promote the competitiveness of the export industry had success in developing countries.

It is important to emphasize that REER policy is the only “second-best” solution for growth and industry promotion. At the same time, the elimination of market and institutional distortions are the best strategies, which is not easy to implement in developing countries. In the observed post-communist countries, the implementation of these reforms was at a different pace, which has led to different industry structures, the degree of participation in global value chains, and different levels of the countries development. Hence, these differences across countries are an important factor that policymakers have to consider when discussing the implications of real undervaluation on industrial production. This research has shown that the higher country`s global value chains participation reduces the negative impact of REER appreciation on industrial production. Undervaluation will promote only domestic value-added export, which is in a case of a higher share of backward linkages only a small part of the gross amount. So, the multiplicative effect of export promotion on the industry will be lower and imported-dependent companies engaged in global value chains will have higher expenses. All of this will diminish the benefits of undervaluation. Countries that have a higher share of global value chains participation will experience milder rection of their exports to REER depreciation, then the one foreseen by models that do not appropriately account for the involvement in cross-border production chains. This can lead to inaccurate policy actions. So, as the country`s global value chains participation and position changes, the effects of REER on industry production also changes, and countries' optimal REER policies should be modified over time.

Figure 1. Common dynamic factors analysis

The figure presents the value of the coefficients for the Common Dynamic Factor (CDF), which indicates an important role of unobservable inputs, such us common global shocks and the price of industrial products, in variations of industrial production's share in GDP in all observed countries.

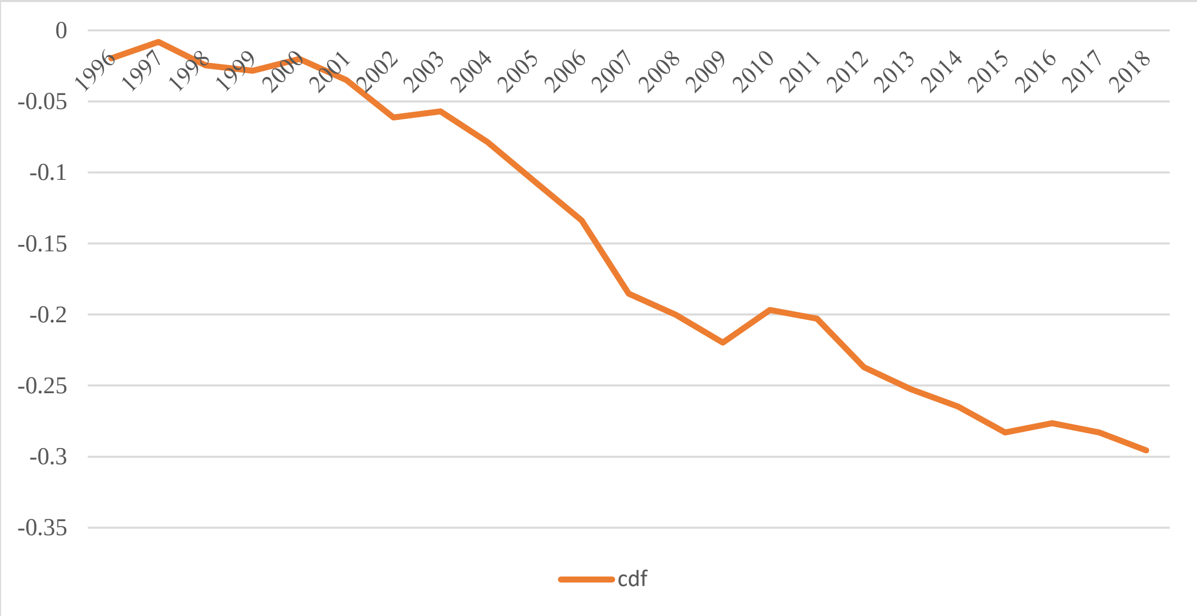
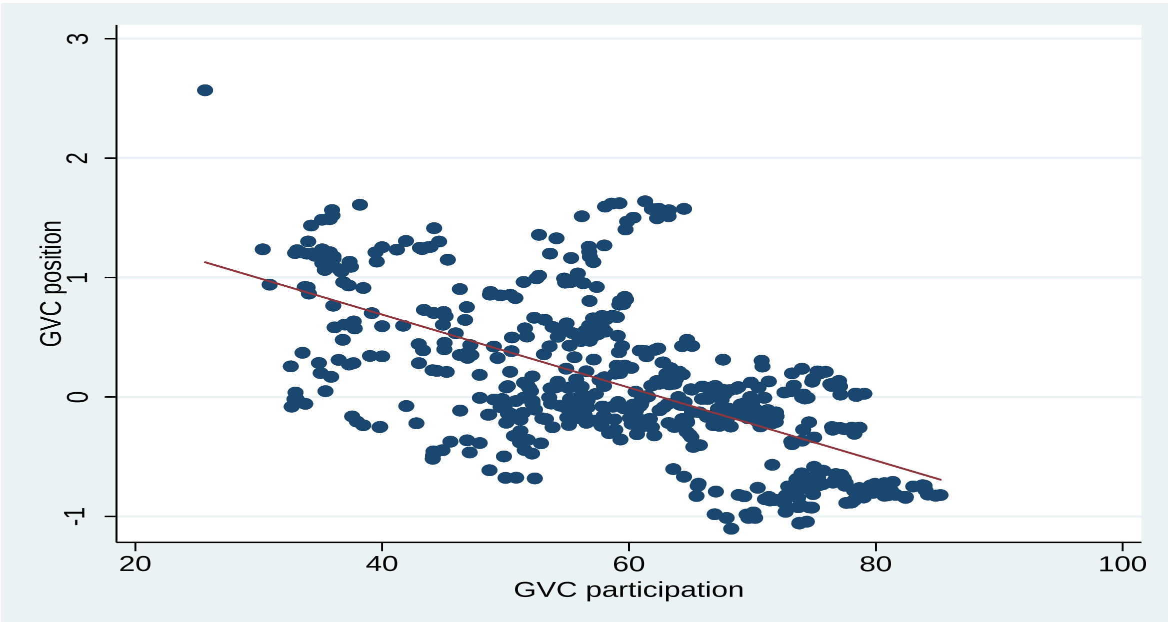


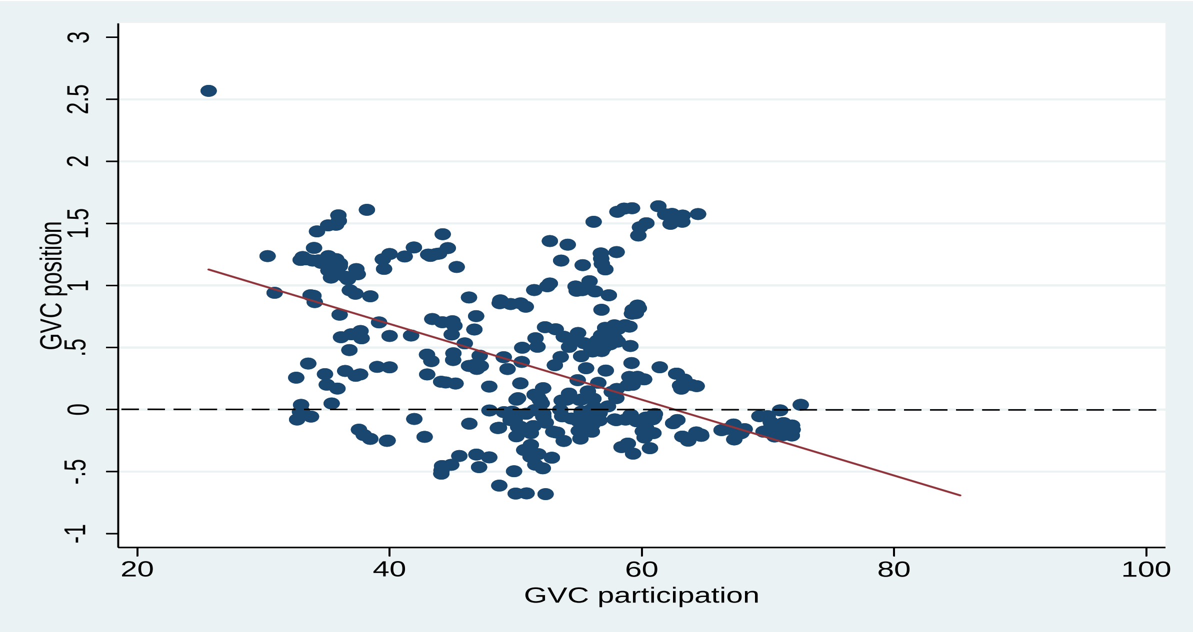
Figure 2. Global Value Chain (GVC) participation and position relationship of countries

The first graph A shows the relation of the global value chain participation and position relation of the particular county in the entire sample chain. The graph B in the middle shows the same relation for high-income countries in our sample (CE and Baltic countries). The third graph C shows the relation for the upper and lower-middle-income countries (Former Soviet Union (FSU) and Southern Eastern Europe (SEE) countries)

Graph A: Entire Sample



Graph B: Central Europe and Baltic Countries



Graph C: Former Soviet Union and Southern Eastern Europe countries

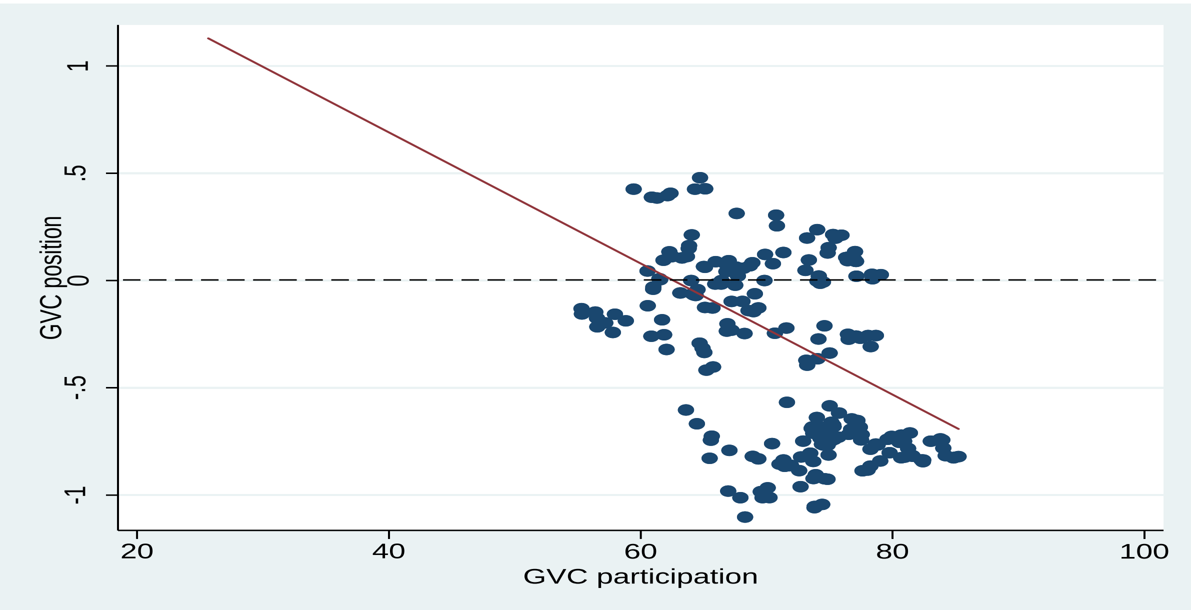


Figure 3. Economic complexity index (ECI) – global value chains (GVC) participation relationship

This figure shows the correlation between economic complexity index (ECI) , as an approximation of a country`s development and export sophistication, and global value chains participation (GVC) for the entire sample.

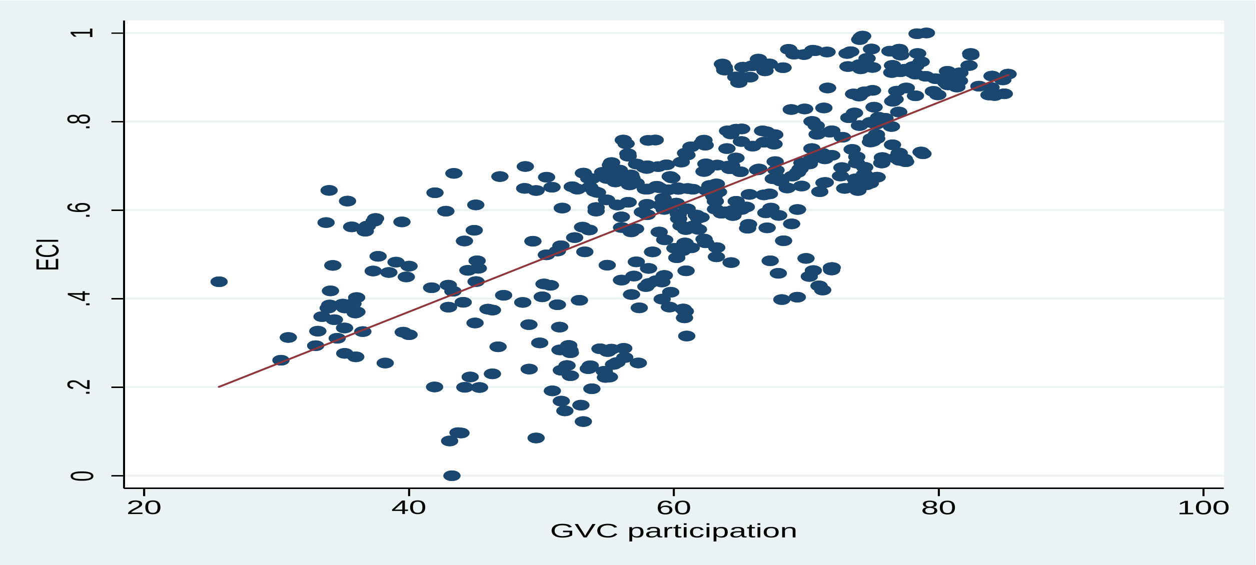


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Table 1. An estimate of the long-term level of the REER aligned with productivity change
The table presents estimation results of the relationship between the real effective exchange rate and the GDP per employee (GDPpe) applying augmented mean group (AMG) methodology. The examined sample consists of 25 post-communist Eastern European countries for the period 1995-2018

Variables	**AMG**
GDPpe	0.471**
	(0.230)
CDF	0.821***
Constant	0.091
	(1.893)
Observations	600
Number of id	25
e - integrated	I(0)
Pesaran CSD test (p value)	0.084
RMSE	0.093

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Tests for cross-sectional dependence, heterogeneity and nonstationarity for these variables are given in results section. Stationarity of residuals confirm cointegration.

Table 2. Descriptive statistics

The table presents the descriptive statistics of the sample of 25 post-communist Eastern European countries for the period 1995-2018. Where in the columns, ***Obs*** represents the number of observations. The remaining columns present the mean, the standard deviation, minimum and maximum values.

Variable	Obs	Mean	Std. Dev.	Min	Max
Industry value added (share in GDP)	600	24.770	7.321	8.632	59.790
Real effective exchange rate	600	100.174	34.541	43.441	409.154
Real exchange rate	600	2.738	1.239	1.077	7.257
GDP per capita	600	13427.110	34880.390	148.928	260739.000
Trade openness	600	90.822	38.526	15.860	287.461
Gross fixed capital formation (share in GDP)	600	22.828	7.894	2.772	81.308
Government expenditure (share in GDP)	600	18.515	5.311	5.624	38.371
CPI	600	68.419	30.680	0.091	145.640
Political stability	597	0.011	0.770	-2.139	1.311
Rule of law	597	-0.236	0.815	-1.648	1.373
Human development index	570	0.749	0.077	0.517	0.902
ICT index	575	0.352	0.132	0.182	0.602
Economic complexity index (ECI)	506	0.398	0.702	-1.782	1.695
Global Value Chanel participation share	552	59.337	13.256	25.655	85.236
FVA share	552	29.690	13.994	0.970	59.724
DVX share	552	29.717	7.270	15.636	54.355
Logarithms of variables					
Industry value added (share in GDP)	600	3.169	0.286	2.155	4.091
Real effective exchange rate	600	4.569	0.255	3.771	6.014
Real exchange rate	600	0.920	0.406	0.074	1.982
GDP per capita	600	8.484	1.324	5.003	12.471
Trade openness	600	4.406	0.480	2.764	5.661
Gross fixed capital formation (share in GDP)	600	3.080	0.307	1.020	4.398
Government expenditure (share in GDP)	600	2.875	0.307	1.727	3.647
Global Value Chain participation share	552	4.056	0.242	3.245	4.445
FVA	552	3.252	0.574	-0.030	4.090
DVX	552	3.362	0.244	2.750	3.996
Normalized variables					
Political stability	597	0.623	0.223	0.000	1.000
Rule of law	597	0.467	0.270	0.000	1.000
Economic complexity index (ECI)	506	0.627	0.202	0.000	1.000

Table 3. Cross-Section Dependence Test

This table reports the results of the conducted Pesaran (2015) cross-sectional dependence (CD) test on dependent and each independent variable. Results show that the null hypothesis of weak cross-sectional independence is rejected for each case.

Variable	**CD test**	**p-value**	**alpha**	**Std. Err.**	**95% Conf. Interval**
Industry value added (share in GDP)	84.724	0.000	1.007	0.037	(0.935, 1.078)
Real effective exchange rate	84.68	0.000	1.007	0.022	(0.964, 1.049)
Real exchange rate	82.955	0.000	1.006	0.034	(0.940, 1.072)
GDP per capita	84.828	0.000	0.989	0.050	(0.891, 1.087)
Trade openness	84.653	0.000	1.007	0.060	(0.889, 1.124)
Gross fixed capital formation (share in GDP)	84.433	0.000	0.974	0.034	(0.907, 1.041)
Government expenditure (share in GDP)	84.553	0.000	1.007	0.040	(0.927, 1.085)
CPI	80.992	0.000	1.006	0.214	(0.586, 1.426)
Political stability	3.768	0.000	0.622	0.071	(0.482, 0.762)
Rule of law	23.579	0.000	0.623	0.059	(0.507, 0.739)
Human development index	75.849	0.000	1.000	0.017	(0.967, 1.033)
ICT index	82.47	0.000	1.007	0.009	(0.989, 1.024)
Economic Complexity Index	12.718	0.000	0.693	0.095	(0.693, 0.095)
Global Value Chane participation share	77.913	0.000	1.007	0.028	(1.008, 0.028)
FVA share of export value added	77.544	0.000	1.006	0.039	(0.930, 1.083)
DVX share of export value added	77.862	0.000	0.989	0.032	(0.927, 1.051)

Notes: H0: variable is weakly cross-sectional dependent. Alpha is estimated cross-sectional exponent (0.5 <= alpha < 1 implies strong cross-sectional dependence)

Table 4. Pesaran CIPS Unit root test

This table reports the results of Pesaran (2007) CIPS unit root test that assumes cross-sectional dependency in the form of a single unobserved common factor (second generation of unit root tests). The results of the CIPS tests suggest that variables: industry value-added, CPI, political stability, the rule of law, Economic Complexity Index and Human Development Index are nonstationary as the null hypothesis of a unit root cannot be rejected no matter which a number of lags are used. For the rest of the variables, conclusion depends on the number of lags included. At the first differences, stationarity is observed in the case of each variable (Table for first differences not reported, available upon request for both CIPS and CADF test). Reliability of the results of Pesaran's CIPS test can be checked if a different number of lags are allowed for each cross-section, which should cover a different level of autocorrelation, so we do individually analysis of stationarity for each cross-section using ADF test and AIC criteria for determination of an optimal number of lags. Additionally, we conduct Pesaran CADF panel unit root test, where the optimal number of lags is determined as the average of number of lags for each cross-section.

Variable	**Lags**	**Zt-bar**	**p-value**	**Variable**	**Lags**	**Zt-bar**	**p-value**
Industry value added	0	-0.429	0.334	Gross fixed capital formation	0	-1.690	0.046
	1	-0.147	0.442		1	-0.183	0.427
	2	1.988	0.977		2	1.151	0.875
	3	2.129	0.983		3	2.793	0.997
Real effective exchange rate	0	-2.520	0.006	Government expenditure	0	-3.485	0.000
	1	-2.151	0.016		1	-4.642	0.000
	2	-1.554	0.060		2	-1.454	0.073
	3	-0.525	0.300		3	0.049	0.520
Real exchange rate	0	-0.079	0.468	CPI	0	7.357	1.000
	1	-2.954	0.002		1	4.188	1.000
	2	-3.183	0.001		2	6.208	1.000
	3	-0.851	0.197		3	8.456	1.000
GDP per capita	0	-1.944	0.026	Political stability	0	1.402	0.919
	1	-3.915	0.000		1	-0.477	0.317
	2	0.152	0.560		2	1.933	0.973
	3	0.495	0.690		3	1.976	0.976
Trade openness	0	-1.246	0.106	Rule of law	0	0.058	0.523
	1	-3.426	0.000		1	0.132	0.553
	2	-2.232	0.013		2	1.248	0.894
	3	1.212	0.887		3	1.256	0.895
Global value chains participation	0	-2.942	0.002	ICT index	0	1.171	0.879
	1	-2.165	0.015		1	-2.475	0.007
	2	-6.551	0.000		2	-1.532	0.063
	3	-1.800	0.036		3	-0.508	0.306
Economic Complexity Index	0	0.052	0.521	Human Development Index	0	0.569	0.715
	1	0.783	0.783		1	0.964	0.833
	2	1.071	0.858		2	0.732	0.768
	3	3.181	0.999		3	1.004	0.842
FVA	0	-3.481	0.000	DVX	0	-1.863	0.031
	1	-3.685	0.000		1	0.009	0.504
	2	-2.220	0.013		2	-4.067	0.000
	3	0.307	0.621		3	0.655	0.744

Note: Deterministic components include intercept and trend; CIPS test statistics for a different number of lags is given in first three rows

Table 5. CADF unit root test

This table shows results of Pesaran CADF test, were optimal number of lags per variable is average number of lags determined usig AIC criteria for each cross-section. The obtained results of the CADF test indicate the non-stationary level of all the analyzed variables, exept for GDP per capita, Trade openness, Government expenditure, global value chains (GVC) participation, FVA an DVX share. However, the null hypothesis of CADF test is satisfied if all series are non-stationary, while it is consistent under the alternative if only a fraction of the series is stationary. ADF test for individual country time-series for mentioned four variables shows that stationarity is present in only in few individual countries. Considering mixed results depending on an included number of lags, the majority of nonstationary individual country time series, as well as mentioned caveats of panel unit root tests, we can suggest that nonstationarity cannot be ruled out in this dataset, while after first differencing, the series result stationary.

Variable	**lags**	**Zt-bar**	**p-value**
Industry value added (share in GDP)	0.8	-0.873	0.191
Real effective exchange rate	1.16	-0.965	0.167
Real exchange rate	1.52	-1.154	0.124
GDP per capita	1.56	-2.778	0.003
Trade openness	1	-1.866	0.031
Gross fixed capital formation (share in GDP)	1.12	-0.712	0.238
Government expenditure (share in GDP)	0.92	-5.172	0.000
CPI	1.4	6.104	1.000
Political stability	0.96	0.851	0.803
Rule of law	0.84	-0.361	0.359
Human development index	1.08	0.284	0.612
ICT index	1.8	-0.499	0.309
Economic Complexity Index	1.18	-0.011	0.496
Global Value Chane participation	0.65	-2.992	0.001
FVA	0.96	-3.586	0.000
DVX	0.91	-4.199	0.000

Note: Lag augmentation for CADF test statistic is derived from the underlying ADF regression (based on Akaike information criteria) for each country; the number of lags reported is the average across countries.

Table 6. Test of means equality by countries and heterogeneity tests

The table shows results of heterogeneity test by countries for each variable done using Anova F-test and Welch F-test statistics for equality of variables means by countries. Results show that countries differ significantly from each other and that the sample is heterogeneous. Second part of table shows results of formal tests for parameter heterogeneity across countries (Swamy S test for parameter consistency and Roy-Zellner test that is more suitable for non-stationary and small sample (Pedroni, 2007; Pesaran, Yamagata, 2008)). Both tests proved that heterogeneity is present in this sample, and rejected null hypotheses of poolability.

	Anova F-test		Welch F-test	
Variable	**Value**	**Prob.**	**Value**	**Prob.**
Industry value added (share in GDP)	104.054	0.000	159.310	0.000
Real effective exchange rate	9.516	0.000	11.616	0.000
Real exchange rate	33.994	0.000	43.775	0.000
GDP per capita	359.159	0.000	659.436	0.000
Trade openness	49.038	0.000	67.253	0.000
Gross fixed capital formation (share in GDP)	15.679	0.000	32.958	0.000
Government expenditure (share in GDP)	35.642	0.000	45.457	0.000
Cpi	5.288	0.000	4.958	0.000
Political stability	84.203	0.000	125.581	0.000
Rule of law	291.670	0.000	831.147	0.000
Human development index	50.139	0.000	59.233	0.000
ICT index	8.702	0.000	13.878	0.000
Economic Complexity Index	207.230	0.000	514.625	0.000
Global Value Chane participation share	269.359	0.000	380.226	0.000
FVA share	241.048	0.000	533.524	0.000
DVX share	96.954	0.000	169.854	0.000

Test	χ^2	Prob > χ^2
Swamy S test	21164.09 (df=196)	0.000
Roy-Zellner test	11775.17 (df=138)	0.000

Table 7. REER and industrial production

The first column shows results of basic model (defined in Eq.1) of the impact of the REER on the share of industry in GDP (*industry*) in the countries of Eastern Europe. The estimates in the second column are for the group of high income countries, column three upper and lower- middle income countries, in fourth column additional control variables are added to account for institutional and market failures. In the fifth column variable REER is replaced with bilateral exchange rate (national currency versus US dollar). In the sixth column REER is replaced with misalignment of real effective exchange rate from the long-term level aligned with productivity growth, column seven and eight shows estimates with variable overvaluation and undervaluation instead of REER. Pesaran CD and unit root test indicated that residuals are cross-sectionally independent and have no unit root, in case of all estimated models. Stationarity of residuals confirm cointegration. NOTE: The increase of REER and RER index represents appreciation (decrease - depreciation).

VARIABLES	I	II	III	IV	V	VI	VII	VIII
REER	-0.229**	-0.147**	-0.256	-0.227**				
	(0.102)	(0.070)	(0.208)	(0.097)				
RER					-0.096**			
					(0.042)			
REERM						-0.243**		
						(0.113)		
Overvaluation							-0.210*	
							(0.127)	
Undervaluation								-0.271
								(0.211)
GDP pc	0.257*	0.118	0.021	0.170	0.338	0.198	0.290	0.167
	(0.147)	(0.177)	(0.118)	(0.204)	(0.227)	(0.180)	(0.203)	(0.195)
Trade openness	0.060	0.091	0.043	0.073	0.064	0.038	0.057	0.072
	(0.062)	(0.075)	(0.091)	(0.068)	(0.066)	(0.065)	(0.064)	(0.057)
GFCF	-0.116**	-0.079	-0.058	-0.128***	-0.139**	-0.110***	-0.151**	-0.086**
	(0.056)	(0.068)	(0.038)	(0.044)	(0.059)	(0.039)	(0.066)	(0.036)
Gov. exp.	-0.210*	-0.333**	-0.144	-0.074	-0.039	-0.100	-0.146	-0.060
	(0.126)	(0.132)	(0.122)	(0.127)	(0.091)	(0.124)	(0.106)	(0.155)
CPI	0.001	0.001*	-0.001	0.000	-0.001	0.000	-0.001	0.002
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
CDF	1.041***	0.550**	1.141***	0.853***	0.793***	1.000***	0.894***	0.925***
	(0.230)	(0.235)	(0.302)	(0.225)	(0.198)	(0.252)	(0.210)	(0.269)
Political stab.				0.007	0.009	0.022	0.015	0.021
				(0.022)	(0.031)	(0.025)	(0.027)	(0.024)
Rule of law				-0.009	-0.004	-0.034	-0.022	-0.012
				(0.038)	(0.050)	(0.043)	(0.041)	(0.048)
HDI				0.284	-0.496	-0.015	-0.373	-0.298
				(1.122)	(1.112)	(1.029)	(1.110)	(0.981)
ICT				-0.418	-0.315	-0.335	-0.530	-0.336
				(0.320)	(0.286)	(0.345)	(0.374)	(0.358)
Constant	2.543**	4.505***	4.286***	2.473**	0.532	1.600*	1.423	1.638
	(1.220)	(1.070)	(1.211)	(1.010)	(1.167)	(0.882)	(0.947)	(1.229)
Observations	600	384	216	534	534	534	534	534
Number of id	25	16	9	24	24	24	24	24
e - integrated	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
Pesaran CSD test (p value)	0.77	0.018	0.274	0.188	0.144	0.151	0.291	0.186
RMSE	0.042	0.046	0.021	0.028	0.027	0.027	0.028	0.027

*** p<0.01, ** p<0.05, * p<0.1

Table 8. Economic complexity index (ECI) and global value chains (GVC) impact on REER and industrial production relationship

This table presents the effects of economic diversification and production capabilities, as well as the country's export integration in international production networks on REER influence on industry structure. Pesaran CD and unit root test indicate that residuals are cross-sectionally independent and have no unit root, for all estimated models. The full description of independent variables is presented in the Appendix 1.

VARIABLES	I	II	III	IV
REER	-0.682**	-14.122**	-1.718**	0.051
	(0.342)	(6.096)	(0.817)	(1.788)
ECI	-3.487**			
	(1.620)			
REER*ECI	0.743**			
	(0.349)			
GVC participation		-15.719**		
		(6.666)		
REER*GVC participation		3.381**		
		(1.449)		
FVA			-2.303**	
			(1.002)	
REER*FVA			0.492**	
			(0.221)	
DVX				0.169
				(2.417)
REER*DVX				-0.041
				(0.496)
GDPpc	0.205	0.128	0.207	0.381*
	(0.172)	(0.218)	(0.145)	(0.214)
Trade openness	0.069	0.177**	0.203**	0.120
	(0.062)	(0.082)	(0.096)	(0.090)
GFCF	-0.116***	-0.119*	-0.124***	-0.123***
	(0.036)	(0.066)	(0.040)	(0.027)
Gov. expenditures	0.153	0.032	-0.044	-0.013
	(0.149)	(0.132)	(0.101)	(0.085)
CPI	-0.001	-0.000	0.001	0.002
	(0.001)	(0.002)	(0.001)	(0.001)
Political stability	-0.002	-0.015	0.005	-0.005
	(0.019)	(0.021)	(0.018)	(0.026)
Rule of law	0.034	-0.027	0.008	0.074***
	(0.036)	(0.050)	(0.044)	(0.024)
HDI	1.097	1.427	0.669	-0.435
	(1.212)	(1.337)	(1.154)	(1.187)
ICT	-0.383	-0.385	-0.299	-0.185
	(0.254)	(0.395)	(0.321)	(0.296)
cdf	0.908***	0.859***	0.334**	0.343**
	(0.224)	(0.243)	(0.135)	(0.137)
Constant	3.163	65.744**	8.224**	2.330
	(2.098)	(27.541)	(3.752)	(7.839)
Observations	465	488	488	488
R-squared				
Number of id	21	22	22	22
e - integrated	I(0)	I(0)	I(0)	I(0)
Pesaran CSD test (p value)	0.06	0.17	0.282	0.193
RMSE	0.0201	0.0223	0.0226	0.0233

Standard errors in parenthe
*** p<0.01, ** p<0.05, * p

Table 9. Cointegration tests

This Table shows results of formal panel cointegration tests following Pedroni (1999, 2004), Kao (2000) and Gengenbach, Urbain and Westerlund (2009) where an estimate of common dynamic is included in the cointegrating vector. This is reason why cointegration test is done after estimation of results. All tests confirmed presence of cointegration. In Pedroni test 6 out of 11 tests rejected null hypothesis (4 of which are based on the weighted values). Also, given the short time series in the sample, it is important that the tests of group ADF and panel ADF-Statistics reject the null hypothesis of no cointegration at the level of significance of 1%. Gengenbach, Urbain and Westerlund (2009) test for cointegration is based on an error correction model and takes into account the dependence between cross-section data with the use of the residual bootstrap technique (400 bootstrap replications are used). Due to small sample we used maximum of one lag and lead.

Pedroni - Null Hypothesis: No cointegration

	unweighted		**weighted**	
	Statistic	**Prob.**	**Statistic**	**Prob.**
Panel v-Statistic	-1.545	0.938	-2.200	0.986
Panel rho-Statistic	3.693	0.999	3.496	0.999
Panel PP-Statistic	-2.422	0.007	-2.475	0.007
Panel ADF-Statistic	-1.647	0.050	-2.087	0.018
Group rho-Statistic	5.014	1.000		
Group PP-Statistic	-6.693	0.000		
Group ADF-Statistic	-2.575	0.005		

Kao - Null Hypothesis: No cointegration

	t-Statistic	**Prob.**
ADF	-2.896	0.002

Westerlund ECM – Null Hypothesis: No cointegration

	Value	**Z-value.**	**p-value**	**Robust p-value**
Gt	-4.127	-10.045	0.000	0.005
Ga	-5.113	4.160	1.000	0.858
Pt	-22.237	-11.955	0.000	0.000
Pa	-13.069	-4.277	0.000	0.000

Table 10. Common correlated effects mean group estimator (CCE)

These table shows several robustness checks. To check results, we used the Pesaran (2006) common correlated effects mean group (CCE) estimator that also as AMG accounts for the presence of unobserved common factors by including in the regression cross-sectional averages of the dependent and independent variables. CEE estimator is robust to nonstationarity, cointegration, breaks, and serial correlation.

	I	II	III	IV
VARIABLES	CCE-2SLS	CCE-GMM	CCE-2SLS II	CCE-GMM II
l.lnindustry	0.332***	0.346***	0.304***	0.297***
	(0.078)	(0.074)	(0.088)	(0.088)
lnREER	-0.329***	-0.320***	-0.185**	-0.202**
	(0.096)	(0.094)	(0.093)	(0.100)
lnGDPpc	0.051	0.063	0.333**	0.350**
	(0.164)	(0.148)	(0.151)	(0.166)
lntrade			0.103	0.103
			(0.081)	(0.082)
lnGFCF			-0.110**	-0.106**
			(0.051)	(0.052)
lnindstry_csa	0.884***	0.859***	1.121***	1.129***
	(0.333)	(0.321)	(0.429)	(0.426)
lnREER_csa	0.281	0.262	0.032	0.039
	(0.186)	(0.169)	(0.237)	(0.233)
lnGDPpc_csa	0.024	-0.002	-0.251	-0.294
	(0.214)	(0.200)	(0.242)	(0.270)
lntrade_csa			-0.278	-0.285
			(0.178)	(0.178)
lnGFCF_csa			0.302	0.359
			(0.202)	(0.220)
constant	-0.890	-0.693	-0.957	-0.783
	(1.703)	(1.638)	(2.548)	(2.571)
Observations	525	525	525	525
Number of id	25	25	25	25
e - integrated	I(0)	I(0)	I(0)	I(0)
Pesaran CSD test (p value)	0.093	0.08	0.357	0.341

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 11. Dynamic Common Correlated Effects Estimator (DCCE)

Here we employ the Dynamic Common Correlated Effects Estimator (DCCE) of Chudik and Pesaran (2015). We employed Neal (2015) further extensions of the CCE/DCCE approach by estimating the regressions equation with 2SLS or GMM to account for endogenous regressors and improve the efficiency of the DCCE estimator using further lags of the variables to form the instrument set.

	I	II
VARIABLES	DCCE-2SLS	DCCE-GMM
l.lnindustry	0.586***	0.543***
	(0.161)	(0.187)
lnREER	-0.253**	-0.270**
	(0.121)	(0.117)
lnGDPpc	0.036	0.298
	(0.186)	(0.296)
L2.lnindustry_csa	0.043	-0.104
	(0.241)	(0.180)
L.lnindustry_csa	-0.827	0.096
	(0.662)	(0.261)
lnindustry_csa	1.207**	1.024
	(0.577)	(0.626)
L2.lnREER_csa	0.082	-0.206
	(0.194)	(0.174)
L.lnREER_csa	0.034	0.437*
	(0.178)	(0.250)
lnREER_csa	0.047	0.143
	(0.210)	(0.297)
L2.lnGDPpc_csa	-0.472	0.092
	(0.511)	(0.212)
L.lnGDPpc_csa	0.397	-0.325
	(0.594)	(0.440)
lnGDPpc_csa	0.169	0.022
	(0.408)	(0.500)
constant	-0.776	-2.222
	(2.681)	(3.163)
Observations	525	550
Number of id	25	25
e - integrated	I(0)	I(0)
Pesaran CSD test (p value)	0.053	0.165

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Appendix 1. Variables description and construction

Variable	Description	Variable type	Source
Industry value-added	Mining, manufacturing, and utility sector share in the GDP of the country at constant 2015 US$ prices. Variable is used as a log transformed.	Percentage	UNDP Statistics
Real effective exchange rate (REER)	Calculated as a product of nominal effective exchange rate (NEER) and consumer price index (CPI) of a country divided by a geometrically weighted average of CPI indices of trading partners. NEER is calculated as a geometrically weighted average of the nominal bilateral exchange rates between a particular country and its trading partners. Variable is used as a log transformed.	Index, the base year 2015	Zsolt (2012) database
Real exchange rate (RER)	Bilateral exchange rate - national currency versus the US dollar. Variable is used as a log transformed.	Index, the base year 2015	PWT 9.1 and World bank WDI
GDP per employee	The ratio of GDP and the total number of employees in the country at constant 2015 US$ prices. Represents a proxy for productivity to account for Balassa-Samuelson's effect. Variable is used as a log transformed.	Percentage	World Bank WDI
Long-term level of REER aligned with productivity growth	Calculated based on AMG regression of REER on GDP per employee. Estimated coefficients from the regression are applied to the permanent component of the GDP per employee, which is obtained by using the Hodrick-Prescot (HP) filter. Variable is used as a log transformed.	Index	Authors calculation
REER misalignment (REERM)	Calculated as a difference between the logarithm of the actual level of the REER and the estimated equilibrium long-term level of REER aligned with productivity growth.	Log transformed ratio, cantered at zero	Authors calculation
Overvaluation	Calculated as a product of the REERM values and a dummy variable, with a value of one for the periods of the undervalued exchange rate (when the REERM values are higher than one) and zero for other periods	Log transformed ratio; values higher than zero	Authors calculation
Undervaluation	Calculated as a product of REERM and the differences between one and the above-defined dummy variable.	Log transformed ratio; values lower than zero	Authors calculation
GDP per capita	Ratio of GDP and the total population in the country at constant 2015 US$ prices.	Percentage	UNDP Statistics
Trade openness	Calculated as the summation of the country`s export and import, divided by the level of gross domestic product for a given country	Percentage	Based on UNDP Statistics data

Gross fixed capital formation (GFCF)	The GDP share of gross fixed capital formation at a constant 2015 US$ prices	Percentage	UNDP Statistics
Government expenditure	The GDP share of government final consumption expenditure at constant 2015 US$ prices	Percentage	UNDP Statistics
Consumer price index (CPI)	Consumer price index at constant 2015 US$ prices. Three missing observations were imputed using linear interpolation	Index	IMF - World Economic Outlook database.
Political stability	Measures perceptions of the likelihood of political instability. Row variable is estimated from -2.5 to 2.5, so we standardized values in the range from 0 to 1, to make an easier interpretation of results.	Values in range from 0 to 1	World Bank Governance Indicators
Rule of law	Captures perceptions of the extent to which agents have confidence in the quality of contract enforcement, property rights, and the courts. Row variable is estimated from -2.5 to 2.5, so we standardized values in the range from 0 to 1 to make an easier interpretation of results.	Values in range from 0 to 1	World Bank Governance Indicators
Human development index (HDI)	Composite measure of average achievement in three dimensions of human development: being knowledgeable, a long and healthy life, and a decent standard of living.	Values in range from 0 to 1	UNDP Statistics
ICT index	A composite indicator from 4 sub-indicators: mobile phone subscription per 100 persons, fixed phone subscription per 100 persons, fixed broadband subscription per 100 persons, and percent of individuals using the internet. The index is calculated as the average of the four sub-indicators scores.	Values in range from 0 to 1	Global Adaptation Index Database
Economic Complexity Index (ECI)	Calculated using export data, information on the diversity and similarity of country`s export products. The original index is estimated from -1.8 to 1.7. We standardized values to be in the range from 0 to 1 to make an easier interpretation of results. The database does not provide an ECI indexes for Armenia, Kyrgyzstan, and Tajikistan, as well as for the year 2018.	Values in range from 0 to 1	Observatory of Economic Complexity
Domestic Value Added (DVA)	Measures the value of exports created using domestic inputs. Variable is expressed as a share in gross export, which is a sum of foreign and domestic value added. Data for Serbia and Belarus are not available.	Percentage	UNCTAD database
Foreign Value Added (FVA)	The measure of foreign inputs used in the process of production of exported goods (downstream participation in GVCs or backward linkages). Variable is expressed as a share in gross export, and used as log transformed. Data for Serbia and Belarus are not available.	Percentage	UNCTAD database

Domestic value-added exported as an intermediate product to trade partners (DVX)	Measures part of domestic value-added exported as an intermediate product to trade partners, which is further processed and re-exported. DVX represents upstream participation in GVCs (or forward linkages). Variable is expressed as a share in gross export, and used as log transformed. Data for Serbia and Belarus are not available.	Percentage	UNCTAD database
Global Value Chain participation	Calculated as the sum of FVA and DVX, expressed as a share of gross export. Variable is used as log transformed.	Percentage	Based on UNCTAD data
Global Value Chain position	Measures relative relation between backward and forward linkages. Calculated with the formula; $GVCposition_i = \ln\left(1 + \frac{DVX_i}{EX_i}\right) - \ln\left(1 + \frac{FV_i}{EX_i}\right)$ where EX_i is a gross export.	Percentage	Based on UNCTAD data