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

Supplementary material*

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July 30, 2019

Abstract

We first describe the data used, including from where and how we have obtained these data in section A. Second additional information on our openness shock dummy variable is provided in section B. Section C then explains the pre-treatment control variables used for constructing the impulse-response functions from local projections in sections 3 and 5 of the main paper. Then, we provide robustness results to sections 3 and 5 by using an alternative openness shock variable in section D. Fifth, additional results related to the clustering analysis in section 4 of the main paper are introduced and discussed in section E. Sixth, we provide more general and disaggregated results for the measure for technological directedness introduced in section 4.3 of the main paper (section F). Finally, we present a robustness check for the country taxonomy data discussed in section 4.2 of the main paper: section G includes population-weighted averages for all data presented in this context.

*Supported by funds of the Oesterreichische Nationalbank (Austrian Central Bank, Anniversary Fund, project number: 17383). The data as well as all code required to replicate the empirical exercises in the paper is available at Github: https://github.com/graebnerc/structural-change. The raw data is also published as Gräbner et al. (2019).

A Data

Tables 1 and 2 list all variables and their original sources. This data has then been further processed. For example, in sections 3 and 5 we present impulse-response functions derived from local projections for eight shock-dependent variables. For this purpose we take the raw data from table 1 and calculate future changes as illustrated in equation 1 in section 2, and add lags and differenced lags as described in section C. All code used to process this data can be found in the Github repository associated with this project.[1]

Sections 3 and 5: shock-dependent variables for local projections		
Variable	**Unit**	**Data source**
Adjusted wage share	Ratio to GDP	AMECO
Current account balance	In % of GDP	AMECO
Exports to GDP	In % of GDP	World Bank (WDI)
GDP growth	Yearly growth rate	AMECO; own calculations
GDP per capita	PPP (constant 2011 int. $)	World Bank
Public debt	In % of GDP	AMECO
Share of financial sector in value added	In % of all sectors	EU KLEMS
Unemployment rate	In % of active population	AMECO

Sections 3 and 5: further control variables		
Variable	**Unit**	**Data source**
Capital accumulation	Real gross fixed capital formation/real net capital stock·100	AMECO; own calculations
Economic Complexity Index (ECI)	Index	Observatory of Economic Complexity
Boom-bust patterns in housing (HBOOM)	Deviation (see explanation in text below)	Own calculation based on AMECO)

Table 1: Data used for the regressions in sections 3 and 5.

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. Croatia is not considered because 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 first because the country is expected to leave the EU and second because not all data are available.

[1] For the concrete steps necessary to re-create the data see the readme at https://github.com/graebnerc/structural-change

Section 4: country taxonomy		
Variable	**Unit**	**Data source**
Population	Total de facto population, inluding both Sexes of 1 July of the year indicated.	1000 people UNPD
GDP per capita	Constant 2011 international dollar (PPP)	Worldbank (NY.GDP.PCAP.PP.KD)
Industrial output, excluding construction	Million EUR in current prices	Eurostat (nama_10_a64)
Public debt	Public debt to GDP ratio	AMECO
Private debt	Private debt to GDP ratio[2]	OECD
Adjusted wage share	Adjusted wage share to GDP ratio	AMECO
Employment in industry	Share of total employment	WDI
Employment in services	Share of total employment	WDI
FDI	Net inflows from foreign investors, divided by GDP	WDI
FDI: asset stock	Millions of current US dollars	Lane-Milesi-Ferreti (LMF) database
FDI: liabilities stock	Millions of current US dollars	LMF database
Wealth tax revenue	Tax revenue as percent of GDP	OECD (tax codes 4200, 4500 and 4600)

Section 4.3 (direction of technological change)		
Variable	**Unit**	**Data source**
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

Table 2: Data used for the empirical exercises in section 4.

Variable	Mean value	Standard deviation	Observations
Adjusted_wage_share	59.7219	5.9167	416
Capital_accumulation	9.5255	3.8034	416
complexity_HH	1.1803	0.4989	366
Current_account_balance_to_GDP	-1.5352	6.4546	416
employm_indus	26.9966	6.1808	416
exp_to_gdp	59.2575	34.5636	416
fdi_in_gdp	11.7765	39.5804	412
finance_share_GO	0.0447	0.0728	413
foreign_ownership	-0.3303	0.5508	312
GDP_growth	2.3734	3.8052	416
GDP_pc_PPP	23872.8365	11140.8164	416
Gini_net	28.7736	3.5992	375
ind_output_meur	238342.7123	390811.4893	413
population	16594.9771	21332.4670	416
Private_sector_debt_to_GDP	198.4120	79.0244	313
Public_debt_to_GDP	55.4600	32.8206	416
size_of_finance	4.4669	7.2762	413
Tax_Wealth	0.2125	0.5047	317
Unemployment_rate	8.9781	4.3508	416

Table 3: Summary statistics for the data.

The full time period of the dataset ranges from 1962 to 2016. The panel data are unbalanced. Although the eight shock-dependent variables were available for all 26 EU countries, the data coverage in the time dimension varies.

As an additional control variable we construct a proxy for boom-bust patterns in housing (HBOOM). This 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 ($\cdot 100$).

Table 3 shows the summary statistics for the variables used for the local projections and the country taxonomy.

B Openness shock variable

Our openness shock variable (used for the estimations in sections 3 and 5) focuses on exogenous changes in institutional aspects of European economic integration: as EU countries share relevant institutions and a common currency (De Grauwe, 2012), we construct a dummy variable the following way: for countries that use the Euro since its inception in 1999, we use 1999 as the year from which the dummy variable is set to 1. For countries that do not use the Euro since its inception, we use their entry to the EU as the year from which the dummy variable is set to 1.

Two countries require special attention: Denmark and Sweden. For Denmark we set the dummy variable to 1 in 1999, since this is the year in which Denmark pegged its currency to

Country	Openness shock	Justification
Austria	1999	Eurozone entry
Belgium	1999	Eurozone 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 4: Timing and justification of openness shock

the Euro, and descriptive statistics of other openness indicators (such as Trade/GDP) suggest this to be a convincing date for the shock variable. For Sweden we use their entry to the EU as the year from which the dummy variable is set to 1.[3] Table 4 summarizes our specification of the dummy variable.

To corroborate the robustness of our results we also run all estimations, as well as the clustering, with a specification in which we use the EU entry for all countries as the year from which the dummy variable is set to 1. As can be seen from figure 1, the result is very robust, with Romania being the only exception. Note, however, that Romania is located in between the core and the larger catch-up cluster. The results for the local projections are extremely similar.[4]

[3] Another country which might be classified differently is Greece, since it entered the European Exchange Rate Mechanism with the Euro in 1999, but entered the Eurozone in 2001. We run all calculations with both options and get extremely similar results. In the main paper the logically more consistent option with the shock occurring in 2001 is reported.

[4] We do not report the figures here due to space considerations, but they can easily be reproduced using the R code published alongside the paper.

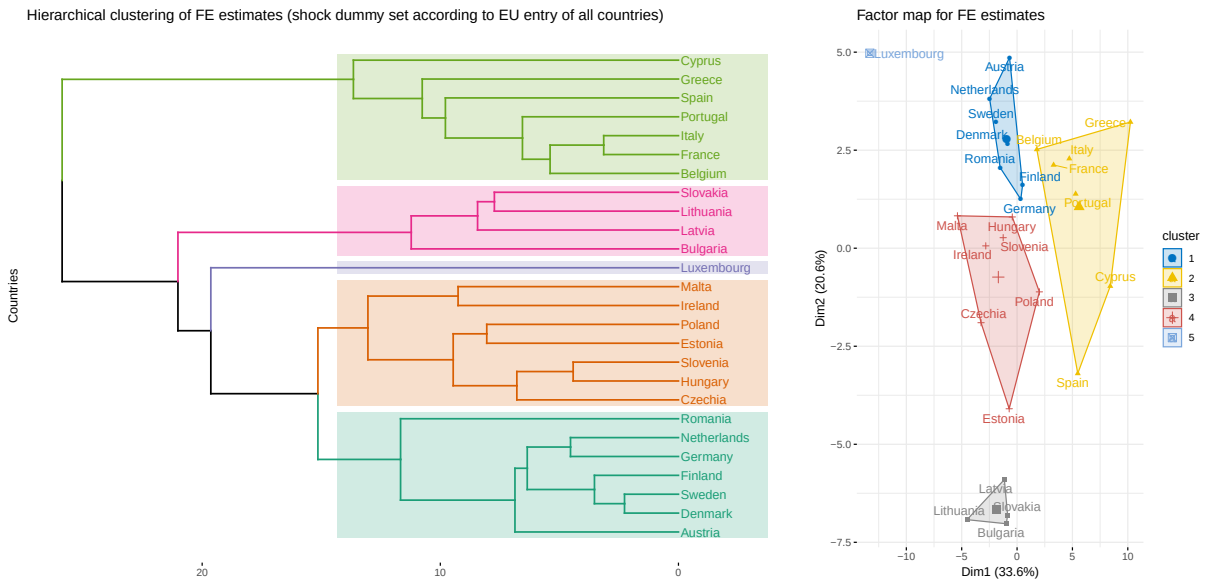

Figure 1: The resulting clustering when the shock variable is set to 1 once a country enters the European Union.

Shock-dependent variable	**Pre-treatment controls**
Current account balance	Unemployment rate
Exports to GDP	Unemployment rate
GDP growth	HBOOM
GDP per capita	HBOOM, unemployment rate
Public debt	Capital accumulation
Share of financial sector	Capital accumulation, HBOOM
Unemployment rate	GDP growth, capital accumulation
Wage share	GDP growth, unemployment rate

Table 5: Pre-treatment controls included in the regressions on which the impulse-response functions in sections 3 and 5 are based. Note that we also include one lag and one differenced lag of the shock-dependent variable as well as lags of all the pre-treatment control variables.

C Notes on estimating impulse-response functions derived from local projections

Table 5 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 3). The choice of the pre-treatment control was based on two criteria: First, which variables might – from a theoretical perspective – also impact the shock-dependent variable? Second, is the variable available over a reasonably long time period for all 26 EU countries?

D 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 (see Gräbner et al., 2018, for a review). As already explained, the baseline results presented in sections 3 and 5 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 3.

Note that we restricted the time dimension for this robustness check to the period 1990-2014. We do so for two reasons: first, we do not want to capture the change in the KOF economic openness index from the 1960s to 1980s; second, this way we can actually capture 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.

Figure 2 is showing a reproduction of our baseline specifications using the KOF economic globalization index instead of the dummy variable as the openness shock variable. For the underlying econometric approach, see section 3 of the main paper, in particular regression equation (1). The country sample consists of the same 26 EU countries. Standard errors are PCSE-corrected (Beck and Katz, 1995) and, hence, robust to cross-section heteroskedasticity and autocorrelation in the residuals.

Figures 3 and 4 represent the corresponding robustness checks for Figures 7 and 8 in section 5 of the paper. Again, we substitute the dummy shock variable with the KOF index for economic globalization and obtain qualitatively similar results.

E Details on the clustering analysis in section 4.1

We decided to use Ward's minimum variance method based on a comparison of all common clustering algorithms suitable for our case (see table 6). The corresponding clustering coefficient is satisfactory and suggests our results are reliable.

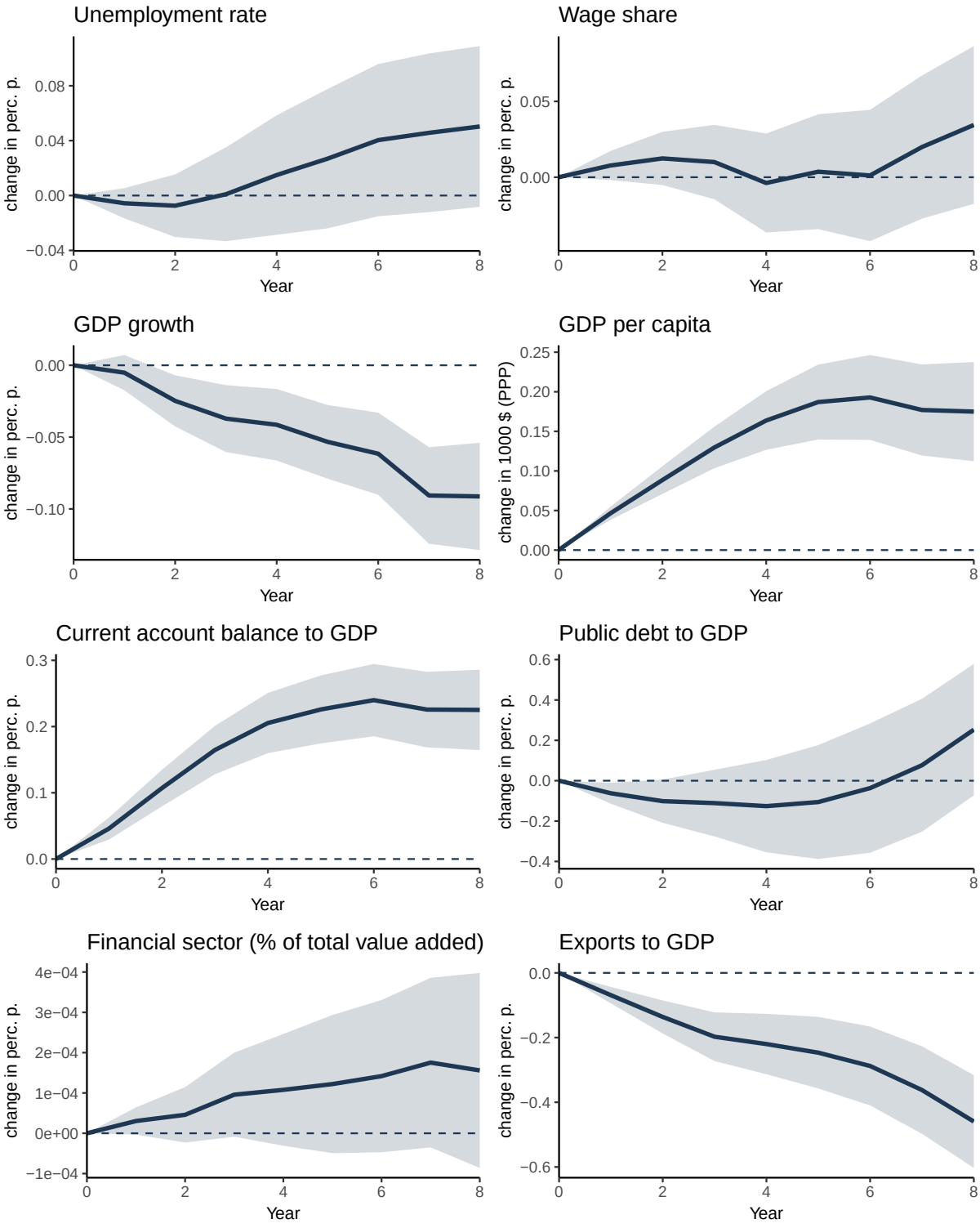

Figure 2: Robustness check for Figure 1 in the paper. Instead of the binary dummy variable of the main paper, the KOF economic globalization index is used.

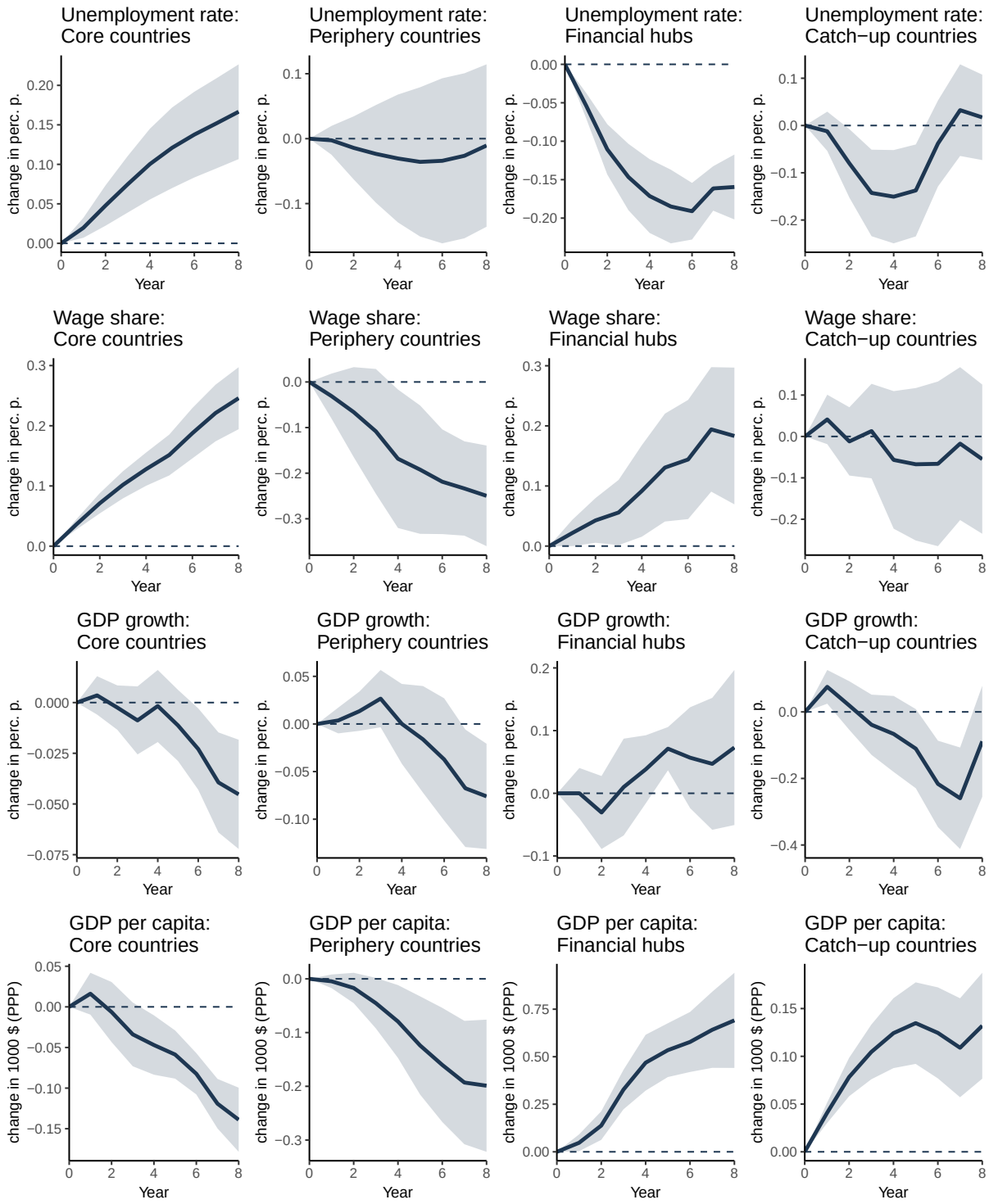

Figure 3: Robustness check for Figure 7 in the main paper.

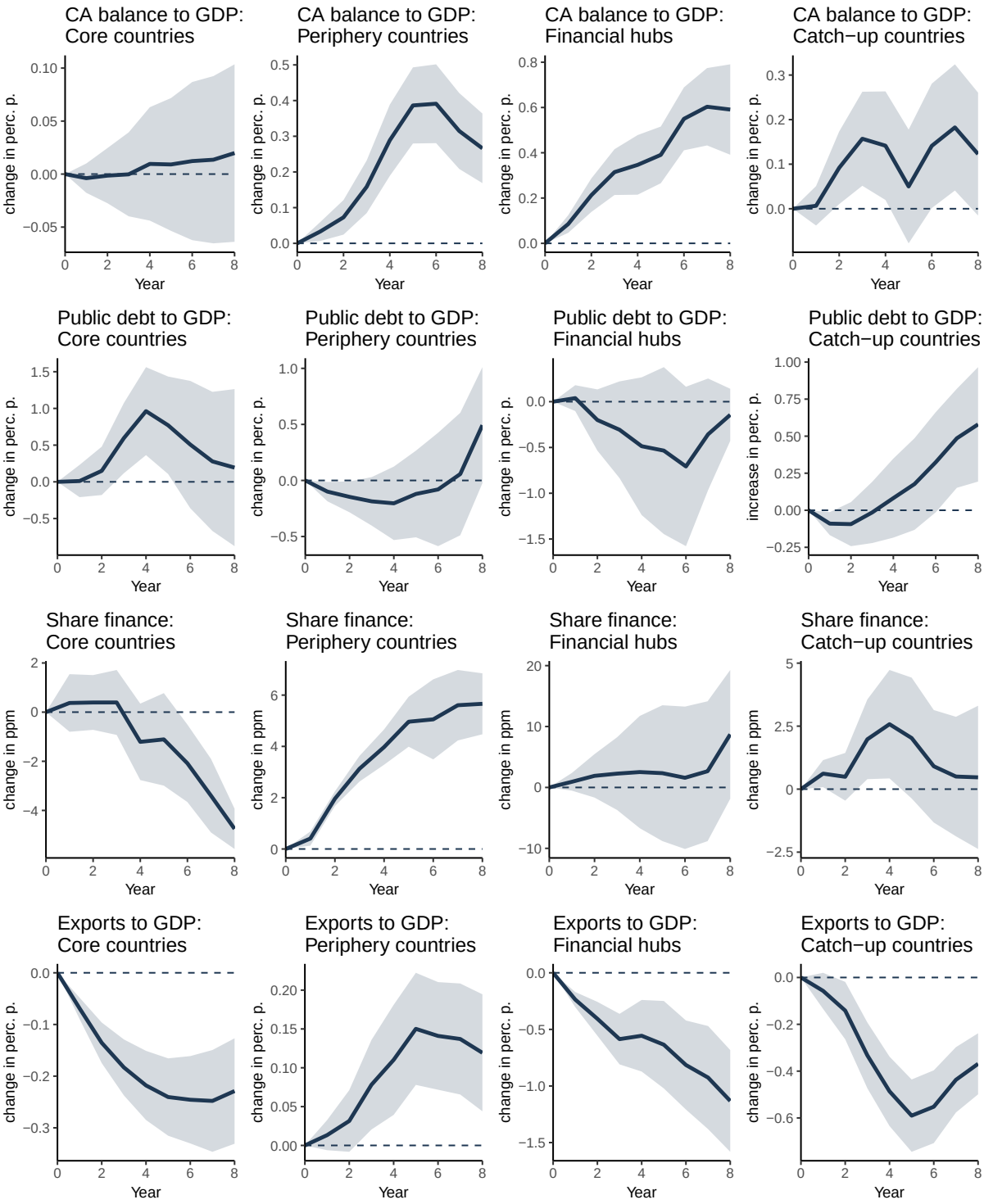

Figure 4: Robustness check for Figure 8 in the main paper

	Algorithm	Clust. coef.
1	agnes_ward	0.71
2	agnes_complete	0.69
3	diana_divisive	0.68
4	agnes_average	0.61
5	agnes_single	0.53

	Algorithm	Clust. coef.
1	agnes_ward	0.76
2	agnes_complete	0.73
3	diana_divisive	0.71
4	agnes_average	0.67
5	agnes_single	0.58

Table 6: Clustering coefficients for different clustering algorithms. The left table provides the coefficients for the clustering used in the main table, the right table the coefficients for the robustness check using only immediate responses.

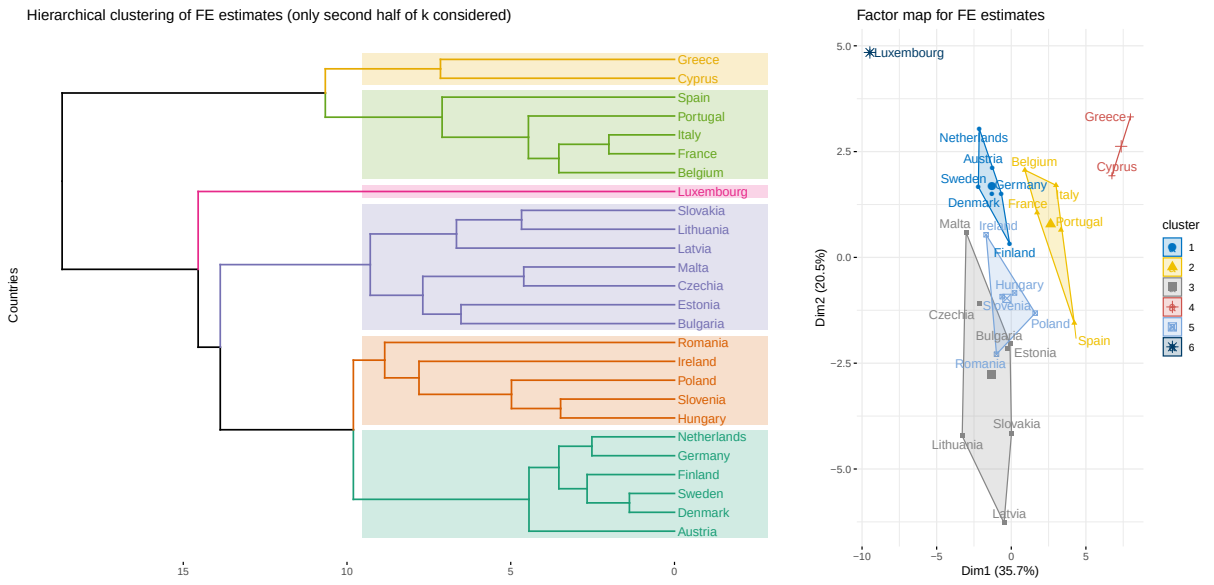

Figure 5: Clustering results considering only long-term reactions of the countries to the openness shock.

In Figure 3 of the main 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. One might, however, also argue that since we are discussing long-term path dependent processes, we should only use the country FE estimates for the later periods after the shock. While such restriction does not seem to be utterly convincing we nevertheless provide the relevant clustering results in figure 5, which underscore the robustness of the results presented in section 4.1, as they point to qualitatively similar conclusions.

Similarly, one might call into question the necessity to include very small and very financialized country such as Luxembourg, Malta or Cyprus. As shown in figure 6, the results of the analysis are robust against the exclusion of these three countries from the estimation.

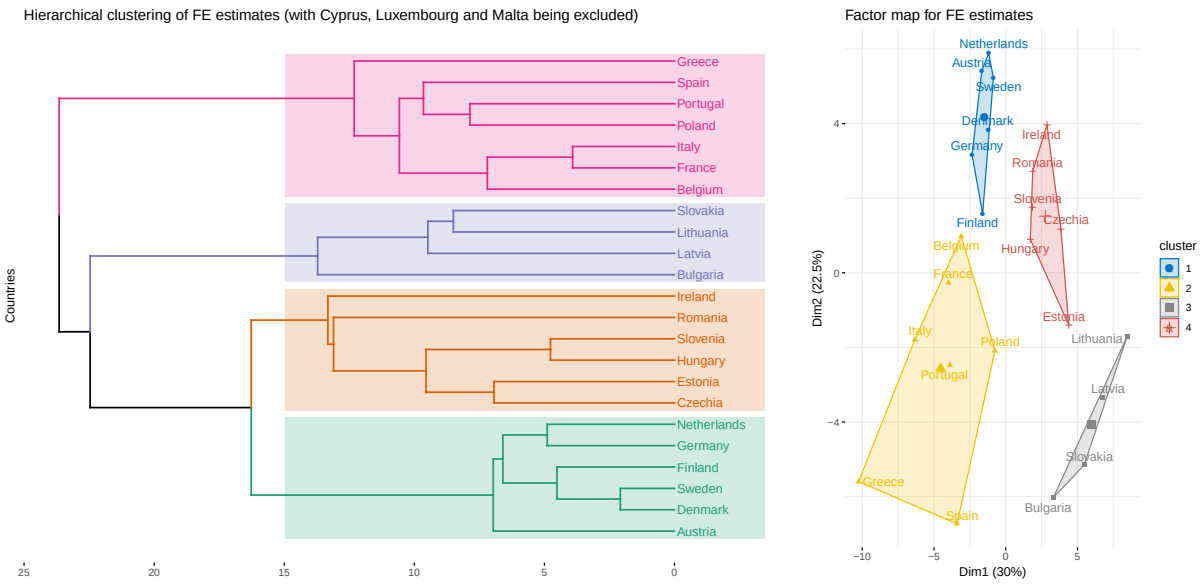

Figure 6: Clustering results with Cyprus, Luxembourg and Malta being excluded.

F Directedness of technological change

In section 4.3 of the paper, we regress the log of the positive and negative difference in the value of exports on the average product complexity, and weight the observations according to the share of the product in the country's export basket in 2012-2014. In figure 7 we provide the visualization of export expansions for all the country groups.

It becomes clear that the core countries in total show a positive relationship between positive changes and product complexity, meaning that they expanded their exports particularly for more complex products. This trend is particularly evident for Austria and Germany, and other core countries are struggling to hold their position (see discussion in the main paper). An even stronger relationship is observable for the Eastern European catch-up countries, particularly if we remove the Baltic states, which do not catch up in terms of technological capabilities at all. At the same time it is important to keep in mind that the *level* of capabilities is still much lower in the catch-up countries than in the core.

Countries in the periphery fall further behind, with their capabilities either stagnating or even worsening compared to the rest of the world. France, as often the case, takes an intermediate position, not showing a clear tendency towards more or less complex products (and by this, loosing ground in relation to the core countries).

Finally, the financial hubs generally show a negative trend, which is not surprising given the fact that their growth model does not rely on the production and the export of complex products.

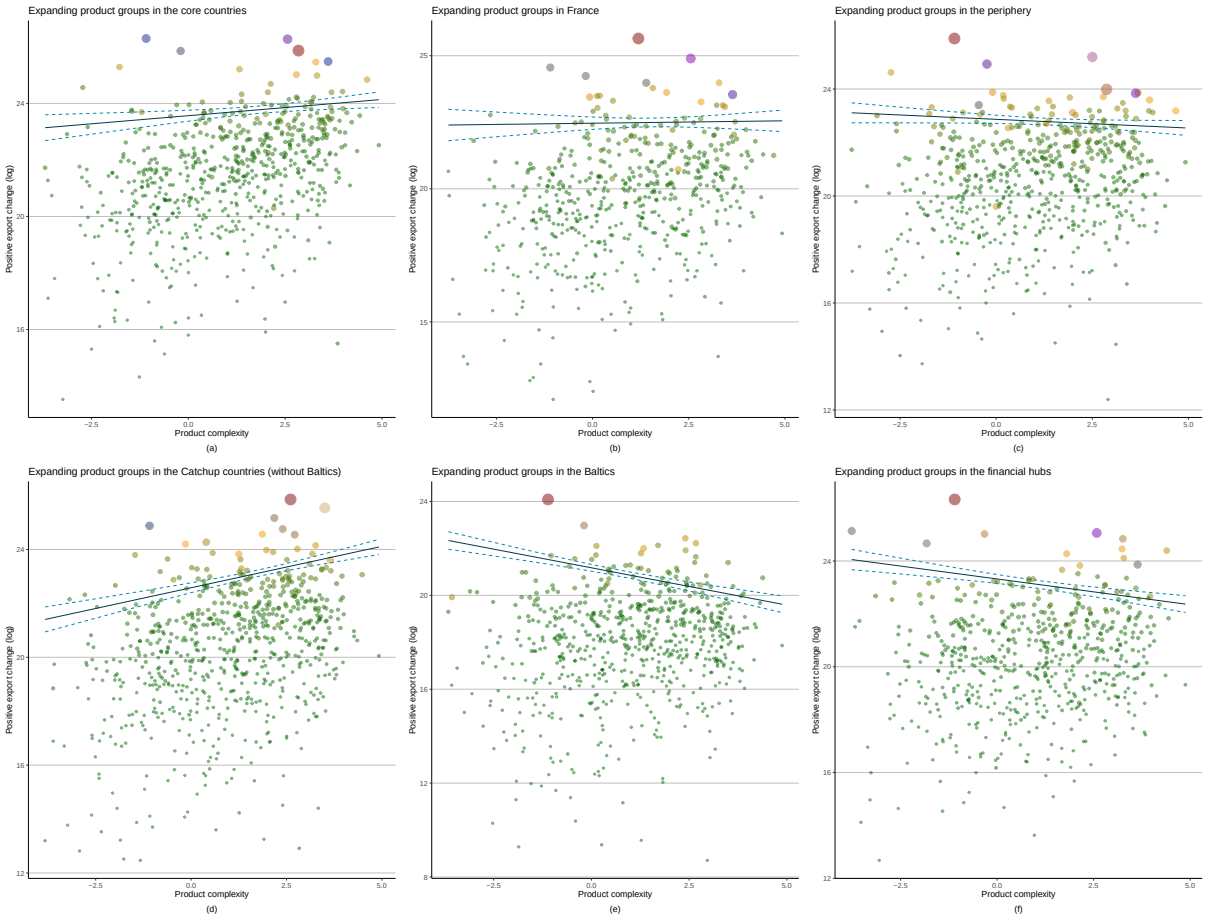

Figure 7: Sectoral development in our country groups.

G Population-weighted country group data (robustness check for section 4.2)

In addition to the plot on comparing the four different country groups with the rest of our sample in section 4.2 – where the data were based on non-weighted averages – we present the results weighted according to the population size of the countries in figure 8. The picture does not change in a substantive way, except for the case of the wealth tax revenues of the financial hubs: here, the Netherlands with their relatively large population push down the mean for the financial hubs even below the mean of the remaining countries. This is not surprising: as explained in the main text, the Netherlands follow a financialization strategy focused on a large shadow banking sector and low corporate taxes, not on the attraction of private wealth. Their relatively low revenue from wealth taxation is, thus, consistent with their classification as a financial hub.

References

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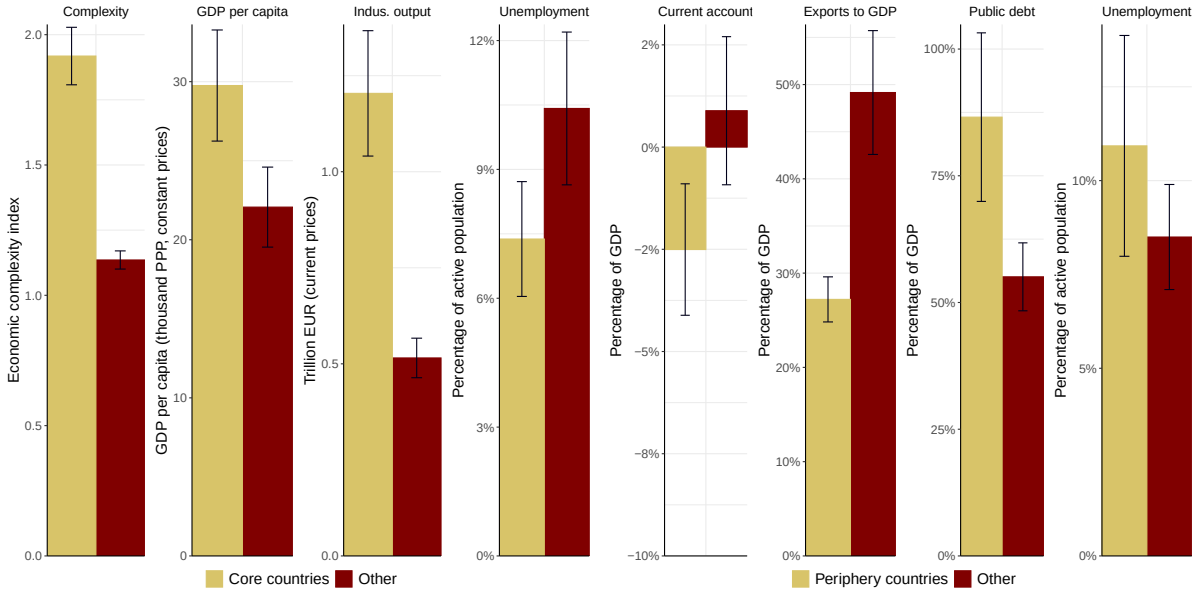
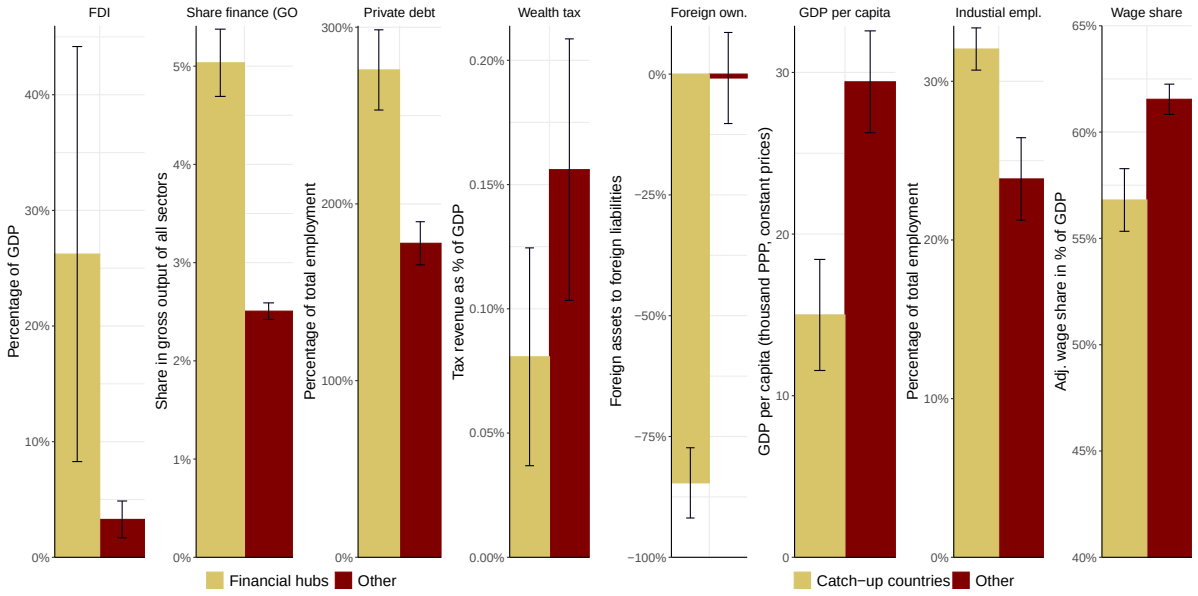


(a) Core countries compared to the rest.

(b) Periphery countries compared to the rest.



(c) Financialized countries and the rest.

(d) Catch-up countries and the rest.

Figure 8: Reproduction of Figure 4 using population-weighted averages.