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Elements of an evolutionary approach to comparative economic studies: complexity, systemism, and path dependent development*

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Abstract

This chapter delineates an evolutionary approach to the comparative analysis of economic systems and illustrates its usefulness via an exemplary application to recent developments in the European Union. The first part of the chapter describes the meta-theoretical foundations of the approach, i.e. its particular ontological and epistemological vantage points. This allows for an easier comparison (and, potentially, triangulation) with other approaches to comparative analyses, and already provides for some practical guidelines for applied work. The second part applies the approach and studies polarization patterns in the European Union. While this application is not meant as a fully self-contained analysis, it not only illustrates how the concepts of the approach can be operationalized and applied in practice, but also the application of several empirical methods that can be used fruitfully within such an evolutionary analysis. The chapter concludes with a non-exhaustive list of concepts and topics that are particularly insightful to consider when conducting an analysis in the spirit of an evolutionary approach to the comparative analysis of economic systems.

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1. Introduction

This chapter describes the central elements of an evolutionary approach to comparative economic studies (EACES). Such an approach is inspired first and foremost by evolutionary economics, one of the most influential 'heterodox' economic research programs that has produced numerous concepts and theories that seem to be natural ingredients to a comparative approach. The evolutionary literature on *National Innovation Systems* (NIS, e.g., Nelson, 1993), the work on *technology gaps* (e.g., Dosi et al., 1990), and *evolutionary growth theory* (e.g., Nelson & Winter, 1982) are early examples for such concepts. As will be argued below, not only has significant progress been made when developing these concepts further, they also align well with concepts that were developed recently in other socio-economic research programs, such as the Post-Keynesian work on *growth models* (Baccaro & Pontusson, 2016), the interdisciplinary work on *economic complexity* (Hidalgo, 2021), and the critical contributions by *structuralists* and *dependency theorists* (Kvangraven, 2020). In this sense, the main goal of this chapter is to synthesize existing concepts within a consistent framework that is immediately useful for a comparative analysis of economic systems.

Integrating concepts from different research programs and fields is not straightforward, however: every research program (or 'paradigm') comes with its own terminology and meta-theoretical foundation, such as a preferred way to explain empirical phenomena, and particular research methods (Gräbner & Strunk, 2020). Thus, whenever one wishes to elaborate on a general approach that encompasses contributions from distinct research programs, a consistent meta-theoretical framework that explicates all the higher-order assumptions of the approach becomes essential. More precisely, just as any research program, the EAECES has, at its core, certain fundamental assumptions as well as certain topical foci. These assumptions do not only determine what kind of theories, concepts, or methods can be successfully integrated into and used within the EAECES, they also provide the analytical vocabulary to distinguish the evolutionary approach discussed here from other approaches to the comparative analysis of economic systems – which is why explicating this core is at utmost essence.

Therefore, the rest of this chapter proceeds as follows: Section 2 gives a general overview about the meta-theoretical foundations in terms of ontology and epistemology. This will allow us to distinguish an evolutionary from a non-evolutionary approach, and to better understand whether and when such an approach can complement or substitute alternatives. Section 3, then, illustrates the approach in practice by applying it to recent developments in the European Union. While this is not meant as a self-contained analysis of these developments (which would go way beyond the scope of a handbook chapter), it illustrates how the theoretical concepts can be operationalized and what kind of empirical methods are often useful in applied work. At the end, it provides a non-exhaustive list of topics and concepts that are usually useful to consider when applying the EACES in practice (see Table 3.3). Section 4 concludes the paper with a short summary, and some suggestions for future applications.

2. The meta-theoretical core of an evolutionary approach

2.1. On the need for a meta-theoretical foundation

Figure 2.1 gives a first indication for why the explication of the meta-theoretical core of a research approach that encompasses distinct paradigms is necessary. What one usually has contact with is merely the tip of the pyramid: concrete models or studies of that apply a certain approach to a particular phenomenon. This is what the typical journal article is concerned with, and what Thomas Kuhn would consider as "normal science" (Kuhn 2012[1962]). Yet, in any such application there are several higher-level assumptions operating in the background. Usually, these are not explicitly discussed in the applied work and refer to what researchers consider to be the *essential properties* of their subject of investigation, i.e. its *ontology*, and the adequate ways to generate knowledge about this subject of investigation, i.e. the *epistemology* of their approach. In economics, for instance, the dominant epistemology is the conviction that any phenomenon should be explained via a model of the phenomenon that features an economic equilibrium and utility maximizing agents.

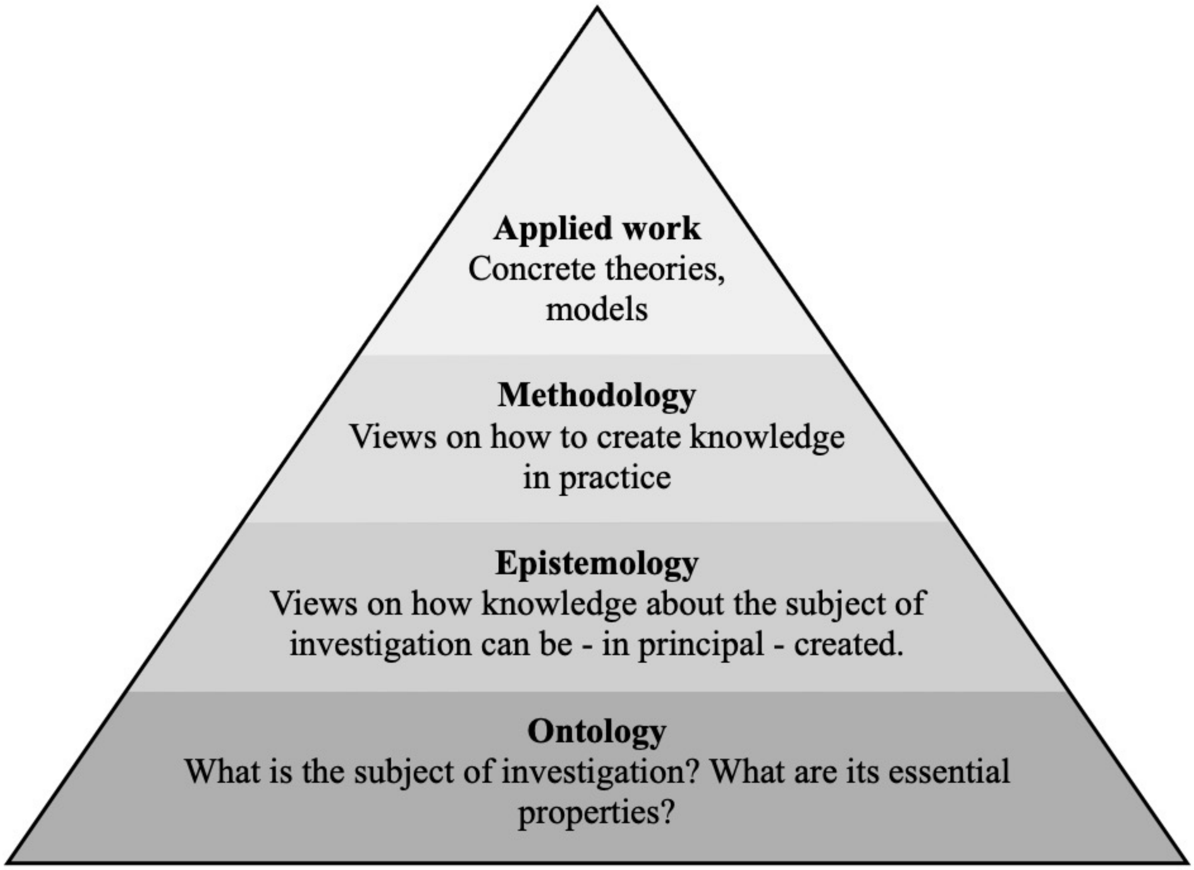

Figure 2.1: *The meta-structure of any scientific research program.*

Whenever we wish to integrate contributions from distinct paradigms, one has to make sure they are consistent on the meta-theoretical level, especially with regard to their ontology and epistemology. In the following, the essential aspects of the ontology and epistemology of an EACES will be outlined, both of which are *systemist* by nature. This means that the essential features of an evolutionary approach can be linked to the idea of *systemism* as originally developed by Mario Bunge (1996), and already proposed as an umbrella framework for various economic paradigms by Gräbner & Kapeller (2017). In effect, the following exposition not only provides a better idea about the central elements of the EAECES, it also helps practitioners to see whether it is compatible with their own approach to comparative economic analysis.

2.2. The ontological core: systems, mechanisms, and evolution

The basic ontological premise of Bunge's systemism is that everything that exists is either a system or a part of a system. A system as such is "a complex object whose parts […] are held together by bonds of some kind", whereby these bonds "are logical in the case of a conceptual system, such as a theory; and they are material in the case of a concrete system, such as an atom" (Bunge, 2004, p. 188).[1] More precisely, every system comprises (i) a set of components – its *composition* C –, (ii) a set of relations – its *structure* S –, (iii) a surrounding within which it exists – its *environment* E –, and (iv) a set of *mechanisms* M that operate within the system. Here, a mechanism is "a process (or sequence of states, or pathway) in a concrete system, natural or social" (Bunge, 2004, p. 186). In fact, both Bunge – as do most evolutionary economists (see Witt, 2014) – adapts the Darwinian premises that not only something like a 'cause' exists in an ontological sense, but also that every event in the world has some cause, which, in principle, can be discovered (e.g., Bunge, 1959, p. 26; Hodgson, 2004, p. 59). These basic premises already provide a useful blueprint that one can use for the description of the essential features of the economic systems that are the main subjects of one's comparative investigation: explicating the most relevant components, relations, and mechanisms, as well as the environments of the systems under investigation provides for a very neat and transparent summary description for one's comparative study (for more details see Section 2.3. below).

The systemist approach explicitly allows for a *layered ontology*, i.e., systems on different ontological levels – often referred to as the micro, meso, and macro level – that are nested and dependent upon each other. For instance, a firm is a system composed by different components (e.g., workers, owners, customers, etc.). At the same time, however, it is also one part of a larger system, e.g., a particular economic sector, within which it has relations to other components, such as other firms or regulatory institutions.[2] For evolutionary scholars, this layeredness of reality, which is illustrated in Figure 2.2, relates to another fundamental ontological commitment, viz, the relevance of *evolution*. There are two reasons for this: first, multi-level systems – where each level comprises a system as defined above, and lower-level systems are components of higher-level systems – are particularly likely to evolve in the presence of evolutionary mechanisms. Thus, evolution explains the empirical relevance of such a multi-level approach (see already Simon, 1962). Second, the terminology of micro-meso-macro resembles the analytical system developed by Dopfer et al. (2004), which they derive from what they consider the fundamental ontological core of evolutionary economics, namely, *evolutionary realism* (Dopfer et al., 2004). They argue the fundamental object of evolutionary analysis is the study of the dynamics of populations of rules, and refer to the level of rule populations as the *meso*, the level of rule users (i.e., agents) as the *micro*, and the level of relations between rule populations as the *macro* level. The processes operating on the meso levels, i.e., the change of generic rules according to a biologically inspired origination-adoption-retention scheme, is where the evolutionary core of evolutionary analysis resides and why any thinking in terms of equilibria is misleading. A more precise discussion of evolutionary realism, however, would go beyond the scope of a single handbook chapter, and excellent introductions are already available (Dopfer & Potts, 2004; Dopfer et al., 2004). Thus, in the following the focus will be more pragmatic and applied, yet it should be stressed that the micro-meso-macro scheme of Dopfer et al. (2004) rationalizes an important link between the concepts of *systemism* and *evolution*.

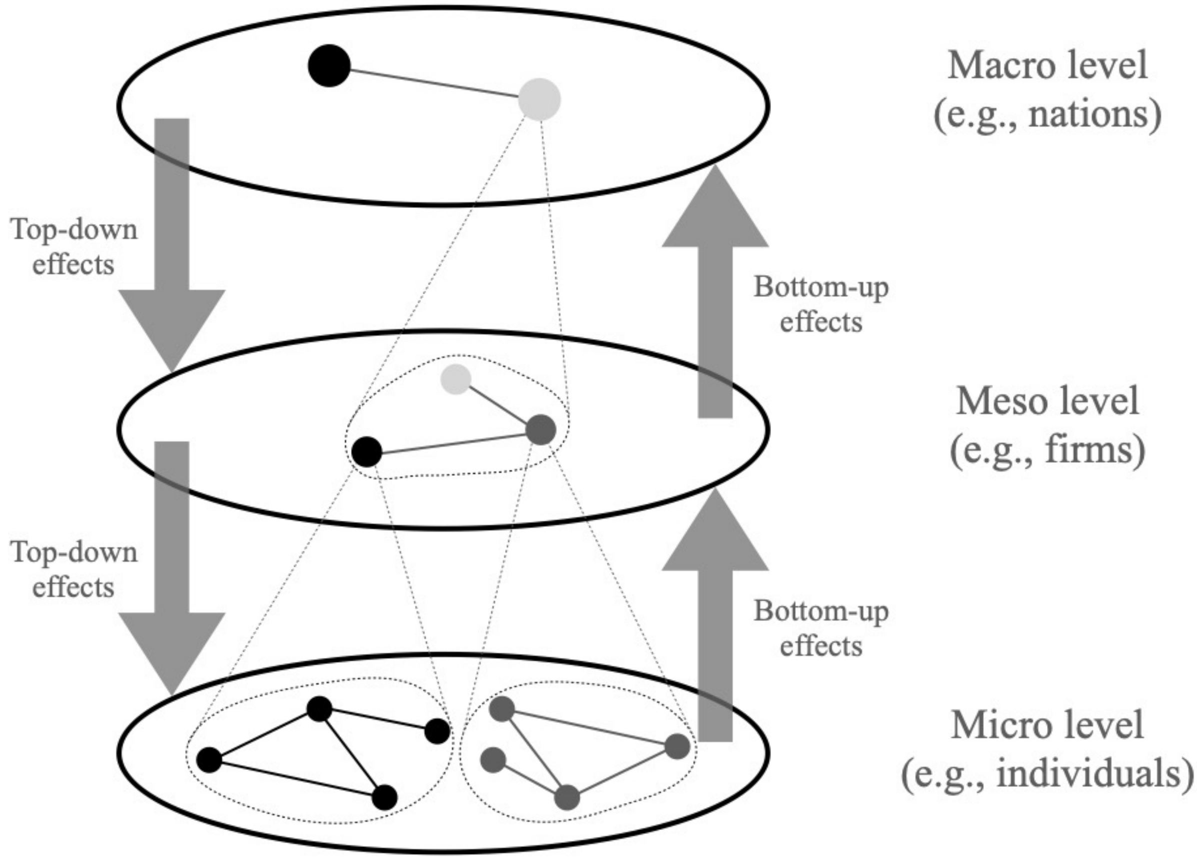

Figure 2.2: *The layered ontology of systemism. Note the pragmatic character of this systematization as a general blueprint to describe the objects one investigates. For a deeper, analytical ontology, which is compatible with this pragmatic approach see Dopfer & Potts (2004) and Dopfer et al. (2004).*

An evolutionary analysis usually stresses the joint relevance and mutual interdependence among different levels, i.e., neither level takes precedence over the others. This represents a departure both from radical individualism or holism: not everything on higher levels can be derived from the mechanisms on lower levels (as in a fully individualistic approach). Rather, there is *real novelty*, or *emergence* of new phenomena on higher levels, which is why the meso is not merely a derivative of the micro, but a subject of investigation proper. At the same time, higher-level systems cannot be expected to fully transcend their components on lower levels, as it would be the case in a fully holistic approach. Related to this is the focus on *reconstitutive downward effects* (e.g., Hodgson, 2006; see also Elder-Vass, 2012) – the basic idea that there are components of systems that emerge on higher ontological levels because of the interactions among entities on a lower ontological level, yet in a next step impact upon these entities on the lower level and so on. A classic example is that of a social institution: it emerges from the behavior of individuals, yet in a next step it affects the behavior of the individuals. Of course, this effect might then lead to certain individuals breaking with this institution, or trying to change it, which then again has an impact on the institution as such, culminating in endogenous and persistent dynamics. Hodgson & Knudson (2004) illustrate this using a model of the emergence and evolution of traffic rules: drivers rather accidentally develop a habit of driving on the left or right side, but from this habit a self-stabilizing convention develops, which then governs the behavior of drivers in the future (see Figure 2.3).

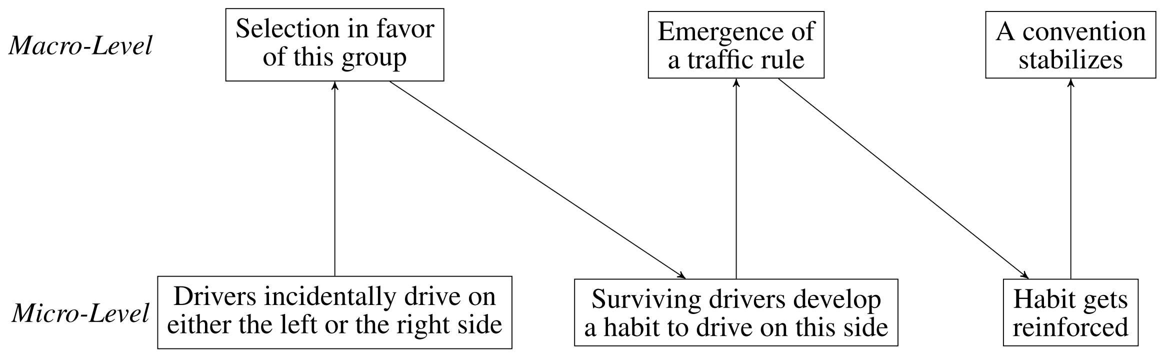

Figure 2.3: *Simple example for the relevance of reconstitutive downward effects, as well as upward effects when studying rules. Source: Gräbner & Kapeller (2017), based on Hodgson & Knudson (2004).*

These circular effects among levels are one reasons why evolutionary scholars are often skeptical of the notion of an explanatory *equilibrium*, since it is easy to imagine circles of top-down and bottom-up effects that yield constant endogenous dynamics, without ever putting the system at rest. At this point we will not explore the deeper reasons for why disequilibrium instead of equilibrium is the natural state of reality from an evolutionary perspective (see, e.g., Dopfer et al. 2004; Heinrich, 2017). Rather, is should be stressed that the constant evolution of novelty, e.g., in the form of new technologies or institutions, is likely to constantly transform the state of a system such that persistent change is the rule rather than the exception. Consequently, any meaningful investigation should be a dynamic rather than a static one. This brings us to the epistemological implications of the basic ontology introduced so far.

2.3. Epistemological features: the CESM model, the principle of evolutionary explanation, and mechanism-based explanations

The ontological commitments introduced in the previous Section already have some immediate implications for the epistemology of an EACES: first, when providing a basic description of the objects under study, one should be clear with regard to the four categories that make up the essential properties of any system. Bunge (2004) refers to such description $\mu(\sigma)$ of a system σ as the *CESM model*: $\mu(\sigma) = \langle C(\sigma), E(\sigma), S(\sigma), M(\sigma) \rangle$. Such a general representation comprises an explication of the components $C(\sigma)$, the environment $E(\sigma)$, the structure $S(\sigma)$, and the mechanisms $M(\sigma)$ of a system, that one considers to be essential, and which should, therefore, form the central part of a comparative exercise. The CESM model is a useful device for explicating the vantage point of a comparative analysis and provides for a very general blueprint on which two or more economic systems, which are the subjects of a comparative analysis, can be mapped onto to guarantee a transparent study design.

Yet, there are more epistemological features that derive from the ontological commitments mentioned above: first, from the prominent role of mechanisms in the systemist ontology, it follows that explanations must be *mechanism-based* (and, thereby, causal; see Hodgson, 2004; Bunge, 2004; Witt, 2014; Gräbner, 2017).[3] Unfortunately, mechanisms as such are often not observable, so identifying mechanisms must start from conjecturing them and then substantiating one's hypothesis through further analysis. Nevertheless, mechanism-based explanations are feasible and continue to be the ideal in any evolutionary approach. Second, any evolutionary approach must be committed to the *principle of evolutionary explanation* according to which "any behavioral assumption in the social sciences must be capable of causal explanation along (Darwinian) evolutionary lines and be consistent with our understanding of human evolution" (Hodgson, 2004, p. 159). This precludes the use of neat as-if assumptions such as given preferences, or utility maximization at the individual level.

This adherence to the ideal of mechanism-based explanations and the principle of evolutionary explanation implies a skepticism against the currently dominant way of explanation in economics, i.e., the commitment to the so-called *optimization-cum-equilibrium modeling approach*. According to this view, a certain phenomenon is explained if one can provide a model of the system in question that features utility maximizing (i.e., optimizing) agents, as well as an economic equilibrium in which all agents make consistent strategy choices. Both its central ingredients are incompatible with the commitment to the principle of evolutionary explanation as well as the commitment to mechanism-based explanations: First, the use of utility maximizing agents either contradicts the principle because of ontological reasons – if one really believes that agents maximize utility –, or the commitment to mechanism-based explanations – if one only assumes them to behave *as if* they maximized utility since then the true mechanisms remain unmentioned.
Second, the *a priori* commitment to an equilibrium is incompatible with the commitment to the principle of evolutionary explanation as well as the commitment to mechanism-based explanations since equilibrium models usually do not explicate how the economy reaches a state of equilibrium (in which the equilibrium would be part of the explanandum, not the explanans), but simply use it as an epistemological device, devoid of any underlying mechanism (see also Varoufakis, 2014, chapter 1).

2.4. Summary and methodological implications

It comes as no surprise that the ontological and epistemological elaborations above also have some methodological implications: not all research methods are compatible with the EACES. General equilibrium models, as widely used in economics today, for instance, are incompatible with an EACES because they rely on the optimization-cum-equilibrium approach discussed above. Thus, evolutionary scholars are much more open to the application of simulation-based models, such as agent-based modeling, dynamical systems modeling, and related quantitative methods, but also qualitative case studies. The reason is that these methods have more potential to meet the ontological and epistemological demands of an evolutionary approach. Section 3 exemplifies the application of some quantitative empirical tools that are useful for applications in the spirit of the EACES. A more general overview of modeling approaches is given, for instance, in Heinrich (2017, especially the online appendix). Given the constant introduction of new methods, however, it is – in the end – the applied researchers who need to judge whether the tools they have in mind are consistent with the meta-theoretical framework introduced above or not.

3. An application to comparative development analysis in the European Union

To illustrate how an application of the research program outlined above could look like, this Section comprises a short study of the recent developments in European Union from the perspective of an EACES. It is, thus, not meant to comprise a self-contained analysis that provides for a complete picture on the said developments, but as an illustration of how the concepts introduced above could be operationalized and applied in practice.[4] Moreover, it is meant to illustrate the usefulness of several empirical methods for a comparative study from an evolutionary view. Each subsection will illustrate one particular method and/or theoretical concept that is useful to operationalize the meta-theoretical approach delineated in Section 2. Table 3.3 at the end of the Section summarizes them and provides references for further readings. Note that the focus here will be on quantitative approaches. For examples of the application of more qualitative methods, especially in the context of the NIS approach, see, e.g., Dodgson et al. (2008) or Lundvall & Rikap (2022).

The main object of investigation here will be the European Union. In a first step, we will map this object of analysis to the micro-meso-macro scheme introduced above (c.f. Figure 2.2). Within the focus of the present analysis, the Union as a whole represents the macro level, while individual countries correspond to the meso level. The micro level, at this point, will be associated with firms.[5] The main phenomenon of interest is the pattern of socio-economic divergence that is visible at the European level and that is illustrated for the case of income in Figure 3.1.[6] Given the relatively high rates of cumulative growth in the poorer Eastern European countries since 1995 shown in Figure 3.1a, this seems surprising. Yet, grouping these countries together to show their absolute levels of income reveals that these rates are far too low to approach the income levels of the central European countries in a reasonable time frame (Figure 3.1b). At the same time, numerous countries in Southern Europe experienced two basically ‘lost decades’ and are falling behind the rest of Europe, whereas a small group of ‘finance hubs’ were able to increase their income relative to the rest considerably. For now, this grouping of the countries will be considered only a pragmatic simplification to aid visualization. As we will discover below, however, this classification of countries can be justified by reference to the underlying development models of these countries (see Table 3.2).

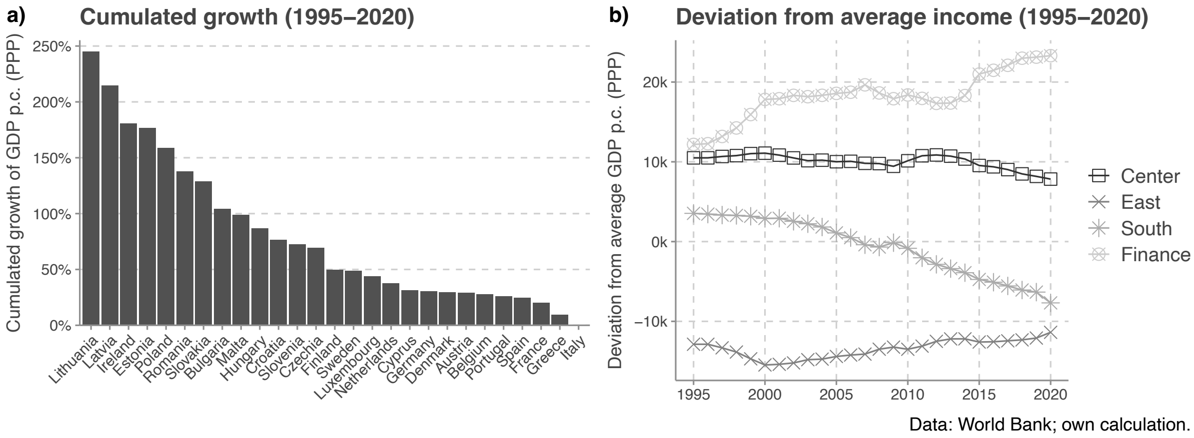

Figure 3.1: *Income polarization within the EU. The country groups in panel b are as follows: Center: Austria, Belgium, Denmark, Finland, Germany, Sweden; East: Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia; Finance: Cyprus, Ireland, Luxembourg, Malta, Netherlands; South: France, Greece, Italy, Portugal, Spain. They correspond to the development models described in Table 3.2.*

The goal of a comparative study in the spirit of the EACES would be to explain this polarization. In accordance with the meta-theoretical framework outlined in Section 2, this means to identify the mechanisms that have brought about these dynamics. The elaborations in Section 2 made clear that these mechanisms might operate within the micro, meso, or macro level as defined above, among these levels, or between the levels and the system environment, i.e. the rest of the world economy. As will be elaborated below, it is indeed a distinctively evolutionary finding that mechanisms on different levels are likely to drive the polarization dynamics – a finding with considerable relevance also for applied policy making.

3.1. The distribution of technological capabilities, economic complexity and growth models

A central conjecture of evolutionary economics is that the set of *technological capabilities* that a country, region or firm has accumulated is one important determinant for its economic success (on the concept of capabilities see Aistleitner et al. 2021). Thus, comparing the set of capabilities accumulated within the various Member States seems to be a viable first step to approach the topic of polarization. To do so, however, one would require a measure for this stock of accumulated capabilities that can be consistently applied to different countries – not an easy task. There are several measures proposed in the literature that run under the heading of 'economic complexity'. In all cases, the goal is to quantify the stock of technological capabilities accumulated by the subjects of analysis. Table 3.1 gives an overview of different approaches, which are all meant to measure technological capabilities, but differ in the particular algorithm used to compute complexity, as well as the fundamental data source. This chapter follows the strategy developed by Hidalgo & Hausmann (2009), i.e. it will apply the so called *method of reflection* to export data, thereby computing the Economic Complexity Index (ECI) for countries and the Product Complexity Index (PCI) for products. For the sake of brevity, we skip the formal exposition of the approach; it can be found in, e.g., Hidalgo (2021), or the appendix of Gräbner et al. (2020b), on which the following exposition is built.

Data source	**Method of computation**	**Example**
Export data	Method of reflections	Hidalgo & Hausmann (2009)
Export data	Fitness algorithm	Tacchella et al. (2013)
Patents	Method of reflections	Balland & Rigby (2017)
Patents	Measure of Structural Diversity	Broekel (2019)
Input-Output table	Method of reflections	Reynolds et al. (2018)

Table 3.1: An overview over selected approaches to compute economic complexity.

The idea of the ECI is to infer the stock of capabilities that is present in an economy by looking at the economic activities the firms in this country are able to perform. For reasons of measurement, the focus is on the activity of producing goods. In other words, a country is assumed to have accumulated a large amount of technological capabilities if its firms are able to produce complex products, i.e. products that *require* a large amount of such capabilities. To break the alleged circularity of computing both the complexity of countries and products, the method proceeds as follows: first, using export data, compute for every country c the *revealed comparative advantage* (RCA) with regard to each product p. A country c is said to have an RCA for a product p, if the share of a product in the export basket of a country is larger than the share of this product in the total exports of the world market. In a next step, one computes the *diversity* of the export baskets of the countries – the number of products a country has a RCA in – and the *ubiquity* of products – the number of countries that are exporting a product with a RCA.

The ECI now seeks to combine two basic intuitions: first, that it seems unlikely that very specific skills or materials are required for the production of a product that is ubiquitous.

Second, that there can be two reasons for why a product can be non-ubiquitous: either it is rare because it is a high-tech product that requires a lot of technological capabilities; or it is rare because some ingredients are rare. Computer chips would be an example for rare high-tech products, raw oil for a rare low-tech product. The ECI seeks to distinguish between these two kinds of non-ubiquitous products by referring to the diversity of the countries that export these products. If a rare product is produced by a less-diversified country, i.e. a country that only produces a small fraction of all products, it is unlikely that this product is rare because of the many technological capabilities it requires: if this was the case, the country exporting this product would possess these many technological capabilities and, therefore, export a variety of goods, not only few. It is, thus, more likely that this country possesses a rare raw material that is required to produce this product, and that the product is rare simply because its ingredients are rare. At the same time, if a rare product is produced only by well-diversified countries, it is more likely to be rare because it requires a lot of technological capabilities – and only few countries have accumulated this amount of capabilities.

To compute the ECI, one weights the diversity of countries by the ubiquity of the products in the export basket, and then the ubiquity of the products by the diversity of the countries that export this good. One continues with this 'reflection' until one reaches an equilibrium and can compute the ECI and PCI (for the technical details see, e.g. Hidalgo, 2021, or the technical appendix of Gräbner et al. 2020b). The resulting ECI is a measure of the technological capabilities present in a country, and the PCI of the amount of capabilities required to produce a product. The prominence of the ECI stems from the fact that it usually correlates strongly with income, and deviations from this correlation are good predictors for future growth rates, indicating that "countries tend to approach the levels of income that correspond to their measured complexity" (Hidalgo and Hausmann, 2009, p. 10574).

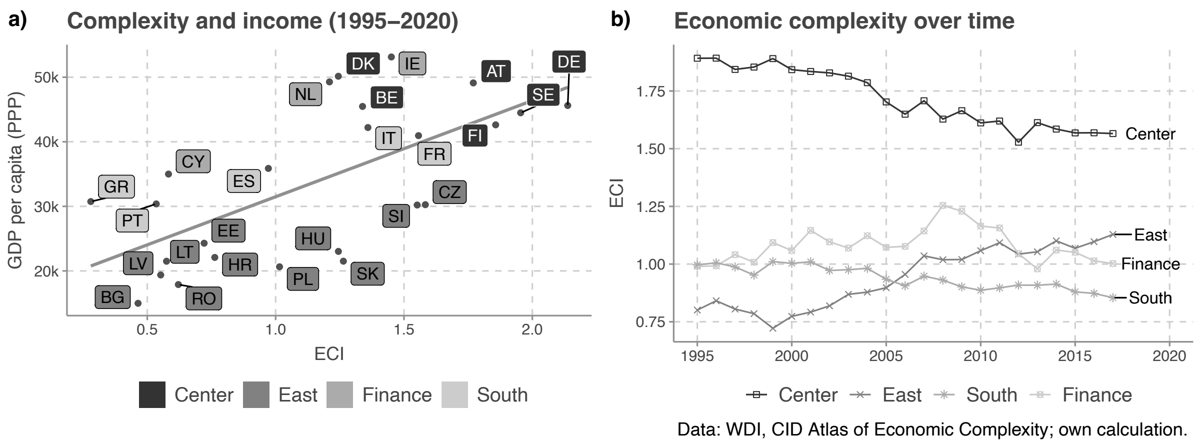

Figure 3.2: The economic complexity of European Member States. Panel a is built on mean values over the whole time period, i.e. 1995-2020. Country groups are the same as in Figure 3.1b and correspond to the development models described in Table 3.2., but do not include Luxembourg and Malta because the ECI is not computable for such small countries.

If one considers the ECI of European Member states, one finds that it not only correlates with their level of income (Figure 3.2a), but also exposes important differences across Member States: Central European countries persistently exceed the rest of the Union, while Eastern countries are catching-up to them and already surpassed the stagnating countries in Southern Europe and the financial hubs (see Figure 3.2b). These differences in the ECI reflect a more fundamental polarization within the EU, one that becomes visible once we complement the classical supply-side perspective of economic complexity with a Post-Keynesian demand side perspective, as provided by the concept of a *growth model* (Baccaro & Pontusson, 2016): a growth model is determined by the major sources of aggregate demand, which Baccaro & Pontusson (2016) consider the main stabilizer of aggregate income. Gräbner et al. (2020b) use this concept to delineate two very broad growth models that are of major relevance in the EU: an *export-led* growth model, in which countries stabilize their aggregate demand by selling products to other countries on the world market, and a *debt-led* growth model, where the aggregate demand gets stabilized by the provision of credit to national households. Both models were developed partly as a reaction to the rising of domestic inequalities and the resulting decrease in domestic demand (e.g., Atkinson et al. 2011; Kapeller et al., 2019). While the export-led model substitutes domestic demand with exports, the debt-led model stabilizes domestic demand via credit. The problem with the latter approach is that it has been rendered infeasible through the institutional reactions to the financial crisis in 2007ff, which now prevent the relevant actors to incur new debt. In effect, the countries following this model suffered considerable losses in income and have not recovered until today (see Gräbner et al., 2020b, for more details).

This begs the question of why – if the export-led model was superior and did not experience these problems – not all EU countries simply decided to follow such an export-led model? The differences in economic complexity discussed above give the answer: in order to follow an export-led growth model, the firm population of a country needs to be competitive on international markets. In principle, there are two broad sources for competitiveness: low costs on the one, and high quality or technological complexity on the other side. For advanced countries, such as basically all members of the EU, the former avenue is, however, difficult to take – at least on a global level: due to social and ecological regulations in the EU, even low-wage countries have difficulty to compete with countries such as India, China, or Bangladesh. Thus, it is a widely accepted empirical result that quality r technological complexity is, by far, the most important determinant for firm competitiveness in advanced countries (e.g., Carlin et al., 2001; Sutton, 2012; Dosi et al., 2015).

The accumulation of technological capabilities is, however, a highly path dependent process (see Aistleitner et al., 2021, for a review on the underlying mechanisms), and specialization patterns, once entered by a particular country, are hard to reverse. Figure 3.3 illustrates the results of this by representing the composition of the export baskets of Germany and Greece since 1995.[7] It is immediately evident that Germany is able sustain its position as exporter of rather complex products, such as vehicles, machinery, chemicals and electronics, while over time Greece has lost ground even further in these areas. Rather, simple products, particularly minerals (here: especially raw oil), have become more important, reflecting the worrying trend of de-complexification and de-industrialization in Greece.

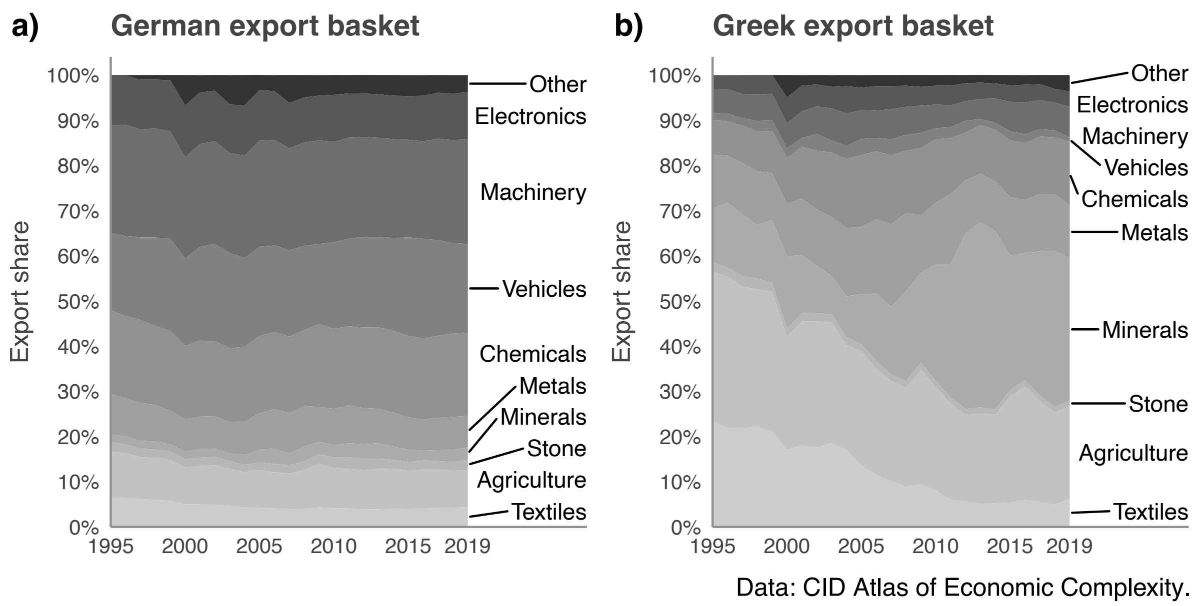

Figure 3.3: *Export baskets of Germany and Greece between 1995 and 2020.*

3.2. Technological directedness and path dependency

To move beyond these illustrative but descriptive examples of Germany and Greece, and to study the path dependency associated with technological change on the meso and macro level via reference to the mechanisms of capability accumulation on the micro level one may use the indicator of technological directedness developed by Gräbner et al. (2020a): this indicator provides information on the general directedness of technological change, i.e. whether a country is able to expand its stock of technological capabilities, or whether it is stagnating or even deteriorating. The general idea is as follows: first, two reference periods must be chosen. In the present case, the period 1995-2005 (pre-Eurozone, pre-financial crisis) will be compared against 2010-2020 (post-Eurozone, post-financial crisis). Then the export baskets for each country c during these two periods will be considered and the set of products for which this country was able to increase its exports, P_c^+ determined. We then take the log of the difference on the average product complexity, distinguishing between products that are in P_c^+ and those that are not. In both cases, the observations are weighted according to their share in the export baskets in the ultimate four years, i.e. 2016-2020. This ensures that, in the regressions below, those products that are currently most important for the respective country receive greater weight in determining the directedness of technological change. Specifying $\Phi_{c,i} = 1$ if $i \in P_c^+$ and $\Phi_{c,i} = 0$ if $i \notin P_c^+$ gives rise to the following two regression equations to be estimated with weighted least squares (WLS):

$$\log\left[\sum_{t=2010}^{2020} \phi_{c,i}\pi_{c,i,t} - \sum_{t=1995}^{2005} \phi_{c,i}\pi_{c,i,t}\right] = \beta_c^+ \,\overline{PCI}_{c,i} + u_{c,i} \;\forall i \in P_c^+$$

$$\log\left[\sum_{t=2010}^{2020} (1-\phi_{c,i})\pi_{c,i,t} - \sum_{t=1995}^{2005} (1-\phi_{c,i})\pi_{c,i,t}\right] = \beta_c^- \,\overline{PCI}_{c,i} + u_{c,i} \;\forall i \notin P_c^+$$

Here, $\pi_{\cdot c,i,t}$ corresponds to the total value of exports of good i by country c in year t (measured in constant USD), and $PCI_{i,t}$ represents the product complexity of product i in year t. Then, $\overline{PCI}_{c,i} = \sum_t \left[\pi_{\cdot c,i,t} / \sum_t \pi_{\cdot c,i,t} \right]$ is the average product complexity over a given time frame. As indicated above, the equations are estimated via WLS, of which the weights $\omega_{c,i}$ are given by the share of the product in the export baskets during the period of 2016-2020:

$$\omega_{c,i} = \frac{\sum_t \pi_{\cdot c,i,t}}{\sum_i \sum_i \pi_{\cdot c,i,t}}, t \in \{2016, \dots, 2020\}$$

In effect, one ends up with two estimates for each country: one, $\hat{\beta}_c^+$, for the relationship between product complexity and product *expansion*, and another, $\hat{\beta}_c^-$, for the relationship between product complexity and product *contraction*. If, for instance, $\hat{\beta}_c^+ > 0$ then the country increases its exports mainly for more complex products, but when $\hat{\beta}_c^+ < 0$, it increases its exports mainly for non-complex products. These estimates are already illustrative, as the example in Figure 3.4 indicates: here, the estimates for the group of expanding products shows that while Germany is expanding its capabilities, the stock of capabilities for Greece is deteriorating (i.e. β_{GRE}^+ is negative and β_{DEU}^+ is positive).

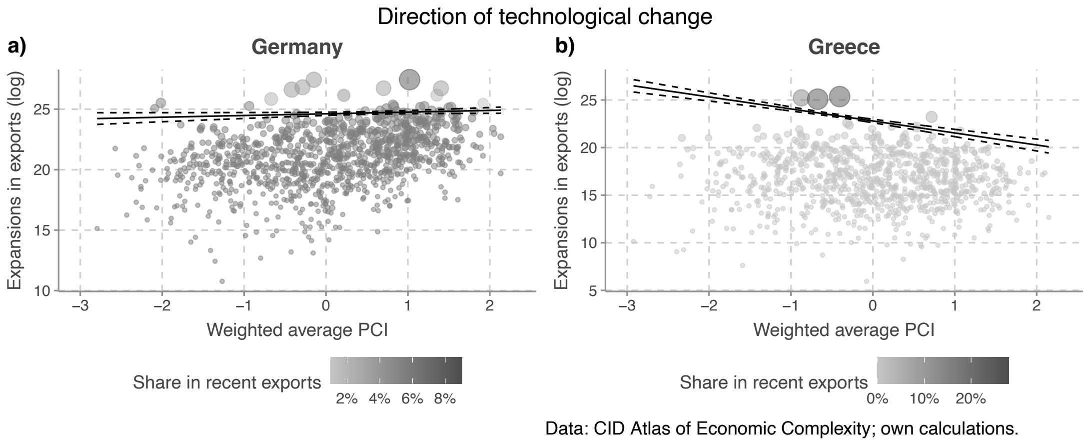

Figure 3.4: *the estimated measures for the group of expanding products in Germany and Greece. The slopes of the regression lines correspond to the estimates for β_c^+ as defined above.*

To reach the final measure of technological directedness for each country one then computes a weighted average of the estimates for expanding and contracting products. As weights one takes the total increases of exports

$$\gamma_c^+ = \sum_{t=2010}^{2020} \phi_{c,i}\pi_{\cdot c,i,t} - \sum_{t=1995}^{2005} \phi_{c,i}\pi_{\cdot c,i,t}$$

and the total decreases of exports

$$\gamma_c^- = \sum_{t=1995}^{2005} (1 - \phi_{c,i})\pi_{\cdot c,i,t} - \sum_{t=2010}^{2020} (1 - \phi_{c,i})\pi_{\cdot c,i,t}.$$

Then, the final indicator can be defined as follows:

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

The resulting indicator θ_c is positive whenever more complex products become relatively more important for country c, i.e. if the direction of technological change is favorable, and negative if simpler products become relatively more relevant and, therefore, the direction of technological change can be said to be detrimental for country c.

This indicator can be used to illustrate the strong path dependence of technological change on the macro level. To this end, one relates the resulting indicator with the initial stock of capabilities in a country, as measured by the ECI at the beginning of the period considered. This is done in Figure 3.5. The strong correlation indicates that the accumulation of technological capabilities is a path dependent and self-reinforcing process: countries with a higher stock of technological capabilities will have it easier to expand their stock further, while countries with few capabilities have difficulties to accumulate more (Hidalgo & Hausmann, 2009). The particularly strong relationship for Eastern countries illustrates the important role economic complexity is playing for their catching-up strategy, which is mainly built on a growing manufacturing sector. These path dependencies suggest that without an exogeneous policy intervention, the endogenous polarization among Member States is likely to continue.

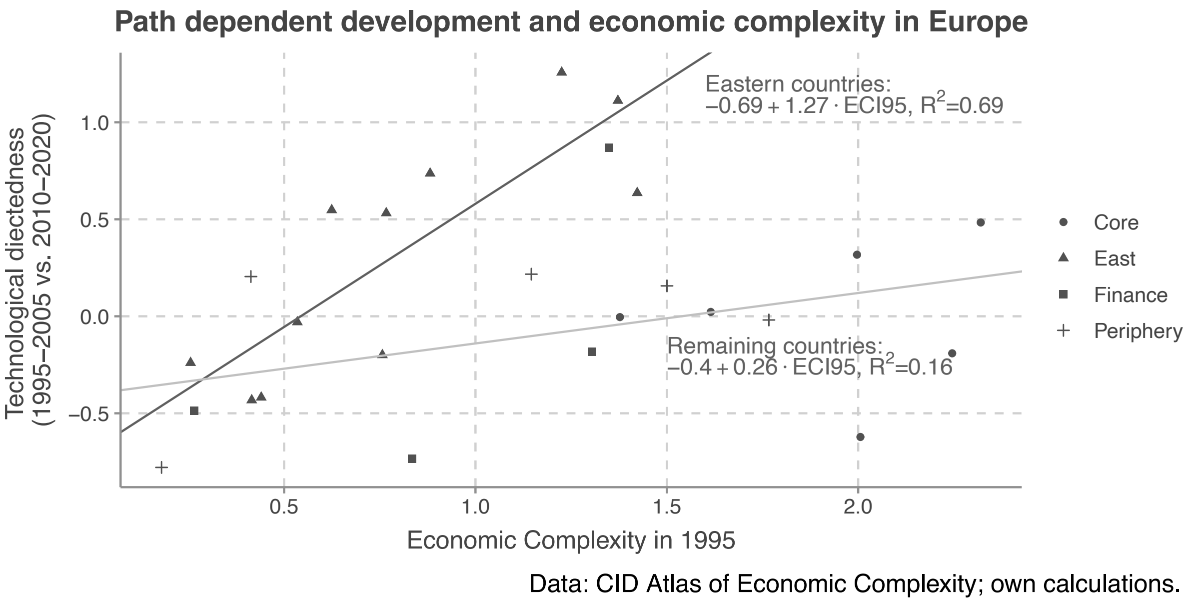

Figure 3.5: *The path dependence of technological development in Europe. Groups correspond to the development models in Table 3.2.*

3.3: Path dependency, development models, and the role of external shocks

The presence of such path dependent development patterns, as well as the considerations about different growth models above begs the question of whether one can delineate a number of different *development models* for the EU, such that countries can be grouped according to the development model they follow. A development model can be understood as a generalization of a growth model and refers to the main driver of socio-economic development in a country. The concept of different development models could also be useful for a comparative analysis since one might begin by delineating different country groups, and then to focus on a comparative analysis of exemplary cases for each country group. This way, one would be able to reduce the number of meso units one needs to consider significantly. The most immediate taxonomy that is suggested by the literature would classify countries into a set of *core* and a set of *periphery* countries, depending on the growth model they are following, i.e. a debt-led or an export-led model, as discussed above. Such simple distinction between cores and peripheries, however, seems to be too coarse to make sense of the European polarization more generally: simply dividing the EU into a core and a periphery does not do justice to the heterogeneity of development models in the Union.

Rather, a distinction of four different development models seems to be a more adequate (see Table 3.2 and Figure 3.6 for an overview, and Gräbner et al. 2020a for a more extensive discussion): first, there is a group of countries which are mostly located in Central Europe and that are distinguished from the rest by (i) relatively high GDP per capita levels, (ii) firm populations that have accumulated a lot of technological capabilities and that are, therefore, highly competitive on international markets, (iii) a relatively large industrial sector, and (iv) relatively low levels of unemployment. These are countries that build their economic success on the technological superiority of their firms and that are able to follow an export-led growth model as explained above. Usually, these countries also play a politically influential and important role within the EU (and are more likely to establish favorable political framework conditions for their firm populations – the mutual relationship of the micro and meso level becomes, again, apparent).

Group	**Driver of development**	**Characteristics**	**Members**
Core	Technological superiority on the world market	- High GDP per capita levels - Importance of industrial production - Production of complex products - Relatively low unemployment	Austria, Belgium, Denmark, Finland, Germany, Sweden
Periphery	Credit (unsustainable)	- Lower export shares - Relatively high public debt - Tendency to current account deficits - Relatively high unemployment	Cyprus, France, Greece, Italy, Portugal, and Spain
Catch-Up	Low factor costs, emerging industries	- Relatively low levels of wages and GDP per capita - High degree of foreign ownership - Small service sector - Important manufacturing sector	Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia
Finance	Financial services	- High debt levels of private firms - Important share of finance in terms of gross output - High foreign investment inflows - Large incomes from wealth taxes	Cyprus, Ireland, Luxembourg, Malta, Netherlands

Table 3.2: *Development models and resulting country groups. The groups as the same as identified by Gräbner et al. (2020a). The group of 'Southern countries' from the previous figures now corresponds to the 'periphery' group, the 'Eastern countries' corresponds to the Catch-up group, and the 'Central European countries' to the 'core'.*

The second group is the classical periphery, most of which are located Southern Europe. While these countries enjoy moderate levels of GDP per capita, their economic outlook is rather sinister: (i) since their firm populations are not nearly as technologically advanced as those of the core countries their export shares are rather low, and (ii) they tend to accumulate significant current account deficits; (iii) in effect they tend to suffer rather high levels of unemployment, and (iv), due to their unsustainable debt-led growth model they tend to have relatively high levels of public debt. These countries suffered from the Eastern enlargement of the Union in the sense that the new members of the EU were able to outperform them, especially via low factor costs, on European markets and substituted them as core suppliers for the complex industries in the core (Gräbner et al. 2020b).

This brings us to the third group, which mostly comprises countries from Eastern Europe. These countries entered the EU only recently and for many of them the future development is much more contingent than for core and periphery countries. And despite important heterogeneity, all of them are characterized by (i) relatively low factor costs, especially low wages, (ii) currently low levels of GDP per capita, (iii) a relatively small service and large manufacturing sector, which is accumulating technological capabilities rather quickly, and (iv) a high degree of foreign ownership, meaning that many firms are dependent on capital inflows from foreign countries. While some of these Eastern countries show promising catch-up dynamics, it remains to be seen whether they are truly catching up to the richer countries in Central Europe, or whether they are converging to the periphery (for a more extensive discussion of the heterogeneity of the Eastern economies see, e.g., Bohle, 2017).

The final country group comprises countries that do not feature any substantial industries but tend to have even higher per capita income levels than the core countries above. This points to the fact that, despite the traditional focus on technology as a driver of development in evolutionary growth theory, there are other ways to become rich. One way, at least under the current institutional framework of the EU and the world economy, is to build a large and deregulated financial sector, and to attract foreign assets through low tax rates and the absence of regulations. Thus, the countries in the EU that follow this strategy are characterized by (i) a large financial sector, both in terms of employment and gross output, (ii) high foreign investment flows, (iii) large incomes from wealth taxes, and (iv) high debt levels of private firms (due to their activities in the financial market). One problem with this development model is that since it is built on the attraction of assets from elsewhere, it often works at the expense of other countries: the Netherlands, for instance, attract US multinationals with very low commercial tax rates, incentivizing these companies to shift their profits into the Netherlands. While this increases tax revenues in the Netherlands by about 2.2 billion USD, the remaining EU Member States tend to lose 10 billion of commercial taxes because of this profit shifting (Cobham and Garcia-Bernardo, 2020).[8]

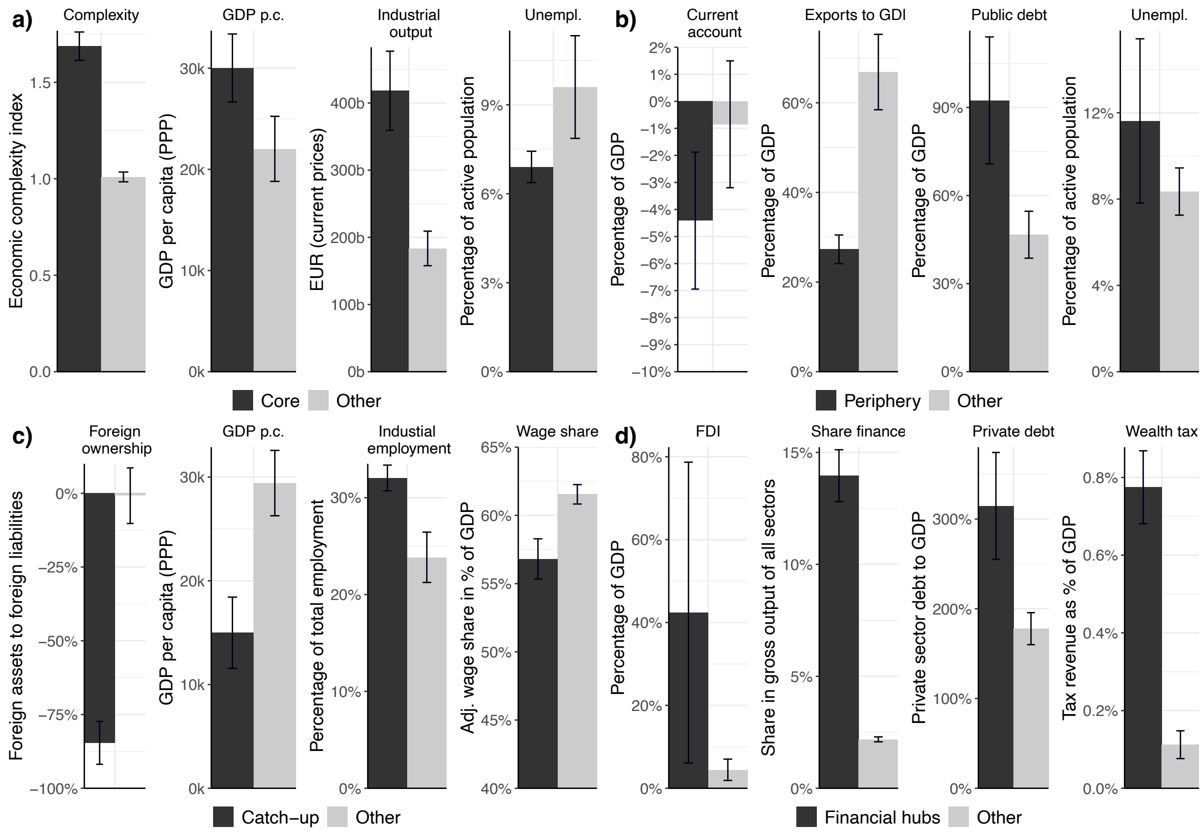

Figure 3.6: The distinctive properties of the countries following different development models; the groups are the same as depicted in Table 3.2, means and variance computed over the time period 2000-2015. Data taken from Gräbner et al. (2020a; see reproduction material for precise sources).

The resulting taxonomy of countries is the same as the one proposed in Gräbner et al. (2020a; for an overview over alternative taxonomies see, e.g., Gräbner & Hafele, 2020). It illustrates that while, especially for advanced economies such as those in Europe, the accumulation of technological capabilities is an essential driver of economic development, it is not the only one: the Eastern countries show that, at least in the short run, low factor costs can also be such a driver, and the financial hubs suggest that a focus on finance can also be a source for positive development – albeit at the expense of others.

One important idea underlying this country taxonomy is that it is not only informative regarding the development dynamics of the countries, but also regarding how these countries react to external events: it is one central argument in structuralist theory that countries belonging to different structural parts or the global economy, such as the core and the periphery, react differently to the same events, usually to the disadvantages of the peripheries. At least at first sight, this is also true for the present case: Figure 3.7 depicts the impact of the financial crises and the Corona crises on EU Member States (for the latter see also, e.g., Odentahl & Springford, 2020, and Gräbner et al., 2020c), highlighting the lower resilience of some development models.

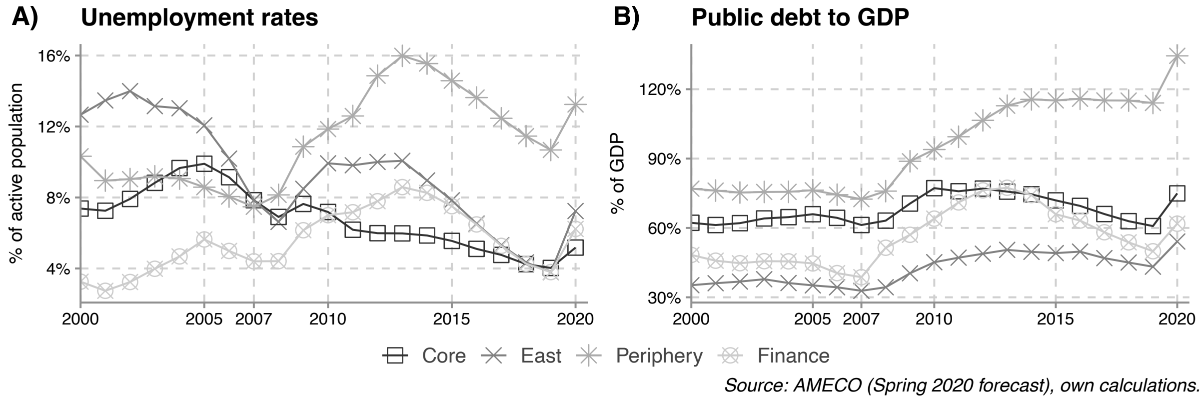

Figure 3.7: Illustration of the different reactions of distinct development models to the same exogenous shock. The same shocks are more severe and persistent for periphery countries than for the rest. The development models are as in Table 3.2.

Some impacts operate in a more subtle way than the ones in Figure 3.7. They also require more advanced techniques to be identified. The example discussed here refers to Gräbner et al. (2020a), who study the effect of economic integration within the EU on various socio-economic indicators on the country level, such as GDP, unemployment, debt or the wage share. To this end, the authors proceed as follows: first, they estimate the dynamic effects of European integration on the various indicators using the method of local projections, which comes down to the estimation of a series of linear regression models using the following regression equation:

$$Y_{i,t+k} - Y_{i,t} = \beta^k X_{i,t} + \delta^k Z_{i,t} + \mu_i^k + \eta_t^k + u_{i,t}^k$$

in which $Y_{i,t}$ is the dependent variable of interest as observed in time t for country c, $X_{i,t}$ the central explanatory (or 'shock') variable, $Z_{i,t}$ a matrix of control variables, μ_i^k and η_t^k are country and time fixed effects, and $u_{i,t}^k$ is the error term. The superscript k denotes the time horizon considered, such that $k = 2$ means to estimate effect of the shock variable on the dependent variable two time periods after the shock has become effective.

From the series of estimations for different k one can then derive an impulse response function to quantify the dynamic effect of the shock variable on the dependent variable over time. There is another way to use the results of this model, however: Gräbner et al. (2020a) use the estimates for the fixed effects μ_i^k to cluster the countries using tools from unsupervised machine learning. Since the fixed effects are used to control for country specific and time-independent effects, grouping countries according to their fixed effects estimates means to put countries in the same group whose time-independent properties lead to a similar reaction to an increase in economic integration. Interestingly, the application of different hierarchical clustering algorithms to these fixed effects estimates in Gräbner et al. (2020a) always produces a country grouping that is surprisingly similar to the theoretically derived grouping depicted in Table 3.2 above – a striking result that corroborates the delineated development models further (for more details see Gräbner et al. 2020a). Such an innovative combination of regression and clustering techniques can be useful whenever one suspects that unobservable country characteristics, which one can assume to be stable over the study period, affect the reaction of a country to some external shock. In the present case, the institutions of the countries, especially their national innovation system, seems to be a natural mediator variable that could be driving the results, and which could be subject to a more qualitative and specific comparative analysis.

At this point, however, a word of caution is adequate: while the identification and analysis of different development models and country groups can be very enlightening, it also comes with potential pitfalls. According to Gräbner & Hafele (2020), there are three main challenges which should always be taken into account when using the concept of a development model for comparative analysis: first, the *challenge of dynamics* points to the fact that while the development trajectories of countries are rather stable, there is the possibility that a country switches from one development model into another. Ireland comes immediately to mind when one is looking for an example: while being heavily dependent on the UK until the 1990s, it then transformed into a highly financialized economy that experience considerable growth rates (for more details on this case see Regan & Brazys, 2018). The second challenge is the *challenge of ambiguity*. It refers to the fact that some countries are very difficult to classify since they possess properties that one would usually associate with different development models. The most obvious example for this case is France, which is economically part of the European periphery (see also Gräbner et al. 2020a), but because of its size and historical reasons might well count as part of the political core (Gräbner & Hafele, 2020). Finally, the fact that there might be considerable heterogeneity *within* countries gives rise to the *challenge of granularity*: within a country, certain regions play the role of internal peripheries, while others are internal cores. The East/West/North/South-divide of Germany, or the North-South divide in Spain are examples for this challenge (see also Immarino et al., 2018).[9] Studying these internal heterogeneities further is an obvious area for future applications of the EACES, given its commitment to the layered ontology of systemism as described in Section 2.

Therefore, it is always useful to complement the group-based analysis with a closer look at the individual units. Such an approach should be considered complementary to the analysis of development models, since the delineation of the different country groups provides an immediate suggestion on how to select countries to be studied in more depth. The single cases could then be studied qualitatively, e.g. using methods developed in the context of the national innovation systems literature (e.g. Lundvall, 2007), or more quantitatively with tools developed explicitly for comparative case studies, such as the *synthetic control method* discussed at length in Abadie (2021).

3.4. Synthesis and further concepts

The previous three subsections were each concerned with a particular aspect of the polarization process in the European Union. In each of the subsections, quantitative empirical methods and theoretical concepts that are useful to operationalize EACES was introduced. While space constraints prevent a more complete analysis and a more nuanced introduction of the methods, the exposition was hopefully sufficient to illustrate the application of some of the essential elements of the EACES, and to show how even a superficial application already points to some interesting avenues for future research.

Concept	Description	Guiding questions	References
Path dependence	In the presence of positive feedback mechanisms, dynamic processes are often non-ergodic and give rise to non-linear dynamics and persistent differences between the objects of the comparative study. Identifying the kind and sources of positive feedback is often an important part of the comparative study.	- What kind of path dependent process is operating? - Which are the elements competing with each other? What are the quality criteria determining the ‘successful’ elements? - What are the sources for positive feedback? - Is the process still contingent or is the system already in a state of lock-in?	Dobusch & Kapeller (2013)
Technological capabilities	Capabilities are not only a determinant for economic success at various level, but due to the often path dependent way capabilities are accumulated they are also a source of persistent differences in the development paths of different subjects.	- At which level are capabilities accumulated? - Which mechanisms of accumulation are most relevant? - What are barriers for accumulation? How do they differ across subjects?	Aistleitner et al. (2021)
Economic complexity	Economic complexity is one influential and effective way to measure technological capabilities on various ontological levels using different data. Especially interesting are cases where subjects over- or under-perform as compared to what their level of complexity predicts – the explanation is often illuminating.	- How do subjects of analysis differ in terms of their complexity? - What subjects are under- or over-performing with regard to their complexity? Why?	Hidalgo (2021)
Development models	Often the objects of analysis differ regarding the main sources of economic development/success. To explore the questions of whether the resulting models differ in terms of long-term sustainability and whether they are in conflict with each other is often insightful.	- What are the main drivers of development for the different models? - What is the role of the supply and demand side? - Is there rivalry between the models? - Is there a power asymmetry among the models?	Baccaro & Pontusson, (2016), Gräbner et al. (2020b)
Dependency	Whether the objects of the comparative study are independent, or dependent on each other is a key element shaping their dynamics. This question also makes visible relations of exploitation and structural dependencies.	- Are there relations of dependency among the subjects of analysis? - Where and when are the origins of this dependency? - Through which mechanism and on which levels does the dependency manifest?	Kvangraven (2020)

Table 3.3: A non-exhaustive list of theoretical concepts and topical suggestions that often turn out to be insightful when conducting a comparative study in the spirit of the EACES.

This Section closes by providing a non-exhaustive list of theoretical concepts in Table 3.3. These concepts often play an important role in comparative studies in the spirit of the EACES. Thus, the list should serve researchers as a guidance when conducting a comparative analysis: they might go through the list, and test whether each element can help to illuminate the case at hand. Due to space constraints the single concepts cannot be discussed in the analytical depth they deserve, so references to specialized publications are provided for further reference.

5. Summary

This chapter introduced the central elements of an evolutionary approach to comparative economic studies (EACES). Since such an approach contains elements from a variety of different research programs, the first part of this chapter outlined its meta-theoretical foundations. Both the ontology and epistemology of this approach are characterized by a systemist view on its objects of investigation. It is firmly rooted in evolutionary theory and stresses the joint relevance of different ontological layers, commonly referred to as micro, meso, and macro, and the mechanisms bridging these levels. Mechanisms also play a central element in the epistemology of the EACES, which is geared to the explication of causal mechanisms driving the dynamics to be explained. The second part of the chapter gave a cursory example of how an application of this approach could look like by studying polarization patterns in the European Union. In this context, several methods that are consistent with the approach were illustrated, and further references to more specialized applications were given. The chapter concluded with a non-exhaustive list of theoretical concepts and topics that are usually valuable to consider within a comparative analysis in the spirit of the EACES. While the chapter necessarily remained cursory in many ways, it hopefully illustrated the potential of the EACES for comparative analyses. The ontological and epistemological guidance it provides, as well as the methods commonly used in the related literature certainly show much potential to illuminate a number of promising avenues for future research, such as the likely effects of social and ecological transformations as well as adaptations to climate change: in all these (and many more relevant) cases, mechanisms on various ontological levels are important, the mutual dependency of economic and non-economic systems is obvious, and endogenous and nonlinear dynamics are prevalent. The EACES is well prepared to deal with such challenges.

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Endnotes

[1] Systemism is a neat intermediary position between the classical extremes of 'holism' – which focuses social aggregates – and individualism – which focuses on individuals and denies the existence of aggregates, such as social structures altogether.
[2] This example illustrates that the terms ‚micro', 'meso' and 'macro' do not come with a fixed reference level but are context dependent and need to be explicated. In the example above, for instance, 'micro' might refer to a single firm, 'meso' to a sector' and 'macro' to a nation. But, in another context, 'meso' might be the nation, and macro a supranational entity such as the European Union.
[3] This commitment to mechanism-based explanations is complementary to the commitment to *causal explanations*, which are also considered to be an essential feature of evolutionary approaches and directly follows from Darwin's work on evolution (e.g., Hodgson, 2004; Witt, 2014).
[4] Such an encompassing analysis would go beyond the scope of a single chapter. This Section draws on the insights from a number of earlier works, especially Gräbner & Hafele (2020), Gräbner et al. (2020a, 2020b, 2020c) and Kapeller et al. (2019).
[5] As described above, the allocation of the different levels of analysis is pragmatic. One might well introduce an additional level of analysis, e.g., between the micro and the meso level, such as regions. This would help highlighting the polarization patterns that are taking place *within* European Member States (see, e.g., Iammarino et al., 2018). Such analysis, however, would go beyond the scope of this Section, which is mainly meant to illustrate the concepts introduced above.
[6] This is not to say that there are not important polarization processes at the individual or regional level in the EU. On these topics see, e.g., Atkinson et al. (2011) or Iammarino et al. (2018).
[7] As explained above, data on exported goods is used as a proxy for the goods produced in an economy since data on produced products as such are rarely available. Previous research has been shown that exported goods are indeed a good proxy for the latter (e.g. Saltarelli et al., 2020).
[8] This practice is one symptom of a detrimental *Standortwettbewerb* among EU Member States, a phenomenon that is discussed more completely in, e.g., Kapeller et al. (2019).
[9] From a more general perspective, this challenge also applies whenever the overall focus of the analysis is shifted: once the main subject of investigation is not Europe, but the world economy, it might make sense to consider Europe as a meso entity playing the role of a global core region, despite comprising countries such as Greece, which are globally rather part of a core, but locally within Europe part of the periphery.