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Structural change in times of increasing openness: assessing path dependency in European economic integration*

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Abstract

This paper analyzes the dynamics of structural polarization and macroeconomic convergence vs. divergence in the context of European integration, where the latter is understood primarily as an increase in economic and financial openness. In the process of estimating the dynamic effects of openness shocks on 26 EU countries, we develop a taxonomy of European economies that consists of core, periphery, financialized and Eastern European catch-up economies. As these four country groups have responded in a distinct way to the openness shocks imposed by European integration, we argue that the latter should be seen as an evolutionary process that has given rise to different path-dependent developmental trajectories. These trajectories relate to the sectoral development of European economies and the evolution of their technological capabilities. We propose a set of interrelated policy measures to counteract structural polarization and to promote macroeconomic convergence in Europe.

1 Europe between convergence and divergence

Once upon a time, the perspective of deepened economic integration on the European continent seemed to provide a route to successive economic and political convergence of the European nation states. Especially the establishment of the European Monetary Union (EMU) and the

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introduction of the Euro had raised high hopes for rapid convergence among member states (e.g. Blanchard and Giavazzi (2002)). And indeed, in retrospect, a series of empirical patterns were pointing to such an economic convergence: a coordinated monetary policy reduced the differences in official inflation rates across countries, increasing integration in terms of trade and investment resulted in a catch-up process of Eastern European countries (Goedemé and Collado, 2016), the integration of financial markets has reached unexpected heights (Baldwin et al, 2015; Hale and Obstfeld, 2016) and the successive harmonization of environmental legislation, labor standards and consumer protection regulation has contributed to a partial unification of regulatory environments within Europe. Correspondingly, until the advent of the financial crisis, the Eurozone as well as the wider part of the European Union were said to witness a phase of widespread convergence. This belief was strengthened by the fact that major macroeconomic indicators, like unemployment, growth and per-capita-income or interest rates, were converging in pre-crisis times (Gräbner et al, 2017), which was widely interpreted as evidence for progress in terms of an overall economic convergence within Europe (Giavazzi and Spaventa, 2010).

Yet, the simultaneous divergence of current account balances already indicated before the crisis that the convergence of certain macroeconomic indicators did not reflect long-term structural changes to the benefit of (at least the Southern Eurozone) peripheral countries (Simonazzi et al, 2013; Storm and Naastepad, 2015b; Gräbner et al, 2017). Rather, the observed catch-up process of peripheral countries was in large parts driven by expansions of private indebtedness and the corresponding emergence of large-scale housing bubbles in some countries (e.g. Storm and Naastepad (2016); Heimberger and Kapeller (2017)). These developments were enabled by the harmonization of interest rates across countries and the corresponding regulatory integration of financial markets (Baldwin et al, 2015). However, after the financial crisis, the debt-driven growth-model of peripheral Eurozone countries quickly turned out to be unsustainable and the underlying structural polarization between core and periphery countries within the EMU became apparent (Gräbner et al, 2017). In sum, the catch-up tendencies observed after the turn of the century masked the emerging structural polarization among European countries, yet eventually proved to be unsustainable.

In this paper, we aim to rationalize the complex European dynamics of convergence, divergence and polarization with reference to theories of path-dependency in international trade (Myrdal, 1958; Krugman, 1991), where past "success breeds further success and failure begets more failure", leading "to a 'polarization process' which inhibits the growth of such activities in some areas and concentrates them on others" (Kaldor, 1980, p. 88). Theoretically, we argue

that European countries exhibit specific development paths, i.e. they follow different developmental trajectories. These trajectories are coined by typical mechanisms that give rise to path-dependency (Dobusch and Kapeller, 2013), such as the presence of increasing returns to scale (in manufacturing) or network externalities, which arise from differences in technological capabilities (Arthur, 1989; Heinrich, 2014)) or rules and standards which can only be changed at high cost.

By analyzing path dependent trajectories in Europe, we take the increase in economic and financial openness and international economic integration as a conceptual starting point for exploring convergence and divergence in Europe's more recent past. We employ a data set consisting of 26 EU countries and use the local projections method proposed by Jordà (2005) to estimate how several macroeconomic variables have responded to the openness shock caused by European integration. This econometric approach allows us to study the impact of increasing openness on macroeconomic performance and developmental trajectories. In this empirical context, we also check whether we are able to identify systematic structural differences in the response of EU economies to increasing economic and financial openness. Based on our regression results, we use a hierarchical cluster analysis that points us toward a taxonomy of developmental trajectories across European countries.

We can preview the results as follows: our findings point to the existence of four structurally different developmental trajectories prevailing in the European Union. While large parts of the debate so far have focused on the different developments in Eurozone core countries (northern export-oriented capitalisms in the political economy literature; e.g. Iversen et al (2016)) versus Eurozone periphery countries (debt-led Southern European capitalisms; e.g. Johnston and Regan (2016); Johnston and Regan (2018)), we broaden the debate by proposing a typology of four country groups. This typology consists of core, periphery, financialized and Eastern European catch-up economies. Our findings stress that – due to different growth models operating within the EU (e.g. Stockhammer (2015); Gräbner et al (2017)) – we can neither expect convergence to occur endogenously – nor can we hope to develop adequate policy conclusions without taking the structural differences between these four country groups seriously (Peneder, 2017).

By developing our typology of European countries, we contribute to various streams of literature that make use of such typologies to provide a differentiated analysis of contemporary developments in Europe. First, the debate in macroeconomics focuses on whether country groups that vary in terms of their growth models have been affected differently by European (monetary) integration (e.g. Stockhammer (2015), Stockhammer and Wildauer (2016) or Gräbner

et al (2017)). Second, the comparative political economy literature analyzes whether different varieties of European capitalism and their specific sets of institutions have been equally able to cope with increasing trade and financial openness (e.g. Iversen et al (2016), Bohle (2017); Vermeiren (2017); Johnston and Regan (2018)). Third, the innovation literature engages with the relevance of technological capabilities for path dependent trajectories of European countries by focusing on the relevance of non-price competitiveness and sectoral composition (e.g. Dosi et al (2015), Simonazzi et al (2013),Storm and Naastepad (2015b); Baccaro and Benassi (2017)). In our analysis, we bring together these three strands of the literature by studying the effects of increasing openness on macroeconomic developments as well as by inspecting trends and changes in the sectoral composition of exports in EU countries in the process of European integration.

The remainder of the paper proceeds as follows: the next section studies the impact of increasing economic integration on macroeconomic developments in the European Union. Our results suggest that country-specific characteristics in the response to the openness shock variable have to be accounted for. Section 3 builds upon this observation and provides both empirical and theoretical arguments for the co-existence of currently diverging developmental trajectories in Europe, where we suggest a taxonomy of EU countries. Section 4 exploits this taxonomy and shows that the four country groups identified indeed respond differently to the openness shock of European integration. Section 5 builds upon these insights to suggest policies that take the various developmental trajectories into account and are geared towards achieving structural convergence in Europe. Finally, section 6 summarizes and concludes the paper.

2 The macroeconomic effects of openness shocks in the EU

As we are interested in analyzing the complex dynamics of convergence, divergence and polarization across the member countries of the European Union from an empirical viewpoint, we first take a broad look at the macroeconomic effects of increasing trade and financial openness by estimating the dynamic response of several key variables to increasing economic openness. A large literature is concerned with measuring economic openness in terms of trade openness and financial openness, leading to a broad range of available openness indicators (e.g. Sachs and Warner (2001); Bensidoun et al (2011); Egger et al (2015)). In this paper, we are particularly interested in the effects of European economic and monetary integration. European monetary integration has not only lowered transaction costs of trading within the Eurozone; it also led to a harmonization of interest rates across and increased capital flows between countries in pre-crisis times, which fuelled lending from the EMU core to the periphery (e.g. Lane and Wälti (2007);

Hale and Obstfeld (2016); Fuller (2018)). Against this backdrop, we construct an openness indicator based on exogenous changes in institutional aspects of European economic integration: as Eurozone countries share a common currency and relevant institutions (e.g. De Grauwe (2012)), we construct a dummy variable that represents entering the Eurozone as an openness shock; i.e., the dummy variable is set to 1 from the year onwards when the respective country entered the Eurozone. For EU countries that are currently not part of the Eurozone, we set the dummy to 1 when the respective country entered the EU or pegged its currency to the Euro. More details on this variable and an additional robustness check making use of an alternative openness indicator are given in the appendix.

We estimate the effect of this openness shock variable on eight variables: GDP growth; the unemployment rate; the current account balance in percent of GDP; capital accumulation (defined as real gross fixed capital formation/real net capital stock ·100); the public debt to GDP ratio; the Gini index of disposable income (as a measure for income inequality); the share of the financial sector in gross output of all sectors (in percent); the exports to GDP ratio. We chose this set of variables — whose response to the openness shock variable we want to estimate — as they play a prominent role in academic discussions on European macroeconomic developments.

For doing so, we compose a data set for 26 EU countries (all current EU member countries excluding Great Britain and Croatia) covering the time period 1960-2016.[1] Data were obtained from AMECO (GDP growth, unemployment, public debt, capital accumulation), the Standardized World Income Inequality database (Gini); the World Bank (exports to GDP); and the KLEMS database (share of finance in value added). The panel data are unbalanced; while they are available for all 26 EU countries, coverage in the time dimension varies across countries.

In order to estimate the effects of openness shocks in our sample of 26 EU countries, we use the 'local projections' method of Jordà (2005) for constructing impulse-response functions, which has recently been employed in several papers in the macroeconometric literature (e.g.,Jordà and Taylor (2016); Romer and Romer (2017); Nakamura and Steinsson (2018)). The basic idea of the local projections method — translated into the research framework of this paper — is to separately estimate the dynamic effects of the openness shock variable that we introduced above on the eight variables of interest based on the following regression equation:

$$y_{i,t+k} - y_{i,t} = \beta^k OS_{i,t} + y^k Z_{i,t} + \delta^k Z_{i,t} + \zeta_i^k + \eta_t^k + \epsilon_{i,t}^k \tag{1}$$

[1]We exclude Croatia since it only entered the EU in 2013 and, hence, has a rather short history of 'openness' within the EU. We do not include Great Britain because the country is expected to leave the EU and because of data considerations.

In this equation, y represents the respective 'shock-dependent' macroeconomic variable of interest (i.e. GDP growth, unemployment, current account, capital accumulation, public debt, income inequality, share of finance in value added of all sectors, exports to GDP, respectively) which is expressed in terms of its projected future change $y_{i,t+k} - y_{i,t}$ in country i from year t to year $t+k$. β^k is the estimated coefficient that represents the effect of the openness shock variable ($OS_{i,t}$) on the shock-dependent variable y. $Z_{i,t}$ represents a vector of additional control variables that should be understood as "pre-treatment variables" (i.e. controls determined before the 'treatment' of the openness shock takes place; see Nakamura and Steinsson (2018)). ζ_i^k are fixed effects at the country level which are included to control for country-specific characteristics. η_t^k are fixed effects related to time which allow to control for global shocks that hit all countries equally; and $\epsilon_{i,t}^k$ represents the error term.

Jordà (2005) shows that the standard linear projection is a direct estimate of the typical impulse response, as derived from a traditional vector autoregression (VAR). In principle, other statistical approaches would also be available to measure the dynamic effects of openness shocks; in particular, one could estimate a Panel Vector Autoregression (PVAR) or an Autoregressive-Distributed-Lag Model (ARDL). However, in our case both options would arguably be inferior to the local projections method: the PVAR approach suffers from identification and size-limitation problems, which is not the case for the more flexible local projections method (Gupta et al, 2017, p. 18-19), while the stability of impulse response functions (IRFs) obtained from an ARDL is undermined by their lag-sensitivity (e.g. Ball et al (2013)). Another advantage of the Jordà (2005) method is that the uncertainty around the IRFs can be directly inferred from the standard errors of the estimated coefficients without any need for Monte Carlo simulations.

The 'local projections' method relies on estimating a series of k (fixed effects) regressions based on regression equation (1) introduced above; the regressions are then used to construct the effect of the 'openness shock' on the shock-dependent variable of interest by plotting the estimated openness shock coefficients β^k for each time period k (k=1, ..., k=8). Setting the time horizon at eight years ($k = 8$) allows for assessing the dynamic effect of the openness shock on the shock-dependent variable during the eight years following the shock.

Figure 1 shows the results of openness shocks in our sample of 26 EU countries. For illustration purposes, let us consider the response of the unemployment rate first. As pre-treatment control variables in the unemployment panel, we control for GDP growth and capital accumulation; we also include a lag in the shock-dependent variable as well as lags of the pre-treatment control variables, since it might be argued that these variables also have an effect on (future)

changes in the unemployment rate (see vector $Z_{i,t}$ in equation (1)). Details on pre-treatment controls for estimating the response of the unemployment rate and the other six variables to the openness shock are available in the supplementary appendix.

The local projections in Figure 1 are performed from year zero, with the first impact of the openness shock felt in the first year. The path of the local projection is then constructed to year eight, where Figure 1 shows the deviations from the levels in year zero (e.g. Jordà and Taylor (2016)). Grey areas indicate the confidence bands of the impulse response functions, calculated by using a one standard error band around the estimated coefficients. For all the estimations in Figure 1, we use the panel-corrected standard error estimator (PCSE). Beck and Katz (1995) argue that the OLS-PCSE estimator is well-suited for time-series cross-section models such as ours and allows us to avoid biased standard errors due to cross-section heteroskedasticity and autocorrelation in the residuals.

Unemployment falls slightly by about 0.2 percentage points in the first two years after the openness shock but then increases in response to rising openness (+1.2 percentage points in year 6), before the effects reverts back towards zero. Basically, the results of the openness shock on the GDP growth rate in our sample of 26 EU countries complement the unemployment results: GDP growth does not respond strongly within the first two years; but from year 2 to year 4, the response is markedly negative (-1.4 percentage points in year 4), before it reverts back to (above) zero over the next years. Hence, our results suggest that the increase in openness in 21st century Europe is associated with a relative reduction in economic activity, which emerges after an adjustment phase of two to four years.

Moreover, the impulse-response functions for our sample of 26 EU countries derived from the local projections in Figure 1 suggest the following. First, the dynamic effects of increasing openness on capital accumulation (as a measure for investment in the capital stock) are negative; i.e., on average, capital accumulation is pushed downwards by the openness shock. Second, the current account balance in % of GDP is pushed upwards by several percentage points within the first years before the response reverts back to zero. However, as noted above, this estimated increase in competitiveness did not consistently translate into more favorable macroeconomic conditions. Third, the response of public debt is basically indistinguishable from zero. Fourth, income inequality (measured in terms of changes in the Gini of disposable income) starts to increase in response to the openness shock in the medium-term. Fifth, the share of the financial sector in the gross output of all sectors does not change much in response to the openness shock if one considers that the corresponding standard errors make it difficult to judge whether the

effect is actually different from zero. Finally, exports to GDP are pushed upwards in the short-term (by about 1.4 percentage points in year 5), but the effect then declines. Notably, we have investigated the robustness of the results discussed here by using a different openness shock variable, namely the KOF economic globalization index (Gygli et al, 2018), which is a hybrid composite index that measures economic globalization along de facto (such as trade to GDP) and de jure criterions (such as hidden import barriers). While the KOF-variable has less of a clear-cut interpretation as compared to our dummy-approach, its main advantage is that it offers a discrete instead of binary measure of openness taking different facets of the latter into account. Against this backdrop, it is important to note that the results for the impulse-response functions are qualitatively similar for most parts of our sample, as can be verified in the supplementary appendix.

It is crucial to point out that the results presented so far portray the *average effect* of the openness shock variable on the respective shock-dependent variable. However, it should be expected that the effects actually vary markedly across different EU member countries. To understand whether the openness shock effects are uniform among member states, we can take a closer look at the country fixed effect estimates. Remember that we included country-fixed effects in regression equation (1) to control for country-specific characteristics (ζ_i^k).

In doing so, we exploit the fact that the country-fixed effects may be seen as a catch-all variable for country characteristics such as geography, size and, above all, institutions of the respective country (e.g. Wooldridge (2010)). In other words, similar country-fixed effects point to a similarity in underlying and unobserved country-characteristics, while a broad divergence between the estimated country-specific intercepts would suggest the presence of a sizeable amount of heterogeneity among the units of observation. Figure 2 plots the fixed-effects estimates as acquired in our local projection setup and shows that differences in fixed-effect estimates are large and increasing over the projection period. While the first outcome suggests that unobserved individual country characteristics matter for how countries are affected by openness shocks, the increasing variation in the estimated country fixed effects over time implies that the increase in openness coincided with an increase in structural diversity among the units of observation. In the next section, we will investigate whether a more in-depth analysis of the country-fixed effects points to similarities on how certain subgroups of European countries have been affected by openness shocks of European integration.

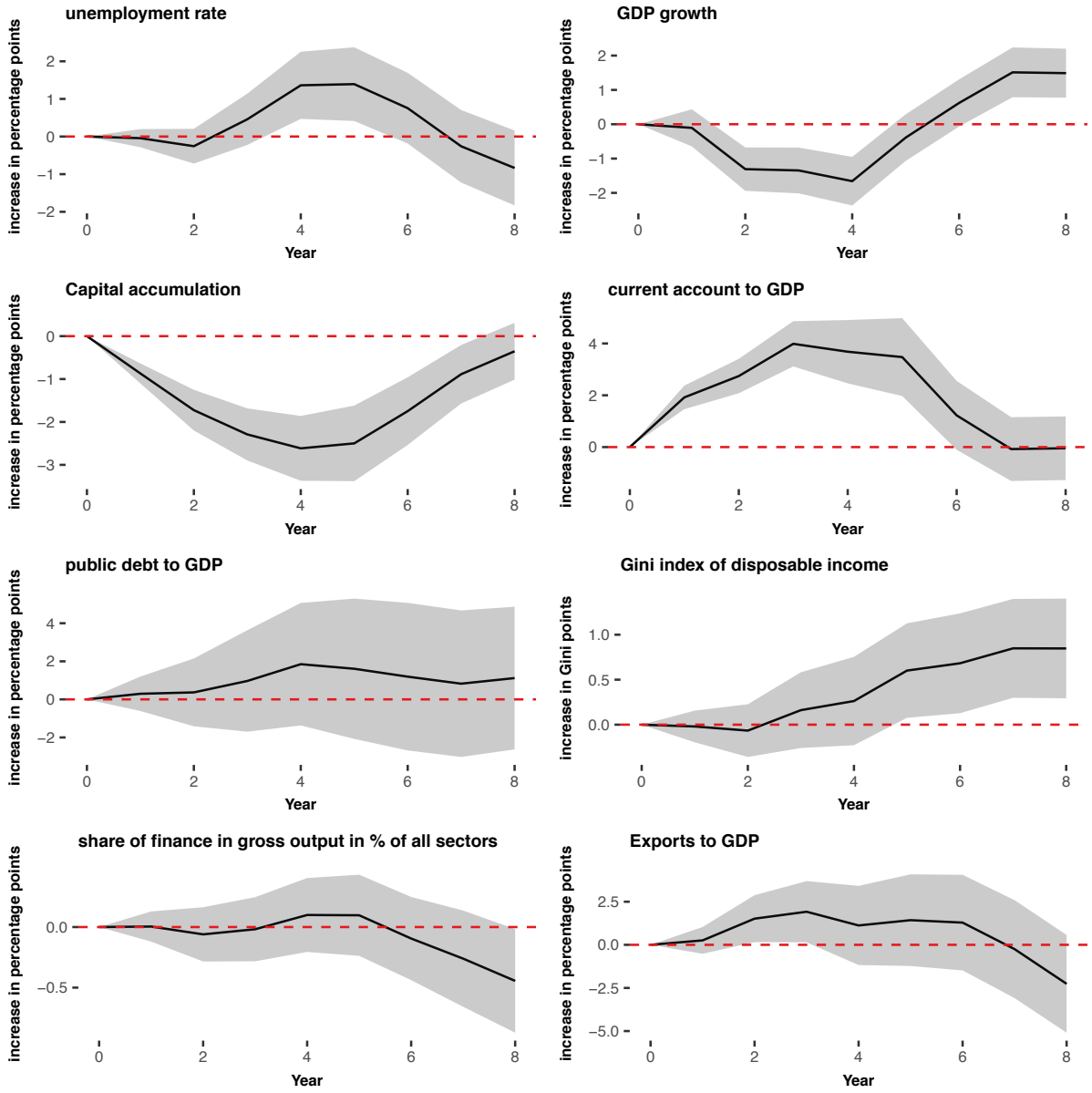

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Figure 1: The effect of openness shocks in a sample of 26 EU countries. Data: AMECO, KLEMS, SWIID, WID (see data appendix for details); own calculations. The country sample consists of 26 EU countries. Impulse-response functions were derived from local projections (see equation (1) and details on pre-treatment controls in the supplementary appendix). Standard errors are PCSE-corrected (Beck and Katz, 1995) and, hence, robust to cross-section heteroskedasticity and autocorrelation in the residuals.

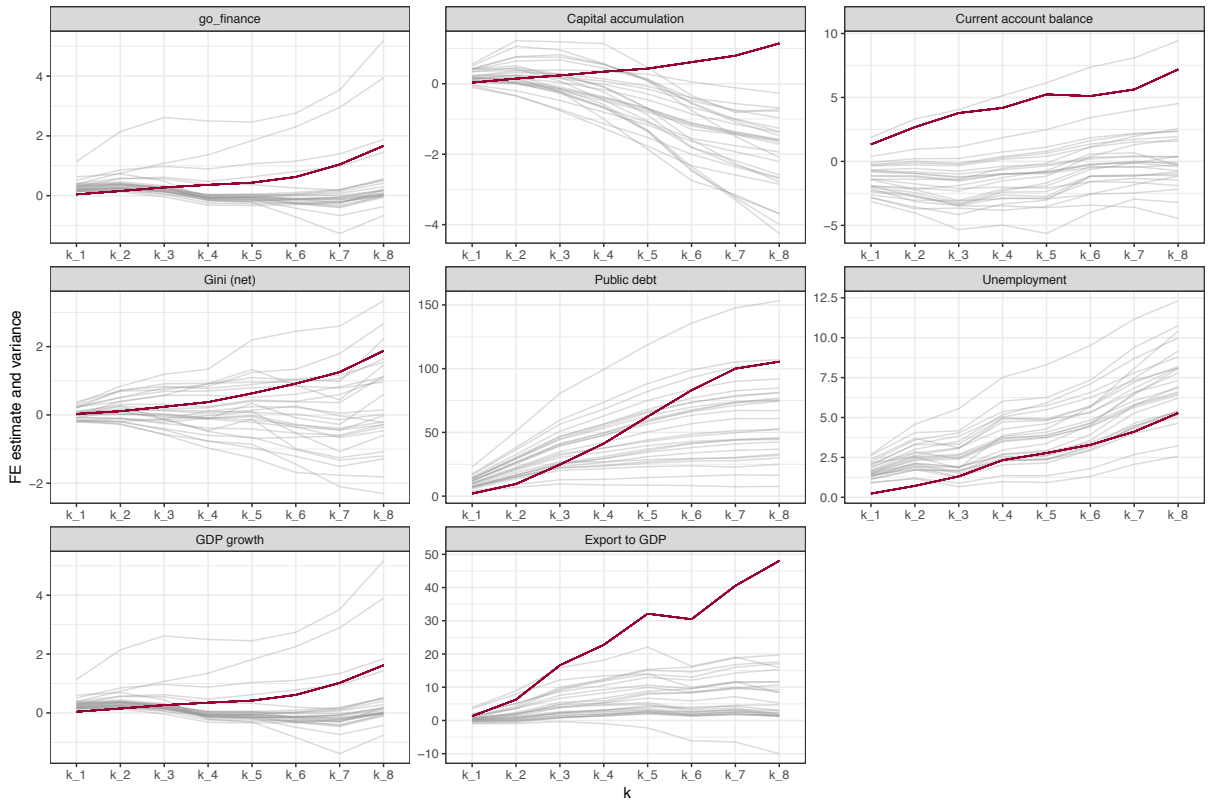

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Figure 2: The evolution of the estimated country fixed effects estimates over the local projections horizon (k=1, ..., k=8). The grey lines represent the obtained country fixed effects for each country. The read line illustrates how the heterogeneity of the estimates increases over time by representing the variance of the estimates. For the sake of visibility the variance of public debt estimates was divided by 10.

3 Openness shocks and path dependent developments in Europe: a typology for countries

The country fixed effects estimates from the previous section suggest that the increase in economic openness in Europe has amplified the structural differences among European economies due to the heterogeneous effect of openness on different countries. We now aim for gaining a clearer understanding of this observed heterogeneity. To this end, we start with an inductive approach and analyze the country fixed effect estimates obtained in the previous section by using a hierarchical cluster analysis. By doing so, we are able to identify sensible subgroups of the European countries in our data set. In a next step, we use sectoral export data to study structural change in European countries to broaden the debate on the link between economic development and technological capabilities. Finally, we enrich these more inductive approaches with theoretical considerations. This will help us to come up with a robust taxonomy of countries in the final part of this section.

3.1 Hierarchical clustering of country fixed effects

In order to identify potential clusters of countries that react similarly to increasing openness we analyze the country fixed effects obtained in the previous section by using hierarchical cluster analysis (HCA, (Tan et al, 2005, p. 515ff)). The general idea behind HCA is to separate a set of objects into disjunctive groups, called clusters, where members of the same cluster are similar to each other, but distinct to members of other clusters. In contrast to partitional clustering, hierarchical clustering produces a set of nested clusters that are organized as a tree, usually represented as a dendogram or a factor map (see figure 3 below), which also allow for analyzing the relation between clusters (see also Tan et al (2005, p. 526)).

Specifically, we apply Ward's minimum variance method (Ward, 1963) to the country-fixed effects estimates obtained in the previous section and cluster the countries.[2]

The results are presented in Figure 3. Obviously, two countries are very distinct from the rest: Luxembourg and Malta – which supports our intuition of separating financialized countries into a proper sub-group.[3] The remaining countries can be separated into four further groups. The cluster on the bottom consists of Austria, Denmark, Sweden, the Netherlands, Finland,

[2]We compared the performance of the most common clustering algorithms for our case and decided to use Ward's minimum variance method (Ward, 1963). All details and a sensitivity analysis are provided in the appendix.

[3]We thereby relate to the definition of Epstein (2005, p. 3) who sees 'financialization' as "the increasing role of financial motives, financial markets, financial actors, and financial institutions in the operation of the domestic and international economies." On financializaton, see also Hein et al (2008) and Palley (2013).

and Germany. These are the typical "core countries". The cluster on top, consisting of Spain, Cyprus, Portugal, Greece, Italy, France and Belgium corresponds — with the exception of Belgium – to the classic conception of a European periphery. The remaining two clusters correspond to the Eastern European catch-up countries. Interestingly, these countries are separated into two clusters, of which the smaller one consists of Romania, Latvia, and Bulgaria, while the other comprises all other eastern European countries as well as Ireland. This result is consistent with recent findings that highlight the presence of different sub-groups in the Eastern European countries (see e.g. Bohle (2017)), which exhibit different degrees and intensities in the overall catch-up process observable in Eastern Europe.

While the overall result of the HCE is surprisingly intuitive, the focus on the country fixed effects estimates as inputs for the clustering seems to understate important differences with regard to the policies followed by the countries. For example, both Ireland and the Netherlands are financialized countries (e.g. Karwowski et al (2017); European Central Bank (2016); Schwan (2017)), which have followed an extremely liberal and finance-friendly policy geared towards attracting foreign capital and the associated rents and profits from other European countries. As we shall argue below, this (and the high degree of financialization that greatly exceeds the level of other countries) justifies putting them into the cluster of financialized countries.

In summary, although hierarchical clustering is a purely inductive way of analyzing data that does not exploit theoretical insights other than that involved in variable selection, the results are largely consistent with many classifications used in the previous literature. Nevertheless, the need for further considerations in understanding the core differences across country groups is also evidenced by these findings. This will be the focus of the next two subsections.

3.2 Structural change and the sectoral development of nations

While the previous sections of the paper focused primarily on macroeconomic indicators, we now broaden our argument by supplying additional evidence on the issue of macroeconomic convergence vs. divergence. We do so by analyzing the sectoral development of European economies as it relates to international competitiveness and technological capabilities. Thereby, we construct a measure for assessing the direction of technological change relative to the rest of the world since the onset of the Eurozone on the basis of data on trade and economic complexity.

In particular, we compare trade volumes of all countries on the SITC-V2 4-digit product level over the two time periods 1995-1999 (pre-Eurozone and pre-crisis) and 2010-2014 (post-Eurozone and post -crisis) to assess the changes in a country's export basket. For each country we regress

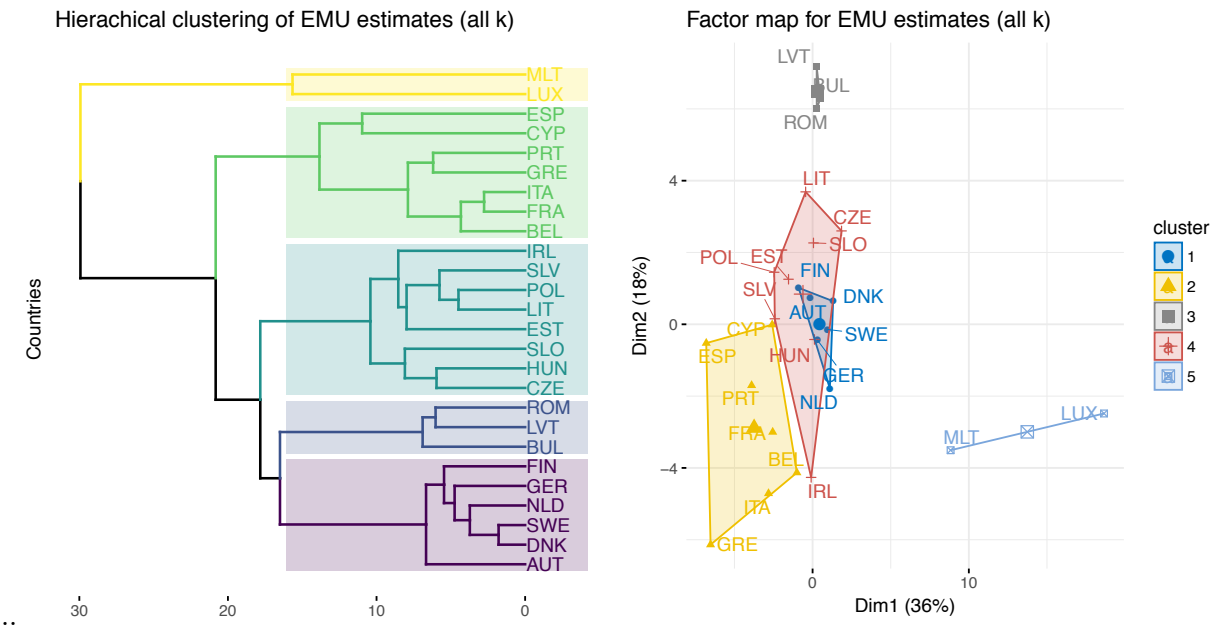


Figure 3: The resulting clusters of countries. Panel (a) illustrates the entire result using a dendogram, panel (b) illustrates how close the countries are to each other by using a factor plot, which only considers the two most distinguishing dimensions, which together account for about 61.7 % of total distance.

the average product complexity on the log of the positive and negative difference in the value of exports, and weight the observations according to the share of the product in the country's export basket in 2012-2014. By doing so, we can understand within a given country whether export values change more drastically for more complex products (or vice versa). The weights ensure that we pay more attention to products that have more recently played an important role in the country's exports.

Define P_c^+ as the set of products for which country c has increased its exports in 2010-2014 as compared to 1995-1999 and $\phi_{c,i} = 1$ if $i \in P_c^+$ and zero otherwise. We then estimate the following two equations for each country:

$$\log\left(\sum_{t=2010}^{2014} \phi_{c,i}\pi_{c,i,t} - \sum_{t=1995}^{1999} \phi_{c,i}\pi_{c,i,t}\right) = \beta_c^+ \bar{PCI}_{c,i} + \epsilon_{c,i} \quad \forall i \in P_c^+ \tag{2}$$

and

$$\log\left(\sum_{t=1995}^{1999} (1-\phi_{c,i})\pi_{c,i,t} - \sum_{t=2010}^{2014} (1-\phi_{c,i})\pi_{c,i,t}\right) = \beta_c^- \bar{PCI}_{c,i} + \epsilon_{c,i} \quad \forall i \notin P_c^+ \tag{3}$$

In both equations $\pi_{c,i,t}$ is the total export of product i by country c in period $t \in (\{1995, ..., 1999\}, \{2010, ..., 2014\})$, and $\bar{PCI}_{c,i} = \sum_t \left[\frac{\pi_{c,i,t}}{\sum_t \pi_{c,i,t}} PCI_{i,t}\right]$ where $PCI_{i,t}$ is the product complexity of product i in year t as defined by Atlas of Economic Complexity (2018). The weights $\omega_{c,i}$ for the WLS estimation are given by $\omega_{c,i} = \frac{\sum_t \pi_{c,i,t}}{\sum_i \sum_t \pi_{c,i,t}}$, i.e. the share of product i in the country's export basket in 2012-2014. This way, we obtain two estimates for each

country, $\hat{\beta}_c^+$ and $\hat{\beta}_c^-$, one for the products for which the country has increased it's export value, and one for the remaining products.

By calculating a weighted average of these two coefficients, one arrives at a final estimate for the direction of technological change in the countries under investigation. To this end define

$$\gamma_c^+ = \sum_{t=2010}^{2014} \phi_{c,i}\pi_{c,i,t} - \sum_{t=1995}^{1999} \phi_{c,i}\pi_{c,i,t} \tag{4}$$

as the sum of increases in exports of country c and

$$\gamma_c^- = \sum_{t=1995}^{1999} (1-\phi_{c,i})\pi_{c,i,t} - \sum_{t=2010}^{2014} (1-\phi_{c,i})\pi_{c,i,t} \tag{5}$$

as the sum of all the absolute values of the losses in exports of country c. Then the final estimate for the direction of technological change in country c is defined as follows:

$$\theta_c = \frac{\gamma_c^+}{\gamma_c^+ + \gamma_c^-}\hat{\beta}_c^+ + \frac{\gamma_c^-}{\gamma_c^+ + \gamma_c^-}\hat{\beta}_c^- \tag{6}$$

A $\theta_c > 0$ indicates a relative increase in exports of more complex products for this country and vice versa. In other words, if $\theta_c > 0$, more complex products become relatively more important for this country's export-basket. Figure 4 provides an illustration of the results. It shows the respective regression lines as well as the composition of the underlying data for the cases of Greece and Germany with regard to expanding products (i.e. $i \in P_c^+$). It indicates that greater expansions of exports in Germany (right panel) are associated with increasing technological complexity, while greater expansion of exports in Greece (left panel) are associated with a decreasing technological complexity, partially driven by a reversal towards being a producer of primary inputs (such as refined oil).

Although our results do not always show such clear trends as in the examples given in Figure 4 (for details see the appendix), in sum they point to a clear pattern of the sectoral developments across Europe from the perspective of international competitiveness: we find that higher levels of overall complexity before the onset of the Eurozone (in 1999) are, on average, associated with stronger gains of complexity measured in terms of the expansion and decline of individual sectors for the larger part of the observed countries (Figure 5, upper panel). While this result is broadly consistent with the Kaldorian prediction that "success breeds success" (Kaldor, 1980), a more nuanced interpretation of this overall quadratic relationship is given in the lower panel of figure 5: although the catching-up of Eastern Europe has an imprint on overall developments, patterns

Figure 4: The directedness of technological change in Greece and Germany. While export expansions in Germany are positively correlates with product complexity, the inverse holds for Greece. The size and color of the points represent the average share of the products in the countries' export basket in 2012-2014. The regression line stems from the WLS estimation as described above. Dashed lines illustrate the estimation errors. Data: Atlas of Economic Complexity (2018) in its 12-2017 version (see data appendix for details); own calculations.

consistent with Kaldorian effects can be identified within the Eastern European countries, where they are rather pronounced, as well as (with a weaker intensity) among all the remaining EU countries. Thereby, large parts of the variety in the results for the Eastern European catch-up economies seem to be moderated by its closeness to Europe's industrial core (Stöllinger, 2016).

The patterns of technological change as depicted in Figure 5 also allow us to emphasize four further observations. First, there is still considerable heterogeneity within the typically proposed country-groups: core countries differ in their development mirroring the fact that some of these countries struggle to hold on to their position, while others, mostly Germany, have managed to expand their technological dominance (e.g. Storm and Naastepad (2015a)). In fact, Germany is the only example of the core countries that finds itself above the value predicted by a quadratic model fitted to the data. Second, the upper panel of Figure 5 shows that we currently cannot find a single periphery country with a decidedly positive technological development: of all periphery countries only Portugal manages to surpass the predicted value, albeit this country starts from a very low level of complexity. Third, we find that most of the Eastern catch-up countries are located above, while only two catch-up economies below the predicted value. This indicates that the economic catch-up process of Eastern European countries is not necessarily tied to a technological catch-up process, as evidenced most forcefully by the outliers Bulgaria and Lithuania. Fourth, the heterogeneity among financialized countries is particularly large, but can be explained by their different financialization strategies: Ireland's

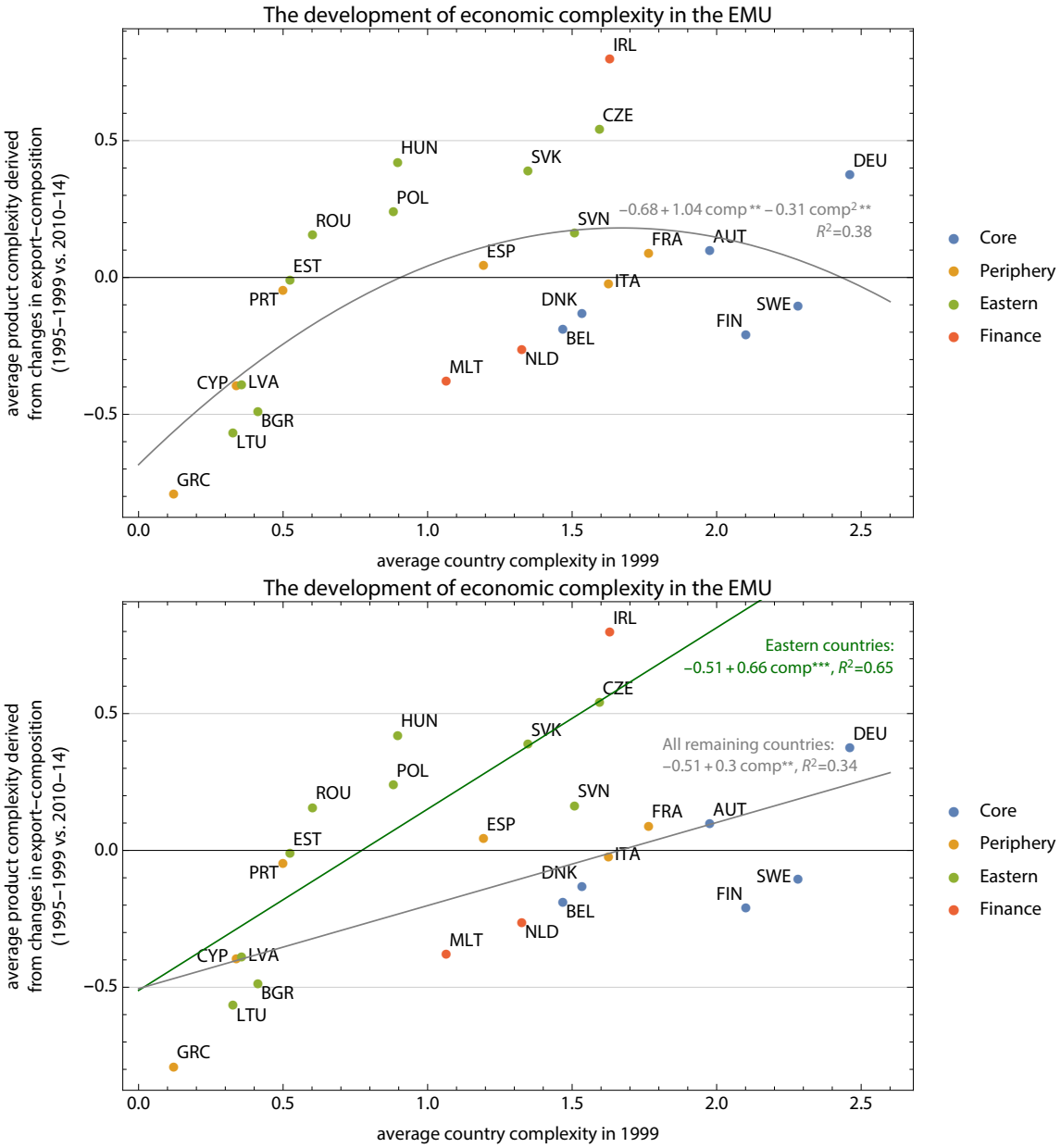


Figure 5: Technological capabilities and structural change. Data: Eurostat; Atlas of Economic Complexity (2018) in its 12-2017 version; own calculations.

role of a corporate tax haven manifests itself in a massive technological upgrading (e.g. Regan and Brazys (2018)), while the more asset-based strategies of the Netherlands and Malta are associated with a tendency for deindustrialization (e.g. Visser et al (2016)).

As international competitiveness and technological capabilities are of prime importance for assessing the future developmental trajectories within given political and institutional constraints (Hidalgo and Hausmann, 2009; Cristelli et al, 2015), it is important to note that we cannot observe convergence in terms of technological capabilities in the current European framework. Quite on the contrary, our results point to the possibility that some countries in Eastern Europe will indeed manage to slowly catch-up to the core (like the Czech Republic, Hungary or Slovakia), while others (like Bulgaria or the Baltic countries) are much more likely to join the

European periphery (Stöllinger, 2016).

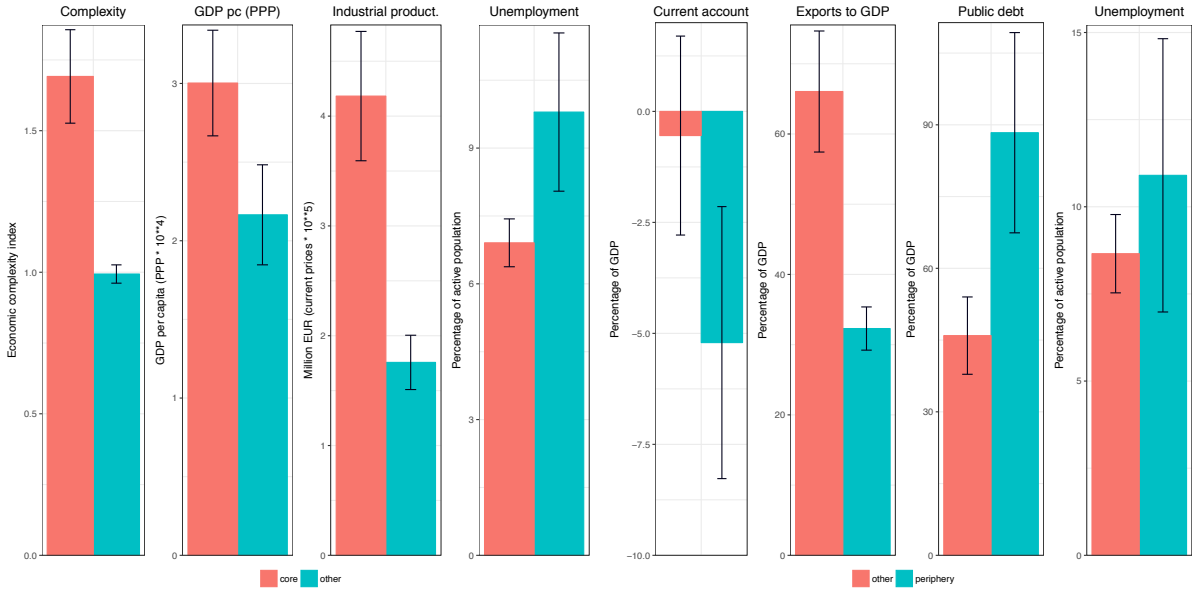
3.3 A country taxonomy for the EU: Illuminating clusters with descriptive statistics

Previous taxonomies usually focused on particular subsets of the Eurozone member countries. The most common distinction is that of a European core, and a European periphery (e.g. Simonazzi et al (2013); Iversen et al (2016)). Since they are difficult to accommodate in this dichotomous classification, the Eastern European countries are usually treated as a third category, if they are considered at all (Bohle, 2017).

Here, we go beyond such a dichotomy and suggest categorizing the European Union's members into four categories: First, the core countries, which we consider to be Austria, Belgium, Denmark, Finland, Germany and Sweden, are usually associated with high standards of living and a modern, competitive production sector. This classification is reflected in the data in Figure 6a, which depicts the mean of several relevant variables for the time period 2000-2015: core countries are characterized by relatively high levels of GDP per capita (measured in PPP), by low unemployment rates (in comparison to other European countries) and by a strong manufacturing sector that is able to produce and export particularly complex products.

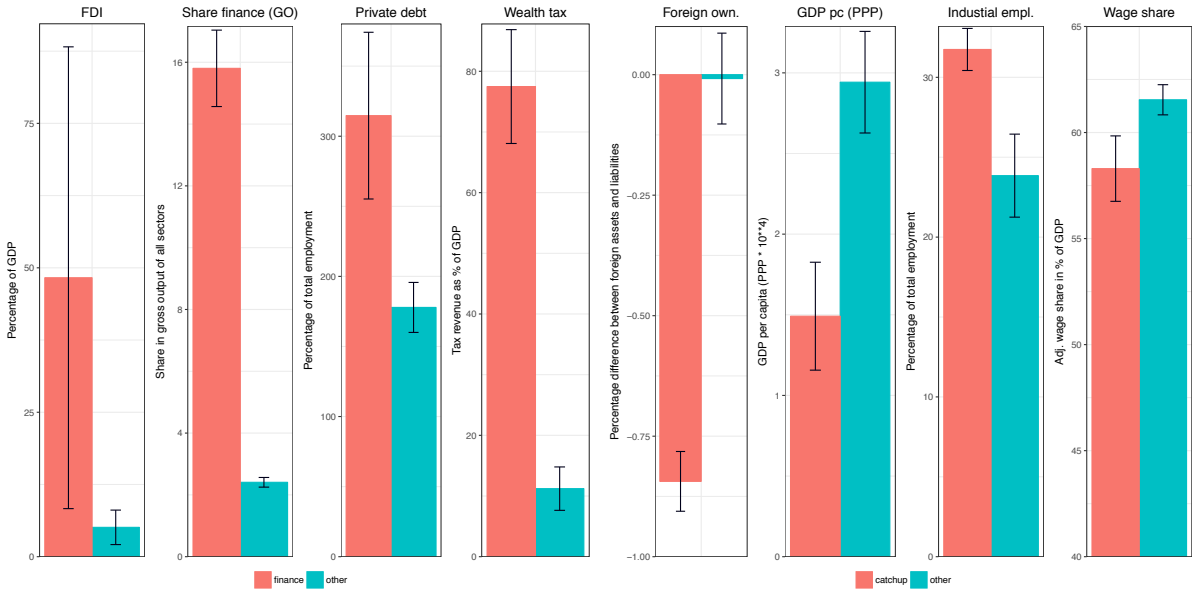
Second, the periphery countries, which we consider to be Greece, Italy, Portugal, France, Spain and Cyprus, are usually said to have a large pool of firms that are less competitive than firms in other countries, higher unemployment rates and especially burdensome levels of debt. These properties are also manifest in the data as periphery countries are coined by pronounced current account deficits, a relatively low export share, relatively high levels of public debt and a comparatively high unemployment rate (see figure 6b).

Third, the Eastern European countries are often termed catch-up countries, and consist of Bulgaria, Romania, Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland, Slovenia and Slovakia. While they still enjoy lower levels of income, they are — at least some of them – catching up in terms of productive capabilities. This catch-up process is, however, accompanied by relatively lower levels of wages and employment standards. Furthermore, the Eastern countries are characterized by large capital inflows. In the data, we see a weak foreign ownership position of the Eastern countries (captured in a negative difference between foreign assets and foreign liabilities of more than 75%). The catch-up economies' GDP per capita levels and their wage share are relatively low (on average). In contrast, their share of the industry sector in terms of employment is large in comparison to the other countries in our data set (see figure 6d).



(a) Core countries compared to the rest.

(b) Periphery countries compared to the rest.



(c) Financialized countries and the rest.

(d) Catch-up countries and the rest.

Figure 6: A comparison of our four country groups with the rest of our sample. The averages refer to the period 2000-2015 and are unweighted. In the appendix, we show the population-weighted data, which do not differ markedly. Whiskers indicate the variation of the variables over time and correspond to the temporal mean +/- one standard deviation.

Category	Distinguishing characteristics	Members
Core	High GDP per capita levels Importance of industrial production Production of complex products Relatively low unemployment	Austria, Belgium, Denmark, Finland, Germany and Sweden
Periphery	Lower export shares Relatively high public debt Tendency to current account deficits Relatively high unemployment	Cyprus, France, Greece, Italy, Portugal, and Spain
Catch-Up	Relatively low levels of wages and GDP per capita Negligible stock of foreign assets and liabilities Small service sector, but important manufacturing sector	Bulgaria, Romania, Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland, Slovenia, Slovakia
Finance	High debt levels of private firms Important share of finance in terms of gross output High foreign investment inflows Large incomes from wealth taxes	Luxembourg, Netherlands, Malta, and Ireland

Table 1: Country taxonomy for 26 EU countries. Own illustration.

Finally, we suggest including Luxembourg, the Netherlands, Malta, and Ireland in a separate category of financialized countries. These countries are characterized by a degree of financialization that greatly exceeds the level of others (e.g. Karwowski et al (2017); Schwan (2017)), and they follow a very particular policy paradigm geared towards attracting foreign capital and the associated rents and profits. The overall size of the financial sector in Luxembourg, the Netherlands, Malta and Ireland is markedly larger than in other euro area countries, and non-bank financial institutions account for a disproportionate share of the overall financial sector (see chart 2 in European Central Bank (2016), p. 8). In our data, we can see a disproportionate amount of foreign investments in the data for the financialized countries as well as high levels of private sector debt, an exceptional share of the finance sector in terms of gross output and relatively large incomes derived from the taxation of wealth (see figure 6c).

Table 1 summarizes our country groups. Comparing our taxonomy with the results of the cluster analysis suggests that neither the results of the cluster analysis nor the taxonomy we have discussed here are accidental. To the contrary: their similarity indicates that certain structural mechanisms lead to path dependencies that require the attention of anybody interested in counteracting polarization patterns in the EU.

4 The accentuation of polarization through openness shocks

On the basis of the taxonomy of countries developed in the previous section, we proceed by further corroborating our intuition that the four country groups — core, periphery, financialized and Eastern catch-up economies — respond differently to openness shocks. In order to estimate the dynamic response of eight key variables to an impulse of increasing openness due to European integration, we again make use of the econometric framework introduced in section 2: we estimate impulse-response functions derived from local projections (Jordà, 2005) based on regression equation (1), but this time we do it separately for each of the four country groups.

Figure 7 shows the dynamic effects of the openness shock variable on our four main shock-dependent variables (with four additional variables covered in Figure 8).[4] The first column is based on the subsample for the six EU core countries; the second column for the six EU periphery countries; the third column for the four financialized countries; and the fourth column for the ten Eastern European catch-up countries (see the taxonomy in table 1 for details on the country groups).

We find that, on average, unemployment rates in the four country groups have responded differently to the openness shock of European integration. While the response of unemployment in the core subgroup is basically indistinguishable from zero, unemployment has been strongly pushed upwards in the Southern periphery (by more than 3 percentage points in the medium-term). And while the particular developmental model in the financialized countries has allowed their economies to respond with a slight decline in the unemployment rate in the years after the openness shock, the Eastern European countries have, on average, seen a decrease in the unemployment rates in the first two years after the shock, followed by a medium-term increase in unemployment that only dissipates several years after the shock. The results for GDP growth basically correspond to the results regarding unemployment: we do not see much of an effect in the core and in the financialized countries, but there is clearly a negative response in the periphery, and a phased response in Eastern Europe (dynamic effect sequence of decrease, increase, decrease over time). The openness shock variable has clearly pushed capital accumulation down in the periphery, without much of a change in the financialized countries. Furthermore, Figure

[4] Note that while the standard errors in Figure 1 are panel-corrected standard errors (Beck and Katz, 1995) and, hence, robust to heteroskedasticity and autocorrelation in the residuals, we have not been able to perform the same adjustment for the country subgroups in Figures 7 and 8. The reason is that the PCSE-correction requires that the number of years covered is not too much larger than the number of countries in the cross-sectional dimension of the data. When we subset the full country sample into our four groups, however, this requirement is not fulfilled anymore, because the number of countries in the regressions drops markedly. As a consequence, the gray standard error bands depicted in Figures 7 and 8 might be too small, i.e. we might somewhat underestimate the degree of uncertainty around the point estimates in the impulse-response function.

7 shows that openness shocks, on average, have slightly worsened the current account balance in the EU periphery. For the EU core, the effect slightly points into the direction of an improvement in the current account balance (although the standard error band is substantial). In the financialized countries, the current account has strongly been pushed upwards. In the Eastern European countries, the current account tends to improve over the first years after the openness shock before it deteriorates.

From Figure 8, we can see the response of four additional variables to an impulse of increasing openness. We again find pronounced differences in the dynamic effects across our four country groups: while public debt goes down in response to the shock in the financialized countries and does not change markedly in the Eastern European countries, it increases strongly in the core but even more so in the periphery countries, with the effect increasing over time. Income inequality (measured in terms of changes in the Gini index of disposable income) does not respond vigorously in the core countries: it increases most in the financialized countries, but we also find positive responses over time in the periphery and in the Eastern catch-up economies, although the standard error bands suggest that there is substantial uncertainty around the estimates. In terms of the effect of openness on the share of the financial sector in gross output, we find that there is an upward pushing response in the periphery and in the financialized countries (although the effect reverts to below zero after several years in the latter group); in the core the average effect on the size of finance is less pronounced, while the share of the financial sector even goes down in the Eastern European countries. Finally, in terms of the effect of increasing openness on exports to GDP, we find that the average response of the core and of the periphery group is difficult to distinguish from zero. For the Eastern European countries, the response is on the positive side, while the financialized countries tend to see a strong boost in exports to GDP in the short-term, followed by a reversal in the years to follow. It should be mentioned that, such as in section 2, we have again checked the robustness of the results discussed here by using the KOF economic globalization index (Gygli et al, 2018) as an alternative openness shock variable. Grosso modo, the results for the impulse-response functions of the four country groups are qualitatively similar (see the supplementary appendix).

Summing up, the four country groups on which we elaborate in this paper have all responded in a distinct way to openness shocks. The results suggest that the complex dynamics of macroeconomic convergence vs. divergence and structural polarization in Europe can only be understood if one takes into account how the response of these country groups to increasing trade and financial openness has shaped their developmental paths. In fact, European (monetary) integration

should be seen as an evolutionary process that has given rise to path-dependency. Notably, the results discussed in this section portray the average response of the relevant shock-dependent variable to the openness shock variable in the respective country group. In other words: while the analysis in this paper has shown that there are strong reasons for distinguishing core, periphery, financialized and Eastern European economies in order to understand developmental trajectories in Europe, it is still important not to overlook that although member countries of a particular group share important features, the experiences of the individual members within those country groups have not been completely homogenous. For example, Bohle (2017) points to differences in the growth regimes and configurations of Eastern European capitalisms, as she distinguishes between a dependent export-driven regime in the Visegrad countries and a dependent debt-driven regime in the Baltic States. Similarly, one could argue that within the group of core countries, Germany – with its superior (non-price) competitiveness and strong export sector, its size and political power – is of particular relevance for understanding complex developmental trajectories (e.g. Simonazzi et al (2013)) or that the experiences of the Southern periphery countries have not been the exactly the same (e.g. Storm and Naastepad (2015c)). Nonetheless, our results in this paper suggest that important insights into the complexity of path dependent trajectories in Europe can be gained by distinguishing country clusters with distinctive features that separate them from other country groups. In the next section, we will elaborate on the policy implications of this finding.

5 Implications for European policy and institutions

The observed polarization in Europe provides a rationale to reconsider current economic policies. We argue that our typology of country groups allows for developing an integrated set of policy conclusions that might help in moving towards a political compromise and macroeconomic convergence. We proceed by, first, discussing existing EU-level initiatives and the recent academic literature on the role of the state in engineering sustainable policies. Second, we propose a coordinated policy strategy across the four country groups based on the results of the previous sections.

Current EU-level initiatives can be found in the Europe 2020 strategy approved in 2010 (European Commission, 2010). Its goals include making European economies more knowledge and innovation intensive, and to render them more sustainable in environmental and social matters. In order to reach these targets, the Commission has focused on a horizontal industrial policy approach by proposing commonly shared development aims and by trying to ensure framework

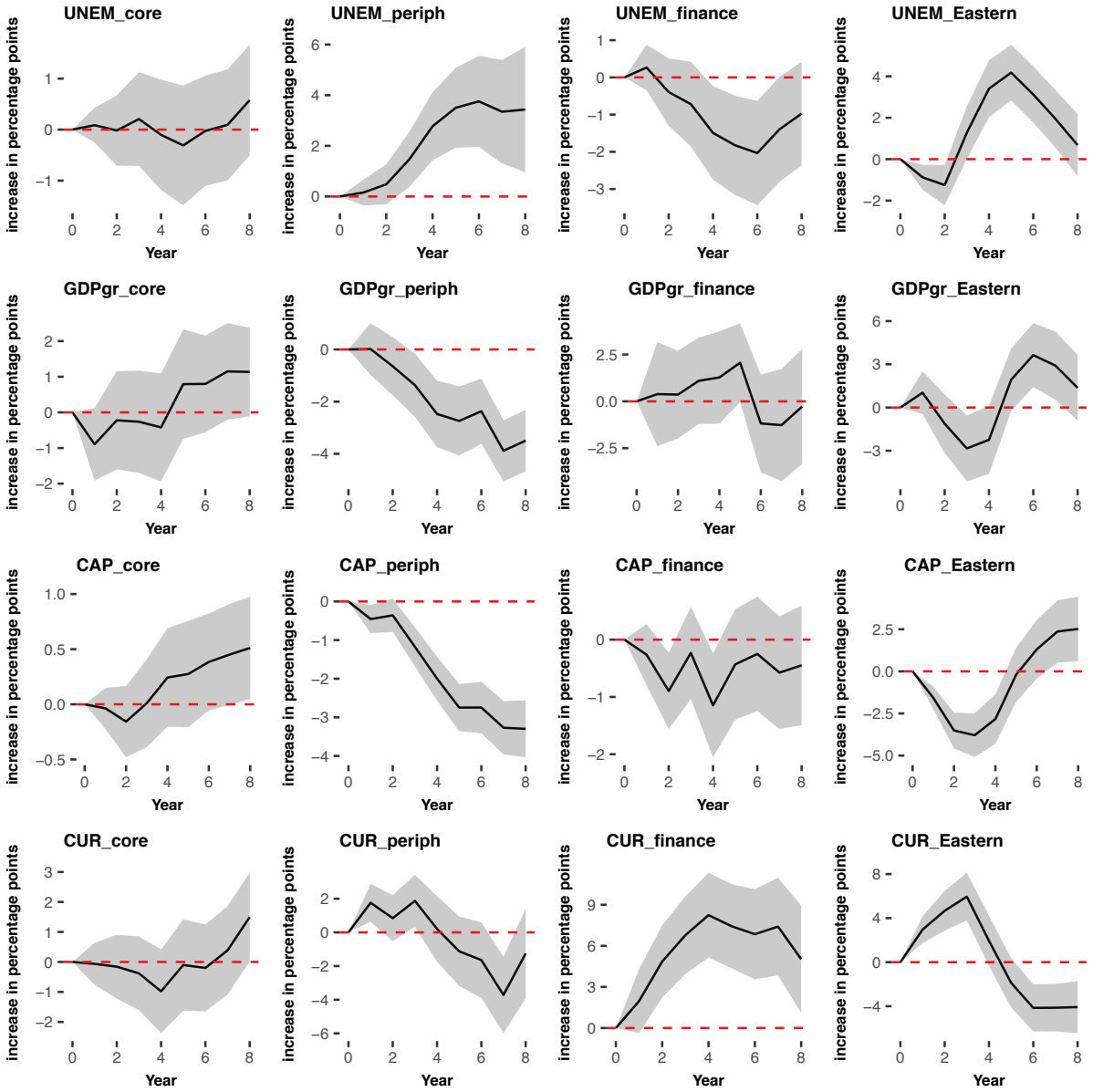


Figure 7: Response of four key variables to openness shocks. Data: AMECO, KLEMS, SWIID, WID (see data appendix for details); own calculations. The country sample consists of 26 EU countries. Impulse-response functions were derived from local projections (see equation (1) and details on pre-treatment controls in the supplementary appendix). Variables: UNEM: unemployment rate; GDPgr: GDP growth; CUR: current account to GDP; CAP: capital accumulation. _all26 in column 1 refers to estimations for all 26 EU countries in our sample; _core in column 2 refers to the subgroup of six core countries; _periph in column 3 refers to the subgroup of six periphery countries. _finance in column 4 refers to the subgroup of four financialized countries: _Eastern in column 5 refers to the subgroup of ten Eastern European countries. See table 1 for the exact taxonomy of countries.

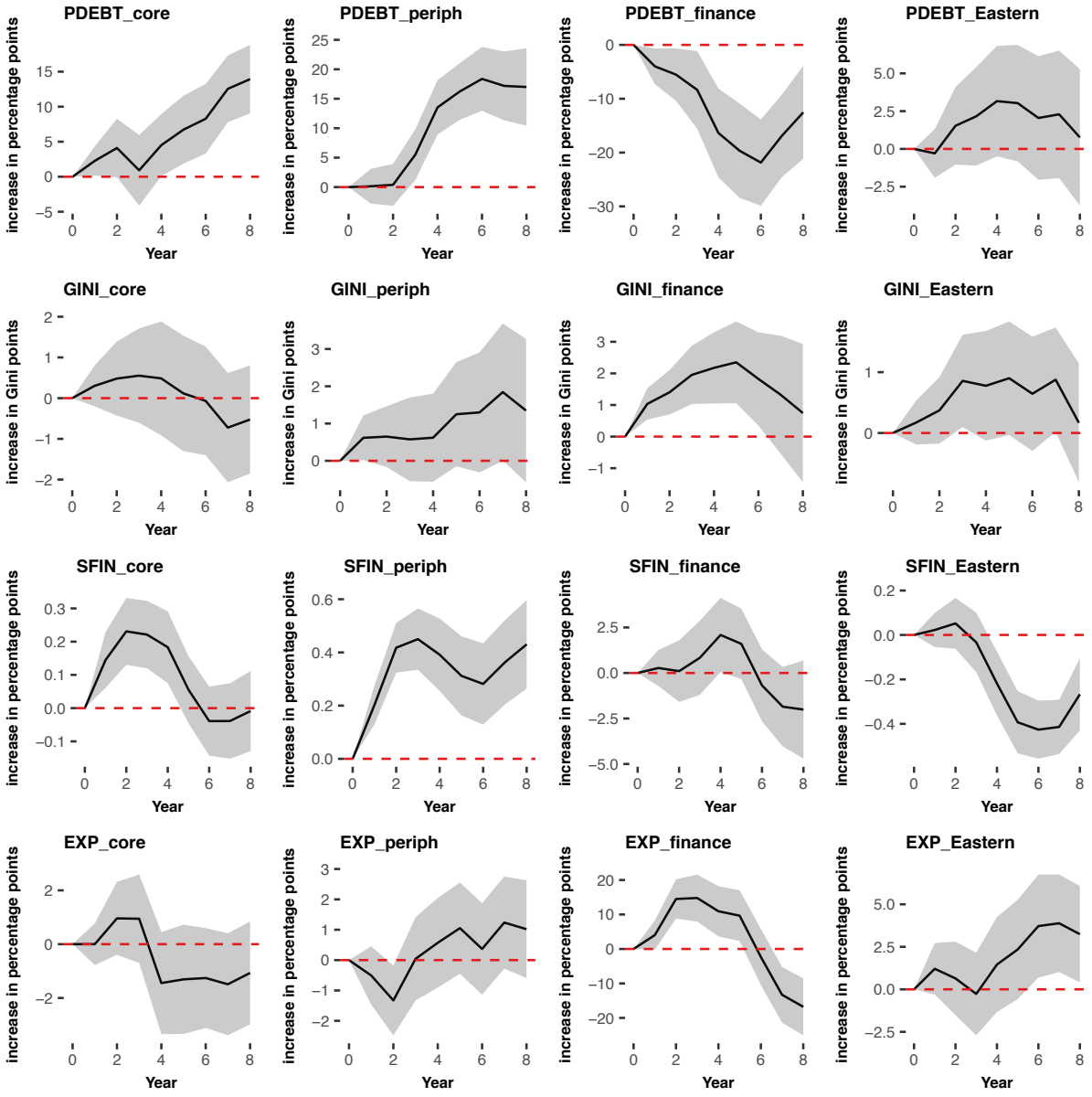


Figure 8: Response of four key variables to openness shocks. Data: AMECO, KLEMS, SWIID, WID (see data appendix for details); own calculations. The country sample consists of 26 EU countries. Impulse-response functions were derived from local projections (see equation (1) and details on pre-treatment controls in the supplementary appendix). Variables: PDEBT: public debt to GDP; GINI: Gini index of disposable income; SFIN: share of financial sector in gross output of all sectors (in %); EXP: Exports to GDP. _all26 in column 1 refers to estimations for all 26 EU countries in our sample; _core in column 2 refers to the subgroup of six core countries; _periph in column 3 refers to the subgroup of six periphery countries. _finance in column 4 refers to the subgroup of four financialized countries: _Eastern in column 5 refers to the subgroup of ten Eastern European countries. See table 1 for the exact taxonomy of countries.

conditions that are favorable to industrial competitiveness, as opposed to a more targeted (vertical) industrial policy anchored in the consideration of national specificities and targets specific sectors and firms (Pianta, 2015; Peneder, 2017). Another policy initiative concerned with industrial policy was launched in 2014 and is referred to as the Industrial Compact (European Commission, 2014). It is mainly concerned with reviving industrial activities in Europe and shows some similarity to the Europe 2020 strategy (Pianta, 2015). Furthermore, the Commission President Jean-Claude Juncker came up with the so-called Investment Plan for Europe later in 2014. It set up the European Fund for Strategic Investment (EFSI), which consists of funds both from the EU and the European Investment Bank. The aim of the fund is to provide finance to private initiatives and thereby to mobilize a multiple of private sector funds. As of December 2017, €51 billion of funding were approved, to which €257 billion private funds were related (European Commission, 2017).

Recently, several authors have questioned the current practice of industrial policy at the EU-level, calling for a more targeted industrial policy, where the public sector takes an active stance in developing key industries and technologies. Cimoli et al (2015) point to the fact that none of the leading economic powers managed to develop without using some form of industry protection as well as direct and indirect subsidies (see also Chang (2003)). These policies are necessary for a convergence process since "endogenous market mechanisms tend to behave in a 'virtuous' manner for those countries that happen to be on the frontier" (Cimoli et al, 2015, p. 128) but not for those falling behind. This phenomenon is due to path dependency, as "future capabilities build upon, refine and modify incumbent ones." (Cimoli et al, 2015, p. 128) The aim of government policies therefore should be to support "good path dependencies" as opposed to leaving it to the 'free market'. They stress, however, that such policies must be accompanied by measures to contain inertia and rent-seeking within protected industries.

Mazzucato (2015) emphasizes that one must question the idea of government intervention being justified only in case of existing market failure. Major technologies of our time (e.g. the Internet, smart phones, wind and solar power) are based on publicly funded innovations and drew on various types of public financial support during their development. Mazzucato (2015, p. 122) emphasizes that policy makers should focus on "understanding how particular directions and routes can be chosen and determining how to mobilize and manage activities that can lead to the achievement of dynamic social and technological challenges." She also emphasizes the importance of the public sector receiving a fair share of the returns in those cases when it takes such an active approach. Possibilities to assure the latter are income-contingent loans and grants

(repayment will be required if profits exceed a certain threshold) as well as the state retaining equity in the companies that it supports (Mazzucato, 2013, 2015).

Pianta (2015) argues that in the context of a globalized economy such a targeted industrial policy can only be executed at the European level, since individual countries are too small to do that effectively. The corresponding funds should come from EU-wide sources to reduce pressure on national budgets. The most viable way according to Pianta (2015) would be the emission of European Investment Bank bonds that could then be bought by the ECB. Another possibility would be the emission of Eurobonds, where the proceeds would be used to finance EU-wide industrial policy or to establish a new European Public Investment Bank that can borrow funds directly from the ECB. Finally, additional funds can be obtained through a European tax reform that includes an EU-wide tax on corporations. This step would come with the benefit of eradicating ongoing tax competition among EU members. Other possibilities consist in a financial transaction tax or a European wealth tax (e.g. DGB (2012)). In order to fight ongoing polarization processes, Pianta (2015) suggests that the majority of these funds should go to activities in the periphery countries, where at least half of it should go to the poorer regions of these countries. What remains should go to the poorer regions of the core countries.

In line with these propositions for alternative economic policies from the existing literature, our results also suggest a targeted approach to industrial policy. Figure 9 summarizes our policy proposals. Specifically, in light of the increasing polarization, it will be necessary to enhance economic capabilities in the European periphery and to increase non-price competitiveness in these countries. This will involve substantial public sector investment, which should be seen as a European project. A public investment strategy would not only modernize and diversify existing economic structures; it would also provide the necessary demand stimulus to lift major parts of Europe out of stagnation. Such an initiative could be financed through additional revenues or through external financing. While the former could consist of a European corporate tax or a European wealth tax, the latter might come from the European Investment Bank or the ECB. In exchange, the expansion of balance sheets in the periphery's banking sector needs to be constrained to avoid future doom-loops between bank risks and sovereign risks that push up public debt (e.g.Beck (2012)).

Making Europe more equitable must involve a continuation of the catch-up process in Eastern European countries in terms of living standards, which involves assuring that wages grow faster than in the rest of Europe and labour standards be adjusted to the higher levels prevalent in other European countries. Yet, convergence policies would not only increase living standards,

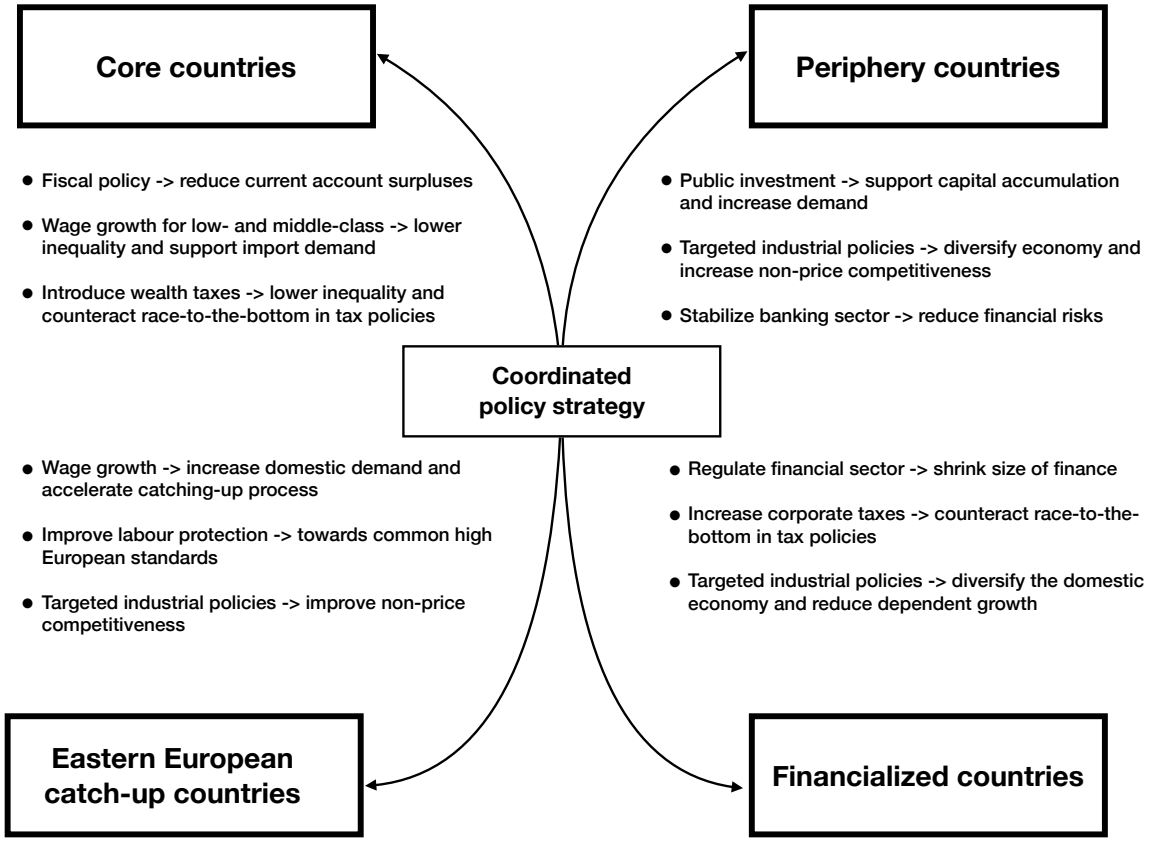


Figure 9: Coordinated policy strategy for supporting convergence and stability in Europe. Own illustration.

but also provide a stimulus to aggregate demand and reduce inner-European tensions related to migration and job displacement. In order to make sure that the respective countries retain and further improve their competitiveness, such a policy has to be accompanied by targeted (vertical) industrial policies along the lines described above.

The core countries (especially Germany) have been running significant current account surpluses for several years (e.g.Gräbner et al (2017)). This means that they possess considerable resources to improve the social cohesion of their societies by reducing unemployment and tackling social inequality through policies that tend to support the domestic economy and reduce the current account. One of these policies consists of increased spending on public infrastructure in order to create more equality of opportunity while at the same time reducing unemployment by adding to aggregate demand. Another possibility is to pursue policies that lead to higher wage growth for the low- and middle-class (e.g. by minimum wage laws, wage bargaining and labor union legislation).

Finally, in terms of moving towards more sustainability in Europe, we argue in favor of a re-regulation of the financial sector in the financialized country group. Here, the goal must be to shrink and restrict the financial sector in order to effectively dampen the impact of destabilizing speculation, tax evasion and the relocation of assets. Moreover, particularly low corporate taxes in the financialized countries (which attract corporate profits through tax incentives) make it clear that a European initiative leading to a substantial increase in the corporate tax rate is required to counteract the existing race-to-the-bottom in regulatory standards. Increasing corporate (as well as wealth and inheritance) taxes would also provide the public sector with the necessary resources to pursue targeted industrial and social policies.

6 Conclusions

This paper has analyzed the effects of increasing economic and financial openness on macroeconomic performance in the context of European integration. Within a data set of 26 EU countries, we have shown that country-specific characteristics have to be accounted for in order to understand how openness shocks have shaped path dependent developmental trajectories. Our results suggest that the focus on a dichotomy of core and periphery countries in the existing literature (e.g. Storm and Naastepad (2015c); Iversen et al (2016); Johnston and Regan (2016)) might fall short of explaining the nuances of current developmental trajectories in Europe. Indeed, we find that a taxonomy consisting of core, periphery, financialized and Eastern European catch-up economies is more suitable when it comes to understanding the evolutionary process that

has been triggered by European integration — a process that has given rise to different path-dependent trajectories, partly by shaping new paths and opportunities, partly by reinforcing pre-existing tendencies. By using sectoral export data to study structural change, we illustrate that Europe is currently characterized by non-convergence in terms of technological capabilities, which are of prime importance for prospects of future economic development (e.g. Hidalgo and Hausmann (2009); Dosi et al (2015)). In light of the goal of achieving convergence and stability in Europe's future, we have provided a discussion of a coordinated policy strategy that would allow for counteracting current polarization tendencies. On the policy front, the taxonomy of four country groups drawn from our analysis — consisting of core, periphery, financialized and Eastern-European catch-up economies — arguably also proves useful in terms of thinking systematically about what needs to be done to avoid further European disintegration.

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Supplementary appendix to the paper:

„Structural change in times of increasing openness: assessing path dependency in European economic integration"

In this appendix, we provide additional information that we could not include in the paper due to the word limit imposed. We will first explain the macroeconomic data under study as well as where and how we obtained these data. Second, we will provide additional information on our openness shock dummy variable. Third, we will supply a table that includes all (pre-treatment) control variables used for constructing the impulse-response functions from local projections in sections 2 and 4 of the paper. Fourth, we provide robustness results to sections 2 and 4 by using an alternative openness shock variable. Fifth, we provide some additional outputs related to the clustering analysis in section 3 of the paper. Sixth, we explain the data sources and background of the sectoral trade data approach in section 3.2 of the paper. Finally, we provide a robustness check on the country group data used in section 3.3 by using population-weighted averages.

1. Data

Sections 2 and 4 provide results (impulse-response functions derived from local projections) for eight shock-dependent variables. Based on the data, we calculated (future) changes in the respective variable (see regression equation (1) in section 2). In section 3.2 we use trade and complexity data to identify the direction of technological change. The following table lists these variables and their sources.

Table: Data used in the regressions in sections 2, 3 and 4

Sections 2 and 4 (local projections)		
Variable	**Unit**	**Data source**
Unemployment rate	In % of active population	AMECO
GDP growth	Yearly growth rate	AMECO; own calculations
Current account balance	In % of GDP	AMECO
Capital accumulation	real gross fixed capital formation/real net capital stock *100	AMECO; own calculations
Public debt	In % of GDP	AMECO
Gini (income inequality)	Index (ranging from 0 to 100)	Standardized World Income Inequality Database v5.1
Share of financial sector in gross output	In % of all sectors	EU KLEMS
Exports to GDP	In % of GDP	World Bank (WDI)
Section 3.2 (direction of technological change)		
Export value	Export value in US dollars (current prices), product classification according to SITC-V2 on the 4-digit level.	"The Atlas of Economic Complexity," CID at Harvard University
Export share	In % of total exports or the country under study in this year	"The Atlas of Economic Complexity," CID at Harvard University

The data were obtained for 26 EU countries: Bulgaria, Romania, Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland, Slovenia, Slovakia, Belgium, Denmark, Germany, Austria, Sweden, Finland, Greece, Spain, France, Italy, Portugal, Cyprus, Ireland, Luxembourg, Malta, Netherlands.

The full time period of the dataset ranges from 1960 to 2016. The panel data, however, are unbalanced. Although the eight shock-dependent variables shown above were available for all 26 EU countries, the data coverage in the time dimension varies.

As an additional control variable, we use a proxy for boom-bust patterns in housing (HBOOM). The HBOOM variable is defined as the deviation of the ratio of employment in the construction sector to total employment in all domestic industries from its mean (*100). The data were obtained from AMECO (own calculations).

Table A1 shows the summary statistics for the variables that we use for the local projections (time period 1960-2016; 26 EU countries):

Statistic	N	Mean	St. Dev.	Min	Max
Capital_accumulation	1,053	8.636	2.881	2.598	31.991
Current_account_balance_to_GDP	1,111	−0.688	5.614	−28.016	25.095
GDP_growth	1,109	2.855	3.749	−32.100	26.276
Gini_net	897	27.028	4.758	12.787	37.820
HBOOM	964	0.286	1.337	−4.080	5.304
Public_debt_to_GDP	637	54.251	32.621	3.664	179.732
Unemployment_rate	1,102	7.207	4.622	1.400	27.500
exp_to_gdp	1,131	45.200	29.437	7.712	227.113

Table A1: Summary statistics of macroeconomic data-series under study

2. Openness shock variable

Our openness shock variable (used for the estimations in sections 2 and 4) focuses on exogenous changes in institutional aspects of European economic integration: as Eurozone countries share a common currency and relevant institutions (e.g. De Grauwe 2012), we construct a dummy variable that represents entering the Eurozone as an openness shock; i.e., the dummy variable is set to 1 from the year onwards when the respective country entered the Eurozone. For EU countries that are currently not part of the Eurozone, we use a more intricate procedure to determine from which year onwards we set the openness shock dummy to one: we look at the year when the country entered the EU, obtain information whether and since when their currency is pegged to the Euro and study descriptive statistics of other openness indicators (such as Trade/GDP) as a plausibility check on when to set the openness shock dummy to 1.

Here, we show from which year onwards we have set the openness shock dummy to 1 for the respective country in our data set:

Setting the openness shock dummy from year X onwards to 1

Country	**Openness shock from year … onwards**	**Due to…**
Austria	1999	Eurozone entry
Belgium	1999	EZ entry
Bulgaria	2007	EU entry
Cyprus	2004	EU entry
Czech Republic	2004	EU entry
Denmark	1999	National currency pegged to Euro + descriptives of other openness indicators
Estonia	2004	EU entry
Finland	1999	Eurozone entry
France	1999	Eurozone entry
Germany	1999	Eurozone entry
Greece	2001	Eurozone entry
Hungary	2004	EU entry
Ireland	1999	Eurozone entry
Italy	1999	Eurozone entry
Latvia	2004	EU entry
Lithuania	2004	EU entry
Luxembourg	1999	Eurozone entry
Malta	2004	EU entry
Netherlands	1999	Eurozone entry
Poland	2004	EU entry
Portugal	1999	Eurozone entry
Romania	2007	EU entry
Slovakia	2004	EU entry
Slovenia	2004	EU entry
Spain	1999	Eurozone entry
Sweden	1995	EU entry

Table A2: Timing and justification of openness shock dummy

3. Estimating impulse-response functions derived from local projections

The following table provides a list of pre-treatment controls that we included in the regressions (see vector $\boldsymbol{Z_{i,t}}$ on regression equation (1) in section 2). The choice of the pre-treatment control was based on two criteria: First, which variables might – from a theoretical perspective – also in impact the shock-dependent variable? Second, is the variable available over a reasonably long time period for all 26 EU countries? The second criterion is important since we cannot drop any country from the estimations in section 2. Otherwise, we would not obtain country fixed effects estimates for all 26 EU countries, which we need for the empirical exercises in sections 3 and 4.

Shock-dependent variable	Pre-treatment controls
Unemployment rate	GDP growth, capital accumulation
GDP growth	HBOOM
Current account balance	Unemployment rate
Capital accumulation	Unemployment rate
Public debt	Capital accumulation
Gini (income inequality)	Unemployment rate, GDP growth
Share of financial sector	Capital accumulation, HBOOM
Exports to GDP	Unemployment rate

Table A3: Pre-treatment controls included in the regressions on which the impulse-response functions in sections 2 and 4 are based

Note that we also include one lag in the shock-dependent variable as well as lags of all the pre-treatment control variables.

4. Robustness checks: Using an alternative openness shock variable

A large literature deals with the question on how to measure exogenous changes in trade and financial openness. As already explained, the baseline results presented in sections 2 and 4 are based on a dummy variable that captures exogenous changes in the institutions of countries (in terms of entering the Eurozone/the EU) as an openness shock. Here, we provide a robustness check by using the KOF economic globalization index, which is a hybrid composite index that measures economic globalization along de facto measures (such as trade to GDP) and de jure measures (such as hidden import barriers). The interpretation for the results is that as the globalization index increases by 1 percentage point, the shock-dependent variables changes by an amount as represented by respective y-variable label. The results are qualitatively similar to the findings presented in the paper in section 2.

Note that we restricted the time dimension for this robustness check to the period 1990-2014. We do so because we do not want to capture the change in the KOF economic openness index from the 1960s to 1980s, since our openness shock dummy also refers to increasing openness from the 1990s onwards (see Table A.2). Another advantage of this restriction is that the whole period of European integration (of the Eastern European countries) after the fall of the Soviet Union as well as the pre-crisis period of the Eurozone countries is captured in terms of changes in economic globalization.

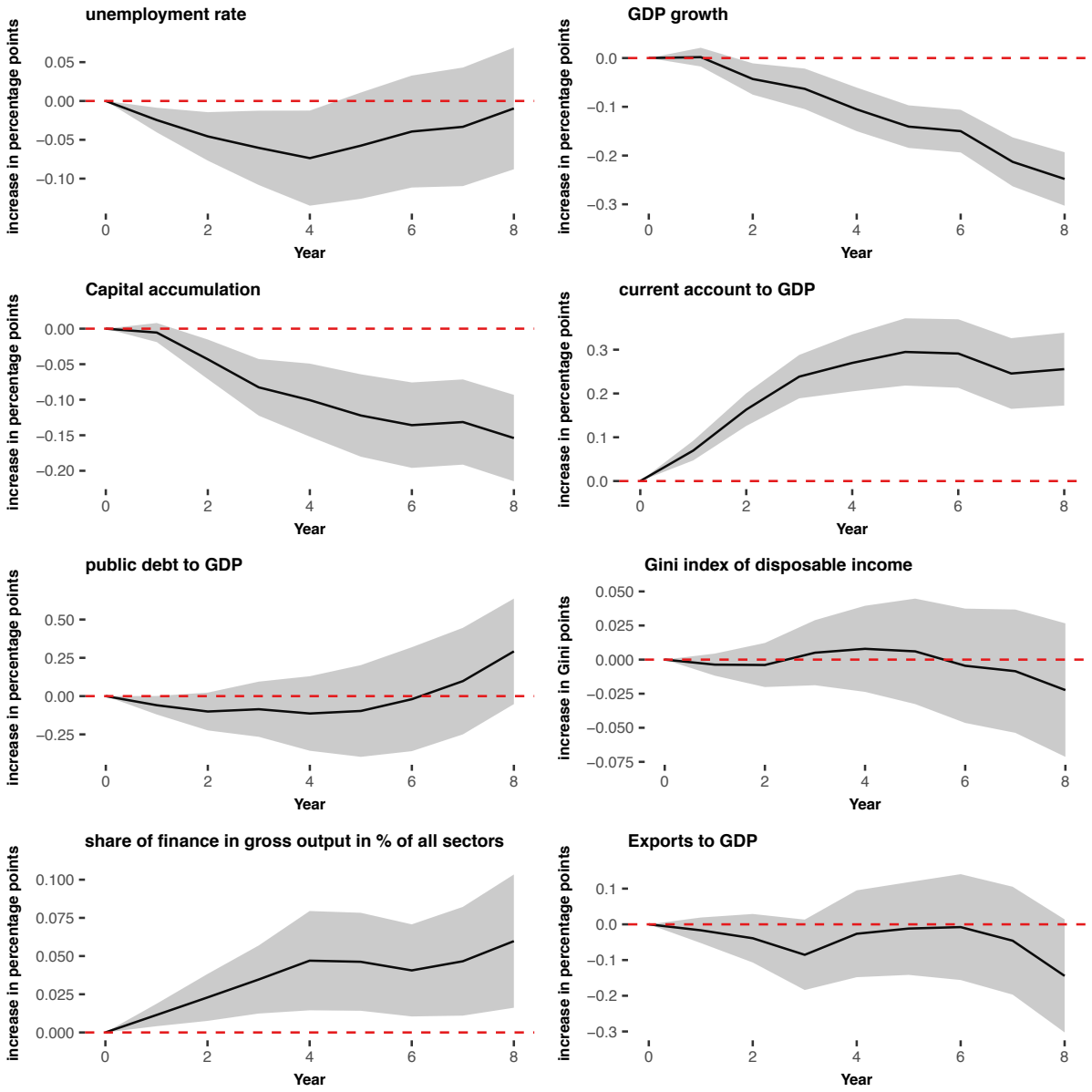

Figure A1: Robustness check for Figure 1 in the paper

Figure A1 is showing a reproduction of our baseline specifications using the KOF globalization index instead of the dummy variable as the openness shock variable. For the underlying econometric approach, see section 2 (in particular regression equation (1)). The country sample consists of 26 EU countries. Impulse-response functions were derived from local projections (see equation (1) and details on pre-treatment controls in the supplementary appendix). Standard errors are PCSE-corrected (Beck and Katz 1995) and, hence, robust to cross-section heteroskedasticity and autocorrelation in the residuals.

Here, we also provide robustness checks for Figure 7 in section 4 of the paper, as we again substitute the dummy shock variable with the KOF index for economic globalization. For most variables, the results of the robustness check are qualitatively similar.

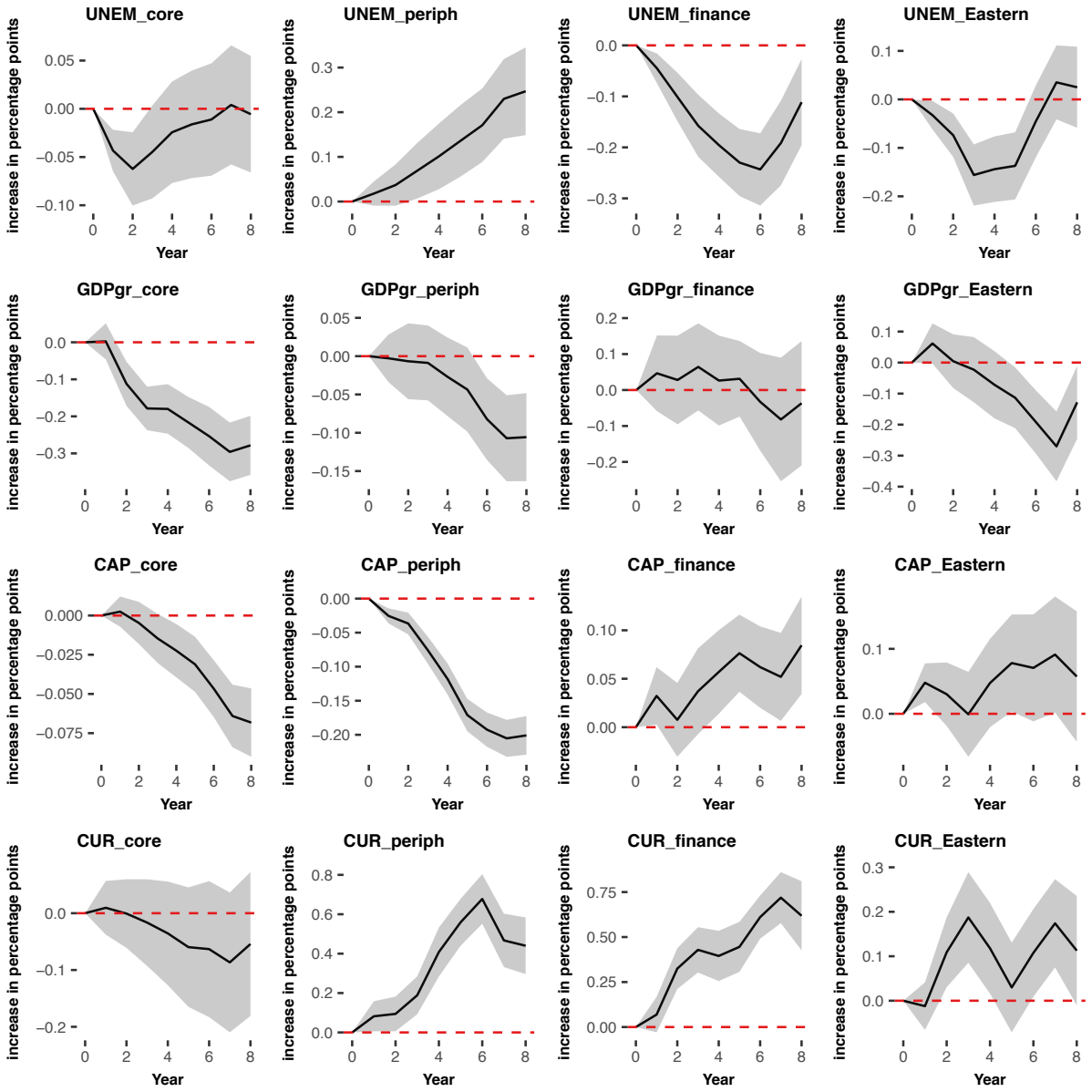

Figure A2: Robustness check for Figure 7 in the paper

Figure A2 is showing a reproduction of the specifications applied in section 4 using the KOF globalization index instead of the dummy variable as the openness shock variable. For the underlying econometric approach, see section 2 (in particular regression equation (1)). The country sample consists of 26 EU countries. Impulse-response functions were derived from local projections (see equation (1) and details on pre-treatment controls in the supplementary appendix). Standard errors are PCSE-corrected (Beck and Katz 1995) and, hence, robust to cross-section heteroskedasticity and autocorrelation in the residuals.

Finally, we provide robustness checks for Figure 8 in section 4, again by using the KOF globalization index as the openness shock variable. For most variables, the results are qualitatively similar.

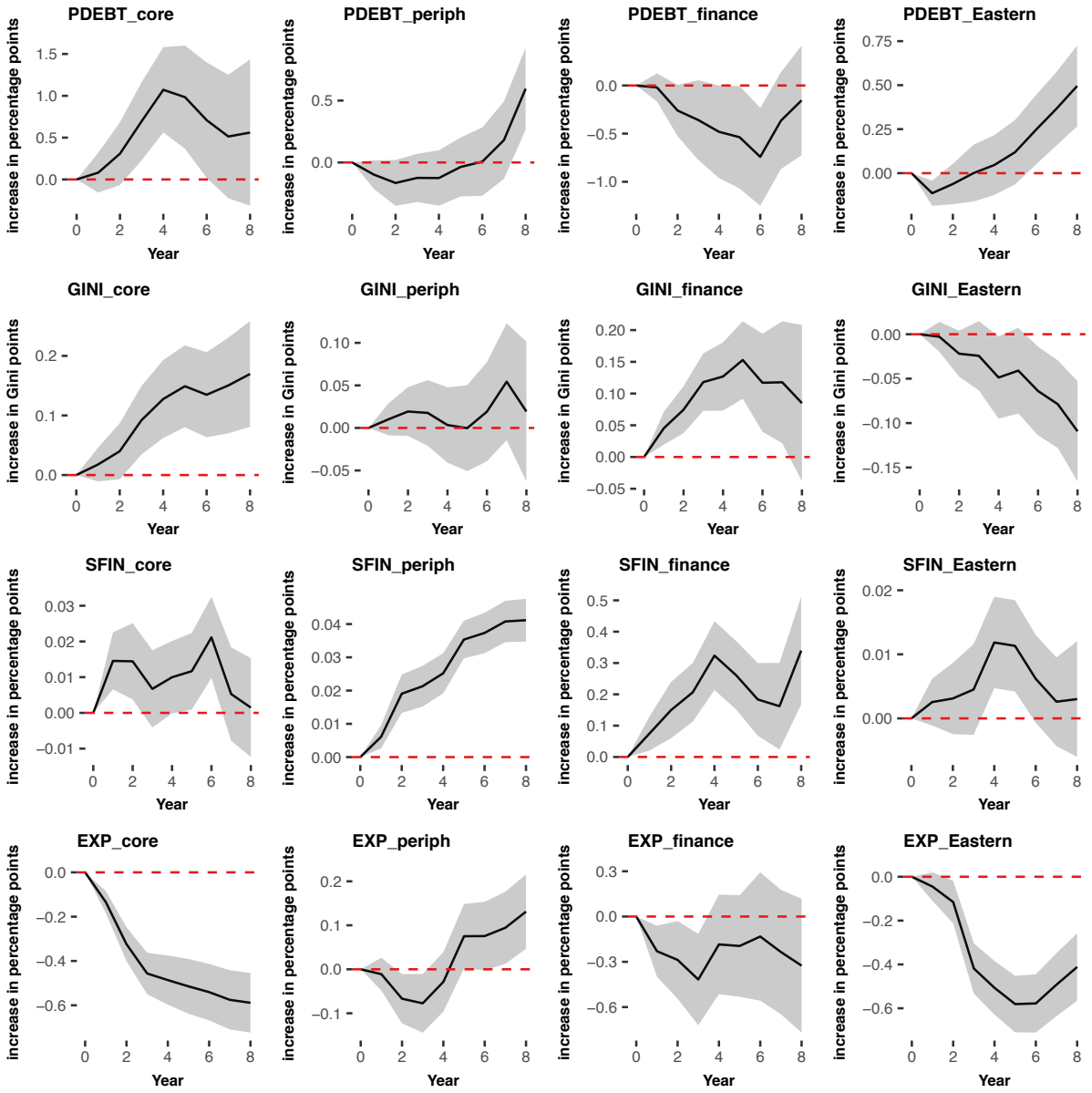

Figure A3: Robustness check for Figure 8 in the paper

5. Details on the clustering analysis in section 3.1

We compared the performance of the most common clustering algorithms for our case and decided to use Ward's minimum variance method. The agglomerative coefficient of our clustering, which has a value of 0.78, is a satisfactory value suggesting reliable results.

	type	dif_coef
1	agnes_ward	0.78
2	agnes_complete	0.75
3	diana_divisive	0.72
4	agnes_average	0.70
5	agnes_single	0.64

Table A4: Agglomeration coefficients for different clustering algorithms

In Figure 3 of the paper, we clustered countries based on the complete set of fixed effect estimates to exploit all the information we can get from the local projection estimations in section 2. One might, however, also argue that we should only use the country FE estimates for the first period after the shock, i.e. k=1. Here we provide the relevant clustering results, which underscore the robustness of the results presented in section 3.1, as they point to qualitatively similar conclusions.

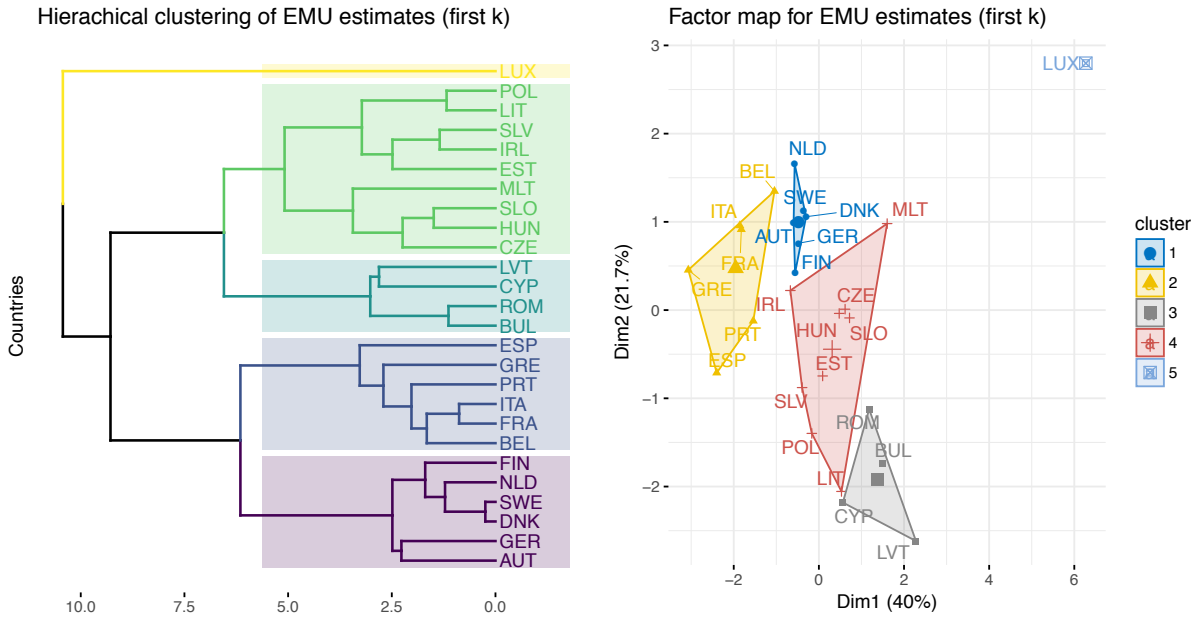

Figure A4: Alternative clustering results

6. Structural change: Using sectoral data

In section 3.2 of the paper, we regress the average product complexity on the log of the positive and negative difference in the value of exports, and weight the observations according to the share of the product in the country's export basket in 2012-2014. We only showed the results for two countries (Germany and Greece; see Figure 4). Here, we provide the results for the other EU countries in our sample. The results do not always show such clear trends as for Greece and Germany. In sum, however, they point to a clear pattern of the sectoral developments across Europe from the perspective of international competitiveness: higher levels of overall complexity before the onset of the Eurozone are, on average, associated with stronger gains of complexity measured in terms of expanding products. This finding points to an increasing polarization in terms of the underlying sectoral composition of individual economies. We present four plots, which include the individual members of the respective country group in our taxonomy.

Core countries

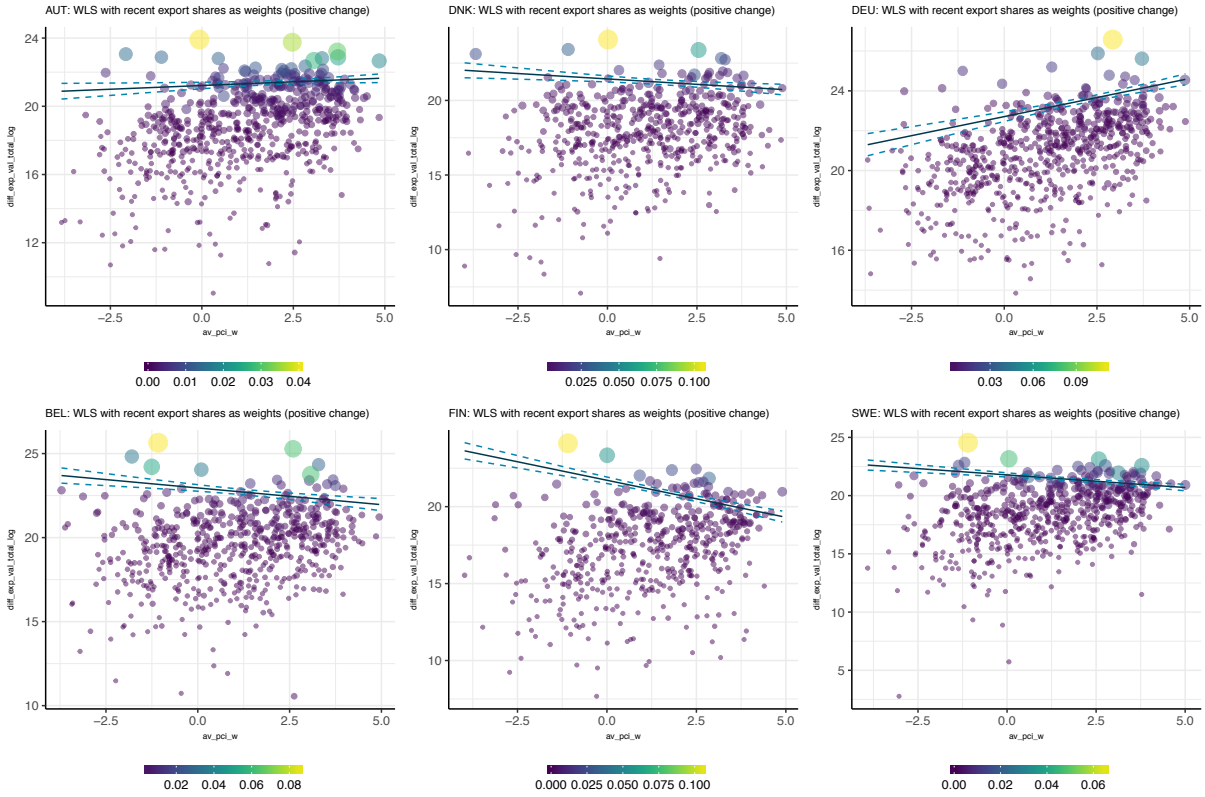

Figure A5: Sectoral development of core countries

Periphery countries

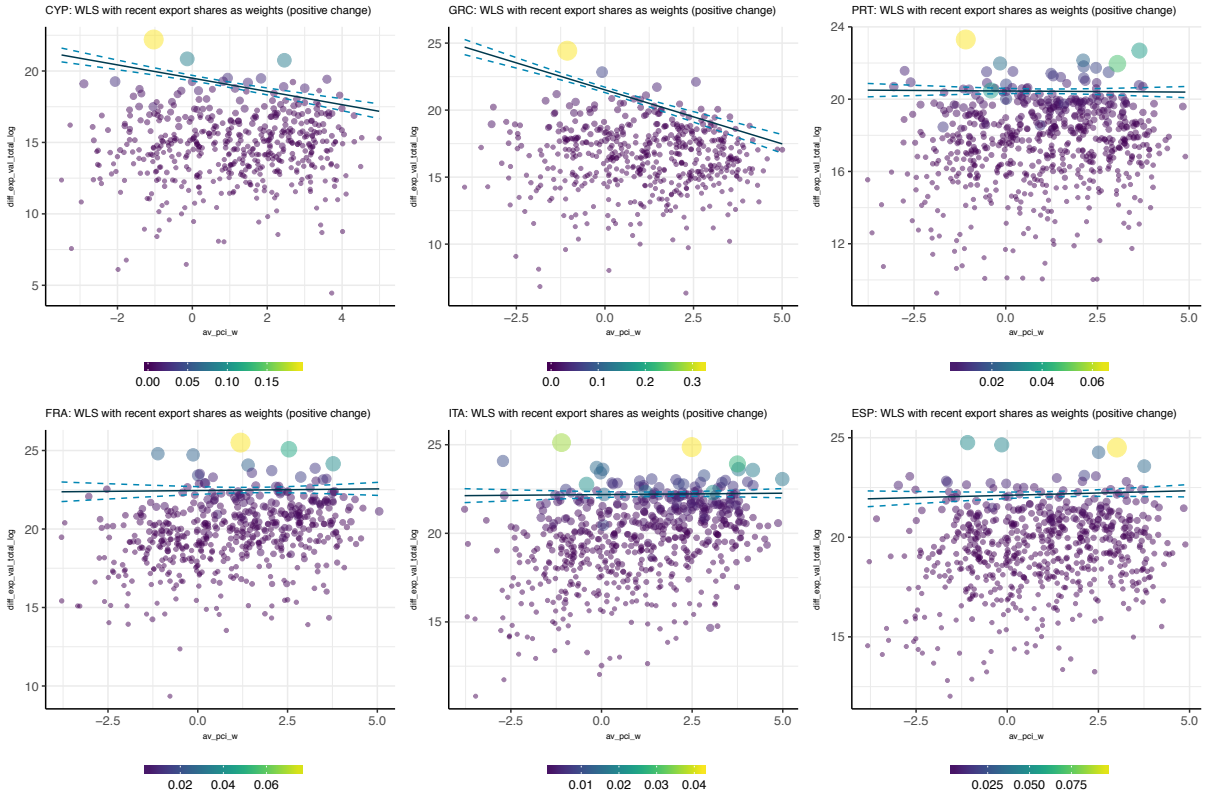

Figure A6: Sectoral development of periphery countries

Financialized countries:

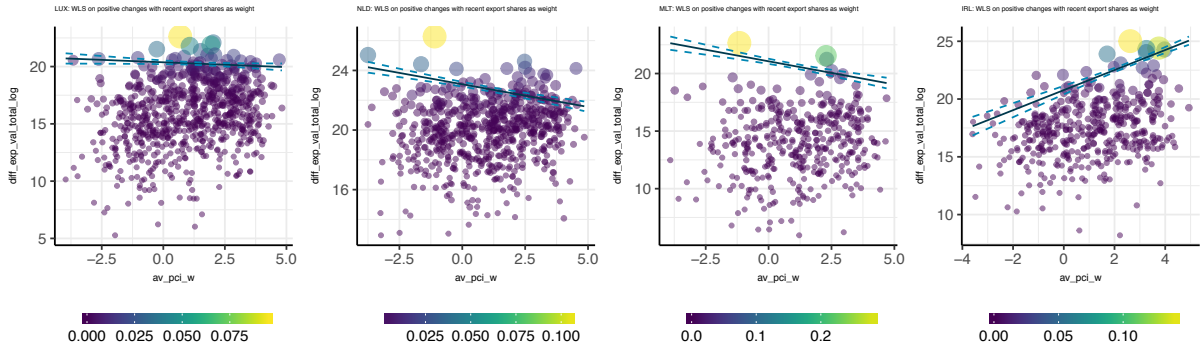

Figure A7: Sectoral development of financialized countries

Eastern-European catch-up countries

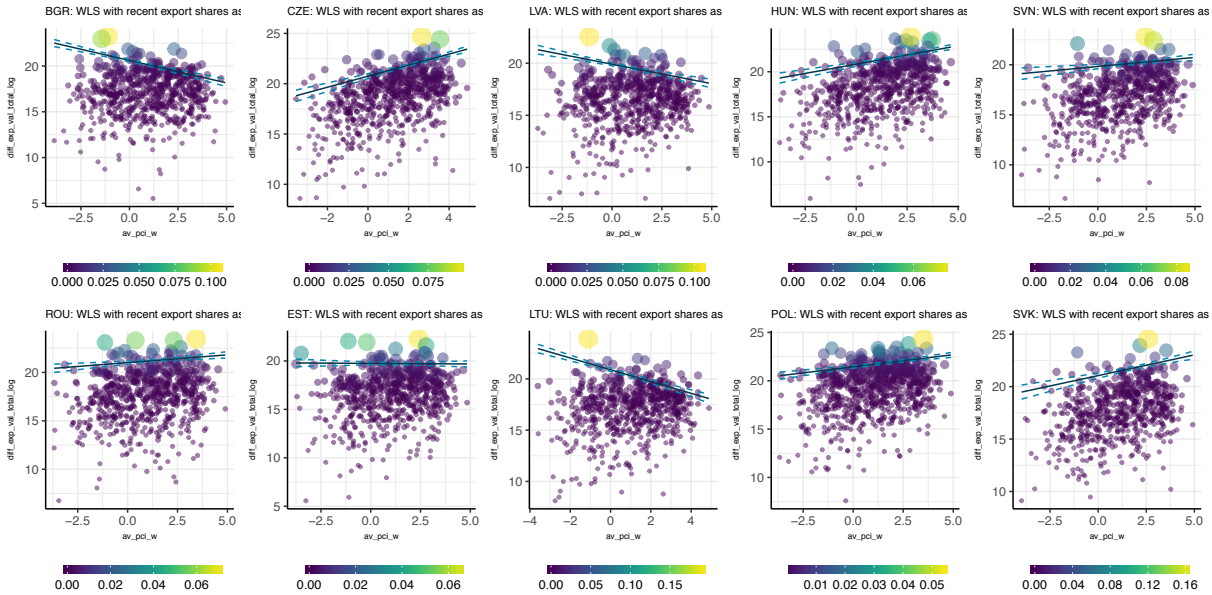

Figure A8: Sectoral development of eastern European countries

7. Population-weighted country group data (robustness check for section 3.3)

In addition to the plot on comparing the four different country groups with the rest of our sample in section 3.3 – where the data were based on non-weighted averages (see Figure 6 –, we show here the results weighted according to the population size of the countries. The picture does not change in a substantive way.

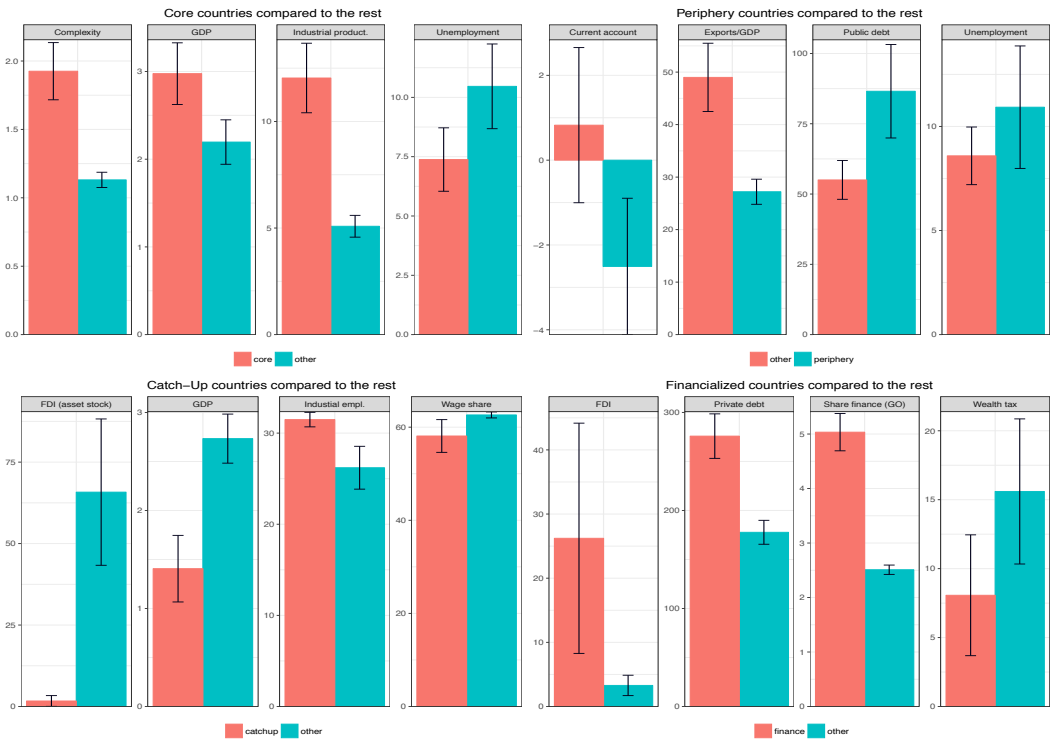

Figure A9: Reproduction of Figure 6 using population-weighted averages