Policy convergence as a multi-faceted concept:

The case of renewable energy policies in the EU

Keywords: policy convergence, economic convergence, renewable energy sources, support instruments, public R&D subsidies

Abstract

The literature on policy convergence has identified numerous facets and causal drivers of convergence. Distinguishing four dimensions of convergence (object, benchmark, drivers, and directed process) helps to clarify why and in what form policy convergence may occur (or not). Thus, depending on, e.g., the object of analysis (policy outcome or instruments used), the same empirical case may give rise to opposing assessments. Furthermore, both economic and political drivers are necessary to account for successful policy convergence: economic convergence partly explains why countries may face similar problems and political mechanisms explain why they might choose similar policies to solve a given problem. The paper illustrates the multi-faceted character of convergence for the dynamic field of renewable energy policies in the EU. The empirical results indicate temporary convergence in the case of policy support instrument choices and conditional convergence in terms of renewables shares. However, the results suggest divergence of public R&D subsidies targeting renewables.

Introduction

"[A]dvanced industrial states are facing similar problems and are tending to solve them in similar ways" (Bennet 1991: 218). This, in a nutshell, is policy convergence. Alas, we need not go far to see this simple rationale shattered – to some, for instance, the European Union (EU) appears as a system of differentiated integration (cf. Leruth and Lord 2015); others ask, more sharply, "how much distrustful divergence the European Union can contain without degenerating into ineffectiveness and fragmentation" (Hayward and Wurzel 2012: 1). Against this backdrop, we analyse how the concept of policy convergence, understood here as an increase in policy similarity over time (cf. Kerr 1983; Drezner 2001; Holzinger et al. 2008b), can be framed and productively employed within a contested empirical context: policies supporting electricity from renewable energy sources (RES)[1] in the EU.

Surprisingly, the convergence literature is rather dispersed: there is a long trail of political science literature, including empirical studies on convergence of environmental policies (e.g., Fernández 1994; Howlett 2000; Holzinger et al. 2008a) as well as specific case studies on RES policy convergence (e.g., Jacobs 2012; Kitzing et al. 2012). Rather independently, economists have thoroughly investigated (both theoretically and empirically) the general mechanisms of economic (growth) convergence (for overviews see Rodriguez and Rodrik 2001; Islam 2003), and its relationship with environmental pollution convergence (e.g., Brock and Taylor 2010). Moreover, a handful of econometric studies assess international convergence along various environmental indicators (e.g., Camarero et al. 2013; Pettersson et al. 2014). Still, as Plümper and Schneider (2009) observe, there exists a gap between theoretical and empirical work on convergence because compared to the many theoretically proposed drivers of convergence, the empirical evidence is rather weak. This implies a problem for the conceptual research on convergence in that it does not sufficiently explain under what conditions and to what extent convergence processes actually unfold.

The paper contributes to closing this gap by extending previous conceptualizations (e.g. Bennet 1991; Holzinger and Knill 2005; Holzinger et al. 2008b) through a systematic differentiation that includes both economic and political science reasoning on convergence issues. Specifically, the paper distinguishes four dimensions (object, benchmark, drivers and directed process) of policy convergence, which help to clarify why and in what form convergence might occur (or not). First, acknowledging that the *object* of convergence may refer to, amongst others, policy instruments or policy outcomes leads to the insight that convergence of the former not necessarily implies convergence of the latter. Second, the *benchmark* of convergence measurement may either be absolute or conditional on some other characteristic (e.g., with respect to geographical variables) so as to take overall heterogeneity between countries into account. Third, the *drivers* of policy convergence include both economic and political processes and these complement each other: economic convergence explains why states are facing the same problems while political drivers account for why states actually may employ the same (or closely related) solutions to address these problems. On their own, however, neither economic nor political drivers can sufficiently explain policy convergence. Fourth, convergence should be understood as a *directed process* that not necessarily leads towards a single final state. In contrast, convergence processes may lead to different final states.

Thus, the main contribution of this paper consists in conceptual consolidation, thereby also setting the stage for more accurate future empirical research: the framework should prevent researchers from confusing evidence for convergence with respect to a specific dimension over a certain period with sustained convergence over all dimensions. In order to illustrate the conceptual propositions, we turn to the empirical case of RES in the EU, a very dynamic field

with rapid technological development and continuous policy evolution over almost three decades now.

The average share of electricity consumption in the EU met by RES has almost doubled from 14% in 2004 to 27% in 2014.[2] Worldwide, in 2014 RES experienced their fastest expansion rate, accounting for almost half of overall additions in electricity generation capacity (IEA 2015a). In other words, RES are leaving their former status as niche technologies, thereby fundamentally transforming electricity systems (e.g. Edenhofer et al. 2013). With increasing RES penetration, the main impetus of RES policies shifts from rapid capacity addition to market and system integration as well as to the cost-effectiveness of RES deployment (e.g., Miller et al. 2013). In consequence, national RES policies are regularly updated, often on yearly basis.

At the same time, RES policies in the EU have been scolded as too fragmented and in need of "Europeanization" (e.g., Tagliapietra 2014). Critics advocate coordinated RES support on EU-level as a means for a more efficient geographical allocation of RES installations (e.g., Teyssen 2013; Unteutsch and Lindenberger 2014). However, these calls for Europeanization of RES policies neglect both normative trade-offs and politico-economic restrictions. From a normative economic perspective, centralization also has its downsides: in particular, the "laboratory federalism" argument (Oates 1972, 1999) points to the advantages of decentralized experimentation (see also Tews 2015; Citation 1). Moreover, Member States do not only dismiss any suggestion to concede sovereignty over energy and climate policy but they are also hesitant to coordinate their RES support schemes (Klinge Jacobsen et al. 2014).[3] Specifically, RES are often used as a vehicle for regional development and job creation and/or as a way to reduce regional and local environmental impacts, outcomes which could not be guaranteed in case of an integrated EU-approach. Thus, bottom-up processes may better

conform to both politico-economic restrictions and normative trade-offs than coercive top-down harmonization (Citation 2; Citation 3).

In consequence, the development of RES in the EU provides a particularly relevant empirical case for policy convergence research. Indeed, it illustrates the main challenge posed by the multi-faceted character of convergence: depending on the specific object of analysis and the benchmark used, the analysis does or does not find convergence. The paper provides some evidence for a temporary convergence around feed-in tariffs as support instrument (i.e., RES producers receive a fixed remuneration for each kilowatt hour (kWh) of electricity), conditional convergence of RES shares and divergence of public R&D subsidies for RES at the national level.

The rest of this paper is organized as follows: in the next Section, we explicate four dimensions of policy convergence. Subsequently, we illustrate the conceptual framework via empirical evidence for economic convergence and RES policy convergence in the EU. Finally, we discuss and summarize our findings.

What is policy convergence? An interdisciplinary recapitulation in four dimensions

Most commonly, policy convergence is understood as the "increase of policy similarity over time" (Holzinger et al. 2008b: 24), although a variety of alternative (albeit similar) definitions could be brought forward. In the following, we systemize the multi-faceted concept of policy convergence via differentiating four dimensions. Within this framework, we draw on both economic and political theories of convergence. In order to contextualize an otherwise abstract discussion, we revert to the case of RES policies for empirical examples.

The object of policy convergence

The objects of policy convergence may be distinguished along the specific stages of the policy process. Figure 1 provides a stylized overview of the development and implementation

of public policies. Needless to say, it is not meant to be a comprehensive and an entirely realistic representation of politics.[4]

Insert Figure 1 about here

Figure 1: Stylized overview of the different stages of the policy process

Compared to rather general notions of convergence such as "the tendency of policies to grow more alike, in the form of increasing similarity in structures, processes, and performances" (Kerr 1983: 3, cited in Drezner 2001: 53), we obtain more specific concepts of policy convergence objects when focusing on particular stages of the above scheme. Similarly, Bennet (1991) argues that policy convergence may relate to the dimensions of *objectives, content, instruments, outcomes* and *style* of policies. The following discussion demonstrates that the question on which dimension to focus on is closely related to normative questions on why convergence might be desirable in the first place.

First, objectives guide the long-term trajectory of policies. For instance, one might explore whether all EU Member States adhere to the main objective of the EU Roadmap 2050 towards a decarbonization of European energy provision. Alternatively, one might investigate policy targets, which typically represent quantified values that shall be attained in a certain period of time, in order to acknowledge distributional aspects (i.e., fair burden sharing).

Second, convergence of policy instruments is of particular interest from the normative perspective of (narrow) economic efficiency. Subsidizing RES deployment in the EU will be least costly – in terms of minimizing RES generation costs only – if the geographical allocation of RES facilities closely follows natural conditions. Such a deployment pattern, in turn, could be achieved via a harmonized scheme of RES support instruments in the EU

(Unteutsch and Lindenberger 2014). Thus, a range of benefits, including economies of scale in RES production, might be realized. However, instrument alignment *per se* is not sufficient for cost-effectiveness, it also requires convergence of *support levels*. Certainly, accounting for country-specific benefits of RES, questions the economic desirability of converging instruments/support levels in the first place (cf. Söderholm 2008a).

Third, policy convergence may refer to outcomes. Yet, the policy outcomes may be more due to other factors rather than being intended policy effects. For instance, RES shares (e.g., out of total electricity consumption) are affected by the cost of these technologies relative to the price of conventional energy sources. The latter, in turn, is influenced by a number of exogenous variables, such as the world market prices for coal and natural gas. Thus, outcome convergence appears as a weak proxy for policy convergence, as it may be primarily driven by strong global factors. Then again, one interesting question is whether policy manages to "even out" differences in natural conditions so that convergence in observed outcomes obtains despite structural differences (cf. Overbye 1994).

In conclusion, it is important to acknowledge that policy convergence of a particular object (cf. Figure 1: objectives-targets-instruments-outcomes) may not align with convergence in terms of another object – in fact, convergence of policy instruments may actually be directly responsible for *diverging* outcomes. To see this, consider the case of Sweden and Norway who merged their quota schemes (i.e., utilities are required to certify a certain amount of RES via tradable certificates), by establishing a common market for RES certificates in 2012. The aim of such a common market is not to achieve identical RES shares. In fact, the scheme should "promote increased wind power in Norway rather than Sweden" due to Norwegian comparative advantages (Söderholm 2008b: 2061). In the same vein, the calls for a uniform quota scheme in the EU actually tend to promote diverging RES shares across the EU following optimal geographical allocation of RES installations: wind farms along North

European shores, photovoltaic energy in Southern Europe and, conversely, less RES production in Central Europe's centers of population and industrial production.

In sum, the first conceptual specification concerns the *object* of policy convergence (cf. Bennet 1991). In particular, one might refer to:

- policy objectives/targets (e.g., RES-objectives/targets),
- policy instruments (e.g., RES-policies),
- policy outcomes (e.g., RES-shares).

The following proposition captures the relevance of choosing the object of convergence in a nutshell: *Convergence of policy instruments does not necessarily imply convergence of outcomes (and vice versa).*

The benchmark of policy convergence

The second conceptual specification concerns the benchmark of policy convergence (cf. Baumol 1986; Holzinger et al. 2008b), and here it is useful to distinguish between:

- *absolute convergence* implicitly assumes that all countries attain the same outcomes, e.g. in terms of the steady-state level of RES generation shares; and
- *conditional convergence* acknowledges key differences among countries, e.g., regarding economic wealth and geographical potential, in turn implying that countries may converge but towards different steady-state levels.

The notion of conditional convergence may be particularly helpful to improve the concept of outcome convergence. As noted above, a sole focus on observed outcomes may not relate much to policy convergence. But correcting for, for instance, Member States' GDP could take exogenous economic factors sufficiently into account. Furthermore, correcting for Member States' RES potential would enable relating conditional outcome convergence to the normative rationale of minimizing RES generation costs. Thus, introducing conditional

convergence measures might, in principle, solve some of the problems related to outcome convergence.

The crucial difference, then, lies in *when* we can argue to have convergence. We might say that conditional convergence is some weak version of policy convergence. For instance, in the case of RES policy instrument convergence in terms of support levels, absolute convergence is only achieved when support levels are equalized. In contrast, conditional convergence may describe a situation where countries are moving in the same direction (e.g., where not some countries are decreasing the support while others are increasing it), and there exist systematic and legitimate reasons for why we may never see completely equalized support levels. In short, the conceptual proposition regarding the benchmark of convergence reads: *Not only absolute but also conditional convergence may serve as a benchmark of convergence analysis.* Table 1 provides an overview of the specifications introduced so far.

Insert Table 1 about here

Table 1: Specifying "convergence" for the case of RES policies in Europe

The drivers of policy convergence

A third conceptual issue relates to the *drivers* of policy convergence, which in turn can be distinguished into economic and political drivers. In Figure 2, the economic drivers roughly correspond to the box at the top while the political drivers correspond to the large box which includes both bottom-up and top-down mechanisms. In the following, we first address the complementarity of economic and political drivers, before sketching possible sub-differentiations among the political drivers.

Let us start with the *economic drivers of convergence*. The introductory quote of Bennet (1991) points at an important precondition for policy convergence – namely that *states are facing similar problems*. In principle, such an alignment of issues-to-be-addressed by policy

intervention can come about through different channels, such as economic contexts, natural conditions, common institutional frameworks and ideological backgrounds. Nevertheless, the sobering experience of Europe's "monetary disunion" (Streeck and Elsässer 2016) hints to a particularly strong link between economic and policy convergence. While a common monetary policy binds the Euro group together, the lack of i) a sufficiently homogeneous area in terms of economic fundamentals and of ii) a fiscal stabilization mechanism has almost teared the Euro apart (thereby also supporting the theory of optimum currency areas, see Mundell 1961; Fingleton et al. 2015). In other words, policy convergence without economic convergence may often not be sustainable. What, then, is the rationale for expecting different countries to converge economically?

The modern economic theory of growth dates back to Solow (1956). It conceptualizes growth as extension of capital stocks (where capital includes all forms of productive assets, from machinery to know-how). If countries exhibit similar characteristics, such as the level of technological progress, the Solow-model predicts convergence of capital stocks (per capita) among these countries. In case the fundamental economic characteristics differ, convergence is not absolute but conditional, reflecting these differences. Yet, declining marginal productivity of capital may erode differences over time: poor economies should grow faster than rich economies because investments in the former yield higher *marginal* returns. Eventually, all countries would converge to the same steady-state level of capital (Baumol 1986). This is the so-called "catching-up" hypothesis – traditionally supposed to hold within an interdependent world of trade (Ohlin 1933; Samuelson 1948). Furthermore, a globalization-driven competitive pressure on economies may induce convergence of regulatory approaches. While Hall and Soskice (2001) pointed to persistent "Varieties of Capitalism", coordinated market economies have in recent years implemented more extensive deregulation than liberal market economics (Ther 2014; Pierre 2015) – possibly pointing towards a convergence of approaches.

Yet there is also a longstanding controversy over the "catching-up" hypothesis, in particular as regards the influence of international trade: for instance, it has been shown that opening up poorer countries to trade may stop growth convergence processes and even cause divergence (Bajona and Kehoe 2010). In addition, the catching-up hypothesis is empirically disputed (see Rodriguez and Rodrik 2001 as well as Islam 2003 for extensive overviews) and even staunch supporters of globalization concede that "catch-up will be a long, difficult grind" (The Economist 2014).

The economic literature on growth and convergence has been connected to environmental policies via the concept of the so-called Environmental Kuznets Curve (EKC, cf. Grossmann and Krueger 1995). The EKC suggests an inverted U-shape relationship between gross domestic product (GDP) and environmental pollution: with raising wealth, pollution at first increases but then decreases. Brock and Taylor (2010) argue that the EKC is a necessary "byproduct" of economic convergence within the Solow model. Yet as to the specific mechanisms that might give rise to such patterns, a range of candidates has been discussed. One prominent mechanism relates to the increasing demand for high environmental quality with rising income levels. Thus, economic convergence would directly translate into convergence of demand for generally stricter environmental policies. For instance, demand for clean energy provision increases as poorer countries catch up economically; due to higher marginal productivity of capital, poorer countries can raise their RES shares (e.g., in terms of photovoltaics (PV), wind power) faster than early adopters, with all countries eventually converging. Conversely, without economic convergence, there *could* be little reason to expect countries to align their energy and environmental policies and to attain similar outcomes in terms of, for instance, RES shares.

Insert Figure 2 about here

Figure 2: Causal mechanisms of convergence.

Based on and adapted from Holzinger et al. (2008b: 24)

Let us now turn to the *political drivers of policy convergence.* Theories of economic convergence are "apolitical" in the sense that they build on economic variables (e.g., technological progress, capital accumulation etc.) that may explain demand for specific polices; yet they are silent on the workings of the "political market" where policy supply needs to meet this demand (cf. Keohane et al. 1998). Policy convergence implies that demand is met in similar ways. In other words, problem convergence is a necessary but not a sufficient condition for policy convergence:[5] in principle, countries might promote rather different solutions to essentially identical problems. Thus, a comprehensive framework of convergence needs to identify the specific mechanisms that lead states to adopt similar policy solutions.

These political drivers may be differentiated into top-down and bottom-up drivers. Within the latter, one may further distinguish policy diffusion (in the narrower sense[6]), relying on interaction between countries, and independent policy formulation without interaction. As Figure 2 demonstrates, the literature on policy convergence mostly highlights different forms of interdependence between states, possibly combined with elements of top-down steering. Bennet (1991) proposed four different drivers of convergence: emulation, elite networking, penetration by external actors and harmonization. Subsequently, the literature focused on specific variations of Bennet's first two mechanisms under the label "policy diffusion" (e.g., Bush and Jörgens 2005; Tews 2005; Maggetti and Gilardi 2016). In particular, the non-hierarchical character of diffusion has been emphasized: "Diffusion is the spreading of innovations due to communication instead of hierarchy or collective decision making within international institutions" (Tews 2005: 65).

Thus, diffusion should be differentiated from coercive imposition and harmonization as other possible mechanisms that may establish homogeneous policies. Diffusion proceeds

horizontally rather than vertically and is "driven by information flows" (Busch and Jörgens 2005: 865) within processes of emulation and learning. Coming back to Figure 2, policy diffusion marks the result of interdependent problem-solving: neither are policies implemented due to pressure from above, nor are they conceived by solitary policy-makers. Empirically, diffusion has been identified as a crucial driver of economic policy reform (Pitlik 2007). The bottom-up drivers of policy convergence were further investigated by Holzinger and Knill (2005), and Holzinger et al. (2008b) who focused on three bottom-up mechanisms of convergence – transnational communication, regulatory competition and independent problem-solving.

In the case of European RES policies, such bottom-up processes may be especially relevant. The main reason here is the relative weakness of supranational EU institutions with regards to energy policy. While the Lisbon treaty for the first time stipulates an active role for the EU in conducting energy policy, Member States have retained their sovereignty over the general course of their energy policies (Article 194(2) of the Treaty on the Functioning of the European Union, see EU 2012). The EU commission, on the other hand, tries to shape Member States' policies even if its *direct* regulatory power is limited. The common EU climate and energy target architecture for 2020 and 2030 constitutes an *indirect* way of top-down influence – a common framework that creates a similar problem context (i.e., "how to increase the share of RES?") for all Member States without prescribing the use of specific instruments. Also, the Commission is increasingly active in using the internal market directives and the guidelines for environmental state aid to steer Member States energy policies in the preferred direction (e.g., in the form of tender schemes that use competitive bidding procedures to determine the level of RES support, or fixed premium schemes that offer RES-producers a mark-up on top of the spot-market price). Eventually, the "EU impact on the national energy mix is predominantly indirect, yet powerful" (Callies and Hey 2013: 88).

Furthermore, the EU's multi-level system with its complex architecture of partly differentiated, partly overlapping and often contested allocation of responsibilities allows for hybrid processes. For example, the so-called Open Method of Coordination (OMC), whereby the EU Commission influences national policies by agenda setting and framing inter-Member State discussions (cf. Ania and Wagener 2014; Borrás and Jacobsson 2004), represents one potentially important driver of convergence. So while national decisions may formally be taken voluntary, they may respond to pressures arising from, for instance, EU-guidelines and intergovernmental discussions. Thus, Member States may cooperate, compete, communicate, emulate one another or combine all of these activities.

In conclusion, theories of economic and political convergence processes complement each other: the former helps explain why states are facing similar problems, the latter provide rationales for why states choose or should choose the same policies to solve a given problem. We may summarize this argument in the following conceptual proposition: *On their own, neither economic nor political drivers can sufficiently account for policy convergence*.

The directed process of policy convergence

Finally, a fourth conceptual dimension of convergence results from its conjunction of both *process* and *final state***.** Specific definitions may accentuate these characteristics to different degrees. Consider, for instance, the following hypothetical situation: some EU Member States move from wide diversity towards more similarity, albeit still far from homogeneity. If we emphasize proximity to *final states*, we would rather not refer to this situation as convergence. However, if we focus on the *process* of increasing similarity, we would speak of a case of convergence – even if the process is far from finished. In a similar vein, Plümper and Schneider (2009) introduce a distinction between complete and incomplete convergence.

Against this background, the process-dimension is a crucial conceptual element of convergence, not least because it directly opens the analytical framework for investigating the mechanisms that may lead to convergence. Furthermore, as Bennet (1991: 230) remarked: "Policy convergence should also be conceptualized in dynamic terms. The relevant theoretical dimension is time rather than space. Otherwise the concept becomes a synonym for similarity". At the same time, final states are important as a benchmark against which to measure the progress of increasing similarity. In the particular context of RES policies, the final states are moving targets (e.g., support level or RES share/per capita GDP) that evolve with technological and political development: unless we refer to the EU's long-term aim of full decarbonisation, essentially implying 100% RES, it does not seem sensible to consider specific support levels or RES shares as "final" in any literal way. In brief, we suggest the following conceptual proposition: *Convergence processes may notwithstanding lead to different final states*.

Methods and Data

The general point of this paper that convergence is multi-faceted has to be translated into a structured conceptual framework that can inform empirical research. To this end, the preceding section differentiated four dimensions of policy convergence (object, benchmark, driver and directed process) and condensed the discussion into one proposition for each dimension:

(1) Object: Convergence of policy instruments does not necessarily imply convergence of outcomes (and vice versa).
(2) Benchmark: Not only absolute but also conditional convergence may serve as a benchmark of convergence analysis.

(3) Drivers: On their own, neither economic nor political drivers can sufficiently account for policy convergence.

(4) Process: Convergence processes may notwithstanding lead to different final states.

Note that the paper's main objective is of conceptual nature and, therefore, it empirically illustrates the relevance of the conceptual propositions; it does not aim at full-fledged, comprehensive statistical analyses itself. Rather, the propositions provide building blocks for future more in-depth empirical assessments.

Methodologically, the multiple dimensions of convergence imply that there exists no uniform measure that fits for all dimensions. More specifically, under some circumstances it may be useful to conceive of convergence as a negative relationship between some initial level and the growth rate – suggesting that countries with lower initial levels catch up with the forerunners. For instance, this notion (often referred to as β-convergence, see Heichel et al. 2005) seems appropriate when policies/outcomes (e.g., emission levels) can be expressed as a continuous quantifiable variable. In contrast, the choice between policy instruments is a discrete choice, which implies that instrument convergence may not be representable in statistical terms. Then again, statistical measures such as absolute and conditional convergence may be relevant for specific policy design issues, such as tax levels, public expenses, etc. All this leads to our main argument that, depending on the specific object of analysis and the benchmark used, the same empirical area may give rise to opposing assessments. As a case in point, we now refer to some empirical evidence for RES policy convergence in the EU – temporary convergence around feed-in tariffs as support instrument, conditional convergence of RES shares, but divergence of public R&D subsidies for RES at the national level.

Specifically, we rely on three different sets of data: First, we present data on the use of support instruments for RES. Information on the type of support instruments that are currently employed is available from www.res-legal.eu, a database initiated by the European Commission. Moreover, information on support instruments that were employed in the past was gathered from Kitzing et al. (2014). Second, we present data on current RES shares and RES growth rates within the EU Member States. This assessment is based on the notion of convergence as catching-up and relates the initial level of RES shares to the respective growth rates. The data are available from Eurostat, the statistical office of the European Union (http://ec.europa.eu/eurostat). Third, we present empirical evidence on policy convergence in terms of public subsidies to R&D in the RES field. The data used are derived from the International Energy Agency's (2015b) *Energy Technology RD&D Statistics* database. Unfortunately, this data set is limited to 14 different EU countries. The empirical assessment builds on the calculation of so-called R&D-based knowledge stocks. Specifically, we start from the premise that previous public R&D expenditures in a country add to an R&D-based knowledge stock, i.e., comprising the cumulative expenditures (e.g., Citation 4, Citation 5). We assume that the R&D expenditures only add to this stock after some years have lapsed, since it takes time for investments in R&D to generate new useful knowledge. Moreover, it is also assumed that the stock depreciates in that the effects of previous public R&D expenses gradually become outdated (e.g., Griliches 1995). We here assume a time lag of two years, and a depreciation rate of 10 percent. The latter choice suggests a fairly high rate of depreciation of R&D-based knowledge, but this is reflected in the relatively rapid development of renewable energy technology during the last decades (see Edenhofer et al. 2013, Johnstone et al. 2010, IEA 2015b). The above permits a test of the convergence hypothesis that countries with low initial R&D-based knowledge states will experience higher growth rates in this stock over time (and vice versa).

In the following, we empirically corroborate the four conceptual propositions, addressing each in turn.

Assessing the case for RES policy convergence in the EU

Convergence of policy instruments does not necessarily imply convergence of outcomes (and vice versa)

The early history of RES support instruments, from 1970 to 2000, is summarized by Knill et al. (2008: 115ff.) as the "emergence of two dominant approaches", first "subsidies or tax reductions" and second "legal obligations for energy users to purchase a certain amount of renewable energy". Yet, in hindsight, the latter cannot be reasonably called a dominant approach. Although quota schemes have been a long-time favorite of the EU Commission, there is no long-term trend towards a more widespread implementation of such schemes. In fact, in 2000, out of the 9 RES-obligation schemes cited by Knill et al. (2008: 118), only one involved tradable certificates; and while the number rose to 6 in 2005, it has been stagnating or even declining since then (cf. Table 2).

Insert Table 2 about here

Table 2: Number of EU Member States that have implemented major RES support instruments, 2000-2015

Source: Kitzing et al. 2012 for years 2000-2010, database www.RES-legal.eu for 2015[7]

Insert Figure 3 about here

Figure 3: Shares of Electricity Generated from RES in Gross Electricity Consumption for EU-27 Member States in 2013

Major support instruments for RES have been available in all EU Member States since 2007. In particular, feed-in tariffs have emerged as the most popular support instrument, (see Kitzing et al. 2012 for more details on the period 2000-2010). Yet, Table 2 also shows that pure feed-in tariffs might have passed a peak around 2010 and that they are increasingly complemented or replaced by feed-in premiums and tenders. Given that often feed-in tariffs enabled the rapid increases of RES deployment in the first place, should we not expect first convergence towards this instrument and then towards specific regulatory details? Why would regulators shift away from a successful policy instrument?

The short answer is that feed-in tariffs have been falling victim to their own success. Feed-in tariffs foster niche technologies and with RES growing out of their niche, policy priorities change too. Specifically, feed-in tariffs have been empirically shown to facilitate technological innovation for solar energy but they are less effective for more mature technologies such as wind that are close to compete with fossil energies (e.g., Johnstone et al. 2010). Furthermore, the crucial success factor of feed-in tariffs, the mitigation of income risk for potential investors, also drives up the overall costs of RES deployment. With technologies maturing and concerns of cost-effectiveness increasing, RES support is entering a "critical policy transition period" so as to integrate RES into electricity markets (Miller et al. 2013).

In addition, EU energy policy puts partly explicit, partly implicit pressure on Member States to move away from feed-in tariffs. The Commission's argument here reads: once common rules for the generation, transmission and distribution of electricity are implemented all over the EU, substantial cross-border interactions will be prevalent, rendering country-specific support schemes incompatible. In order to minimize market distortions and inefficiencies, country-specific RES support should oblige RES producers to directly sell electricity in the market, promoting the overall market-integration of RES and increasing cross-border electricity trading. Recent developments indicate that the Commission successfully frames

national discussions on RES policies along these lines (cf. Tews 2015). In consequence, one might say that during the first stage of RES support, policy instruments converged around feed-in tariffs but that the market integration of RES calls for different approaches.

In comparison to the (temporary) convergence of RES instruments, the diversity of RES shares at electricity consumption in the EU is striking (Figure 3). One possible explanation for this diversity refers to heterogeneity in ideological orientation. Member States' ambitions to decarbonize their energy systems are diverse and RES still inhabit a technological niche in some markets. More importantly, though, geographical conditions seem to determine the sizes of the RES shares. Consider Austria and Sweden, which exhibit the highest shares of RES in gross electricity consumption in the EU: both rely heavily on hydropower – traditionally so, rather than triggered by recent and current RES deployment policies. By comparison, the Netherlands, with an even slightly higher level of GDP per capita, only covers a fraction of its electricity consumption with RES. Also, the EU's aim of finalizing the internal energy market with fully harmonized RES policies, not necessarily implies convergence of RES shares. As outlined above, policy instrument convergence may lead to diverging RES shares with geographically predisposed countries exhibiting higher shares than the rest (e.g., solar in Southern Europe, wind at the shores).

Hence, although RES support instruments (temporarily) converged around feed-in tariffs, this did not result in absolute convergence of outcomes and there is no reason to expect the latter any time soon. In the following, it will also become clear that – even when restricting the analysis to the object "RES policies" – both divergence and convergence may obtain, because different sets of policies need not align.

Not only absolute but also conditional convergence may serve as a benchmark of convergence analysis

The diversity in RES shares notwithstanding, there might be conditional convergence. In order to account for the country-specific history of geography-induced renewables deployment, a look at the growth rates of RES shares seems useful. As Figure 4a shows, the growth rates of RES shares in gross electricity are generally significantly higher for the Member States with low initial levels than for the ones with high initial levels (a very similar pattern emerges in the case of RES shares at overall energy consumption, including heat and transport). This empirical pattern therefore seems to support the catching-up hypothesis.

However, Figure 4b provides a corresponding test of policy convergence in the case of public subsidies (i.e., government expenditures) for renewable energy R&D, here operationalized in terms of an R&D-based knowledge stock with time lags and a depreciation rate attached to the stock. These results show little direct support for the catching-up hypotheses since there is no clear negative correlation between the initial (beginning-of-period) knowledge stock and the growth rate in the knowledge stock over the time period. However, although there are few indications of absolute convergence there may be convergence after having controlled for other factors, such as GDP per capita, energy import dependence etc. In an empirical paper focusing solely on the drivers behind public R&D support in the EU (Citation 5), we employ more elaborate econometric analyses (the bias-corrected dynamic panel data approach) over a more extended time period (1990-2013). The results provide robust evidence for the presence of public R&D expenditures *divergence* across EU countries. In other words, countries with initially low R&D-based knowledge stocks have experienced lower growth rates in these stocks compared to countries that have already accumulated a lot of R&D-based knowledge in the RES field.

Insert Figure 4a about here

Figure 4a: Shares of Electricity Generated from RES in Gross Electricity Consumption (EU-27, excluding Cyprus) over the Time Period 2004-2013:

Annual Average Growth Rates versus the Initial Level in 2004

Insert Figure 4b about here

Figure 4b: Per capita Knowledge Stock based on Public Subsidies for Renewable Energy R&D: Annual Average Growth Rates in 14 EU Countries over the Period 2004-2013 versus the Initial Level in 2004

What might bring these different patterns between RES shares and public R&D RES support about? In contrast to the case of RES shares there are no mandatory targets regarding R&D expenses for the EU Member States, and divergence may be related to the public good characteristics of public R&D. Some countries could thus be free-riding on the others' development efforts through knowledge spillovers. This is not possible to the same extent in the case of RES-shares because of the presence of mandatory country-specific targets. Moreover, the countries' that choose to invest in R&D may experience increasing returns on their R&D investment, and investments may also be further spurred by vested interests and industrial policy motives.[8]

In conclusion, the ambiguous empirical results attest to the complexity of the policy convergence issue.

On their own, neither economic nor political drivers can sufficiently account for policy convergence

To start with, what is the empirical evidence for economic convergence (measured in real per capita income) in the EU? In short, there is meager evidence for overall convergence but there is evidence of convergence within several subgroups – that is, clusters of Member States growing at the same rate (Borsi and Metiu 2015). A clear separation between old EU-Member

States and new Member States in Eastern Europe appears: although the latter have exhibited higher growth rates, catching-up has not yet been sufficient in order to smooth out differences across Member States (Borsi and Metiu 2015). This can also be seen from recent GDP per capita statistics for the EU-28: at the upper end (omitting Luxembourg), the Netherlands stay at 31% above the EU-28 average (year 2013, Eurostat[9]). On the lower end, Bulgaria is listed with a GDP per capita of 55% below the average. In sum, one might speak of clustered, slow and non-monotonic processes of economic convergence in the EU.

It can be noted that the Member States' catching-up in terms of RES shares (Figure 4a) appears similar to this economic catching-up: both catching-up processes occur slowly and have reduced but not yet eliminated substantial differences between the Member States. In other words, both processes display conditional convergence. As laid out above, economic theory could explain this congruency via, for instance, a causal relation from economic growth over changes in peoples' preferences towards more environmental friendly electricity provision. Yet this tells us little about why similar policies should be used to address this demand.

We, therefore, turn to the political explanations for the spread of specific policy instruments to increase RES deployment within the EU. The literature here puts a clear emphasis on policy diffusion: "The international spread of feed-in tariffs and quotas was driven neither by mechanisms of harmonization nor imposition. Rather, the analysis […] points to an important role of diffusion mechanisms during the instruments' spread" (Busch and Jörgens 2005: 876). As outlined above, at the end of the 2000s support schemes for RES in the EU converged towards feed-in-tariffs. To better understand the specific mechanisms behind this convergence/diffusion process, the detailed case study of RES policy convergence in Spain, France and Germany, as performed by Jacobs (2012) is helpful. Building on Holzinger et al.'s (2008b) framework, Jacobs identifies the three mechanisms of transnational communication,

regulatory competition and independent problem solving as main political drivers of convergence towards feed-in tariffs (and their regulatory details).

First, transnational communication aligned approaches towards RES deployment in Spain, France and Germany; in particular, it was "decisive for the spread of certain feed-in tariff design options" (Jacobs 2012: 134). Second, regulatory competition arises from Member States' objective to stay competitive in terms of attracting investment. Here, Jacobs (2012) finds some evidence for convergence of photovoltaic feed-in tariffs due to competition between EU Member States. Interestingly, this contradicts the main results of Holzinger et al.'s (2008a) empirical analysis that regulatory competition has only had negligible explanatory power for environmental policy convergence in the EU. Third, common problem solving pressure may lead states to independently adopt very similar solutions. For instance, rapidly cumulating remunerations for photovoltaic installations was a problem both in Germany and Spain during the late 2000s. As a solution, "flexible tariff degression was developed independently in Germany and Spain" (Jacobs 2012: 227). A related case study suggests that these different convergence mechanisms possibly follow a chronological pattern: Carley et al. (2016) evaluate the diffusion of renewable portfolio standards in the US, demonstrating that processes of inter-state emulation explain the states' decisions on policy adoption and design while internal influences determine subsequent changes to these policies.

Against this background, does not a purely political account sufficiently explain RES policy convergence in the EU? The problem with such an approach is its blindness to economic factors that may disrupt convergence processes. From Jacobs's study one might get the impression that full alignment of feed-in tariffs was imminent – not only was there a general tendency towards feed-in tariffs at the end of the 2000s, but also did very specific regulatory details converge. But then the financial and economic crisis squeezed Member States' budgets and lowered priority of RES support on the overall policy agendas. In Spain, this pressure

resulted in a drastic dismantling of the RES support scheme in 2013. In Germany, the economic repercussions of the financial crisis were not as severe. Thus, the policy agendas in both countries diverged and the RES policy convergence process tended to halt.

Meanwhile, as outlined above, Germany and other countries are beginning to switch away from pure feed-in tariffs. This development is in line with the EU Commission's push towards cost-effective RES support, and, more generally, stems from the growing economic impact of RES. In sum, therefore, a narrow look at the mechanisms of policy diffusion at work in the 2000s would give rise to a completely misleading picture of the way RES policies would be taking in the 2010s – the main reason being the importance of economic drivers in establishing problem-similarity as condition for sustained convergence of policies.

Convergence processes may notwithstanding lead to different final states

Somewhat paradoxically, the very reason the EU Commission pushes for tender schemes, the market integration of RES, also raises doubts as to whether *any* RES instrument will serve as a convergence line. In short, the best way to integrate RES into energy markets remains unclear, as well as the final state of RES support in a world with very high RES shares (e.g., Kopp et al 2012): will there be no more support at all? Alternatively, will "energy-only" markets transform to remunerate production capacities rather than the electricity, thereby fusing RES support with technology-neutral capacity payments?

Eventually, different forms of market integration might be observed, depending on geographical and other country-specific conditions. The heterogeneity of Member States in terms of both RES potential and preferences for sustainable energy provision may imply that, after all, there will not be only one but several final states: for example, we might see several subsets of Member States with similar policies transforming their energy systems at similar speed, corresponding to their respective regulatory models (cf. Ćetković and Buzogány 2016). Furthermore, there may be historic, institutional and cultural path dependencies that make

absolute convergence of RES support polices highly unlikely. The framework of institutional economics (North 1990) may be particularly helpful to carve out the institutional inertia that may inhibit policy convergence. This concerns environmental policy in general (Fernandez 1994), and energy transition pathways more specifically (Kern 2011; Laird and Stefes 2009). Such institutional path dependencies also challenge the quest for adaptive efficiency through RES policy reform efforts (Citation 6).

The gist of the preceding discussion is that convergence processes notwithstanding, final states may not be identical. RES policies may converge towards different final states; or they may converge as regards their basic structure but still diverge in content (Vasseur 2014). That is, on the surface we might perceive similarity, where substantial divergence prevails. So even if all Member States pursue roughly similar energy transition pathways and even if there is broader economic convergence, this may not bring about absolute convergence of RES instruments and RES shares.

Conclusion

Policy convergence is a multi-faceted concept. The main argument of this paper is that distinguishing four dimensions of convergence helps to clarify why and in what form policy convergence might occur. In doing so, the paper aims to guide prospective empirical research. First, convergence analyses may refer to different objects and there may well be convergence for one particular object but not for another. Most notably, convergence of policy instruments does not necessarily imply convergence of outcomes. Second, the benchmark of convergence analysis may be absolute or conditional on some other characteristics to account for heterogeneity: differences in, e.g., economic performance or geographical conditions, can then be framed as conditional convergence. Third, a comprehensive explanation of successful policy convergence needs to account for both economic and political drivers. Economic convergence may explain similarity of problems rather than similarity of policy solutions.

Converging policies, in turn, do not solve the same problems if there is no economic convergence. In other words, economic and political drivers of convergence complement each other. Fourth, convergence processes may notwithstanding lead to different final states. That is, convergence should be understood as an inherently dynamic concept, not to be confused with static similarity – due to heterogeneities and institutional path dependencies, there may exist more than one final state.

The case of RES support policies in the EU illustrates these conceptual propositions very well. First, while there is evidence for (temporary) convergence of RES instruments, RES shares exhibit no absolute convergence – in fact, calls for harmonization of RES support in the EU (arguably the most 'convergence' there might be), have the explicit objective of generating *diverging* outcomes (i.e., RES shares) so as to optimize allocation of production capacities following heterogeneous RES potential. Second, there is conditional convergence of RES shares, possibly reflecting this heterogeneity in RES potential. Interestingly, however, there is no evidence for convergence of public R&D expenses, but rather divergence. Hence, in short, whether an analysis of RES policies in the EU finds convergence heavily depends on the object and the benchmark of analysis. Third, the importance of considering both economic and political drivers of convergence becomes apparent from the evolution of RES policies in the EU: Around 2010, absolute convergence towards feed-in tariffs seemed all but imminent when analytically focusing on political processes of diffusion and emulation. Since then, however, feed-in tariffs have begun to decline from their pinnacle, which can be attributed to changing economic drivers. Finally, RES policies may well converge towards different rather than a single final state.

In conclusion, this paper hopes to inspire further empirical research efforts. Acknowledging the multiple dimensions of convergence and particularly the economic conditions of policy convergence, may help to further close the gap between theoretical and empirical literature

with many proposed drivers of convergence but less actual empirical evidence (cf. Plümper and Schneider 2009). While a number of empirical case studies link *divergence* to institutional factors (e.g. Kern 2011; Laird and Stefes 2009), the importance of economic factors in explaining disruption of convergence processes and diverging pathways seems to deserve far more attention than it has hitherto attracted. As regards our example of RES policies, their prospective evolution in the post-niche era seems predestined for further convergence/divergence research.

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Figures and Tables:

Convergence benchmark Stage of political process	absolute	conditional
policy targets	identical RES targets	identical target ratios, with respect to (w.r.t.) correction factors, e.g: - RES target/GDP/capita - PV target/solar radiation - Wind target/wind speed
instruments/ support level	identical instruments	identical policy ratios, w.r.t. correction factors, e.g.: feed-in-tariff/per capita GDP
outcomes	identical RES shares; identical RES mixes; identical deployment rates (convergence of target fulfillment speed)	identical RES ratios/mixes/deployment rates, w.r.t. correction factors, e.g: - RES share/per capita GDP - PV share/solar radiation - Wind share/wind speed

Table 1: Specifying "convergence" for the case of RES policies in Europe

	2000	2005	2010	2015
Feed-in tariff (guaranteed remuneration for each kWh of electricity from RES)	7	16	23	19
Feed-in premium (mark-up on the electricity price)	-	4	7	8
Tender (RES remuneration is determined in a competitive bidding procedure)	2	2	6	8
Quota scheme (tradable RES certificates)	1	6	6	5

Table 2: Number of EU Member States that have implemented major RES support instruments, 2000-2015

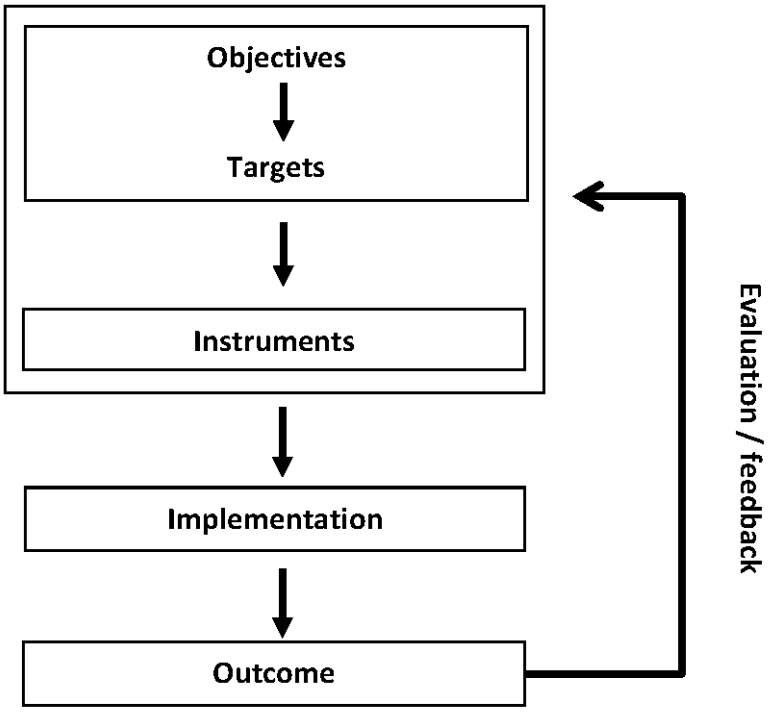

Figure 1: Stylized overview of the different stages of the policy process

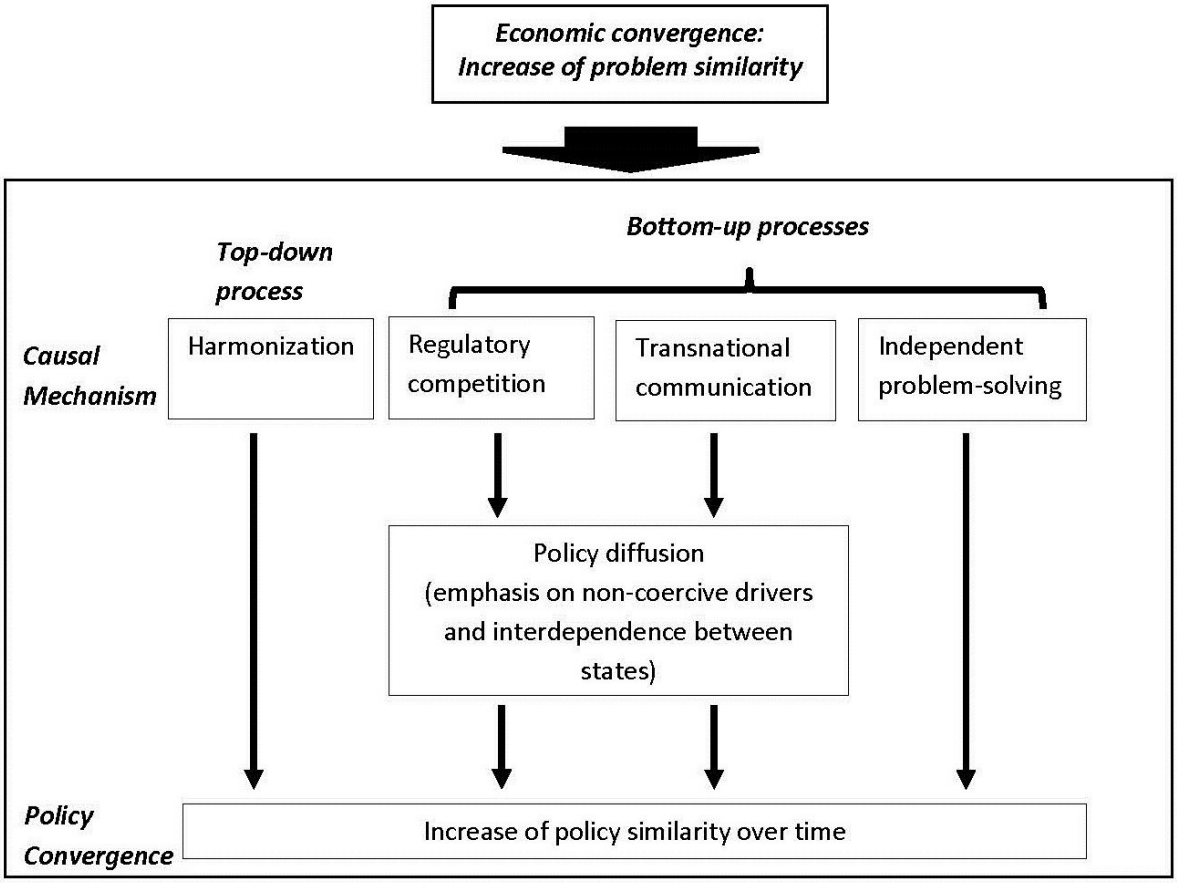

Figure 2: Causal mechanisms of convergence.
Based on and adapted from Holzinger et al. (2008b: 24)

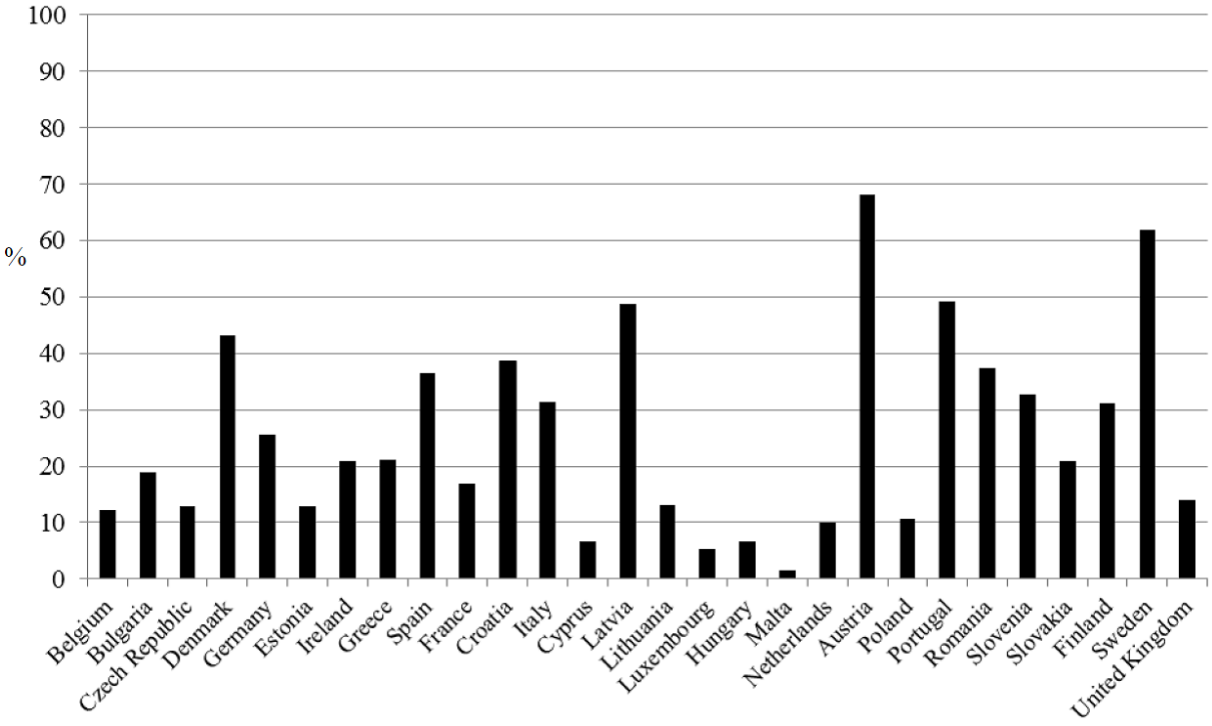

Figure 3: Shares of Electricity Generated from RES in Gross Electricity Consumption for EU-27 Member States in 2013

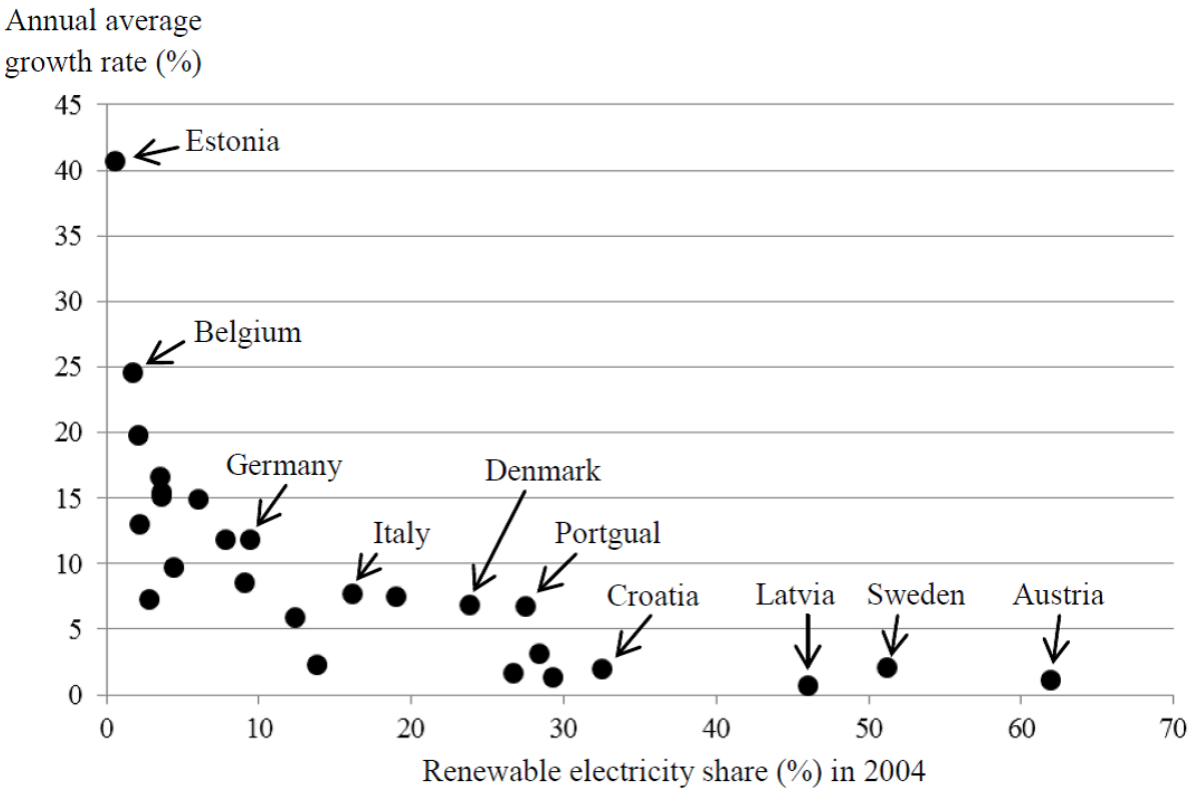

Figure 4a: Shares of Electricity Generated from RES in Gross Electricity Consumption (EU-27, excluding Cyprus) over the Time Period 2004-2013: Annual Average Growth Rates versus the Initial Level in 2004

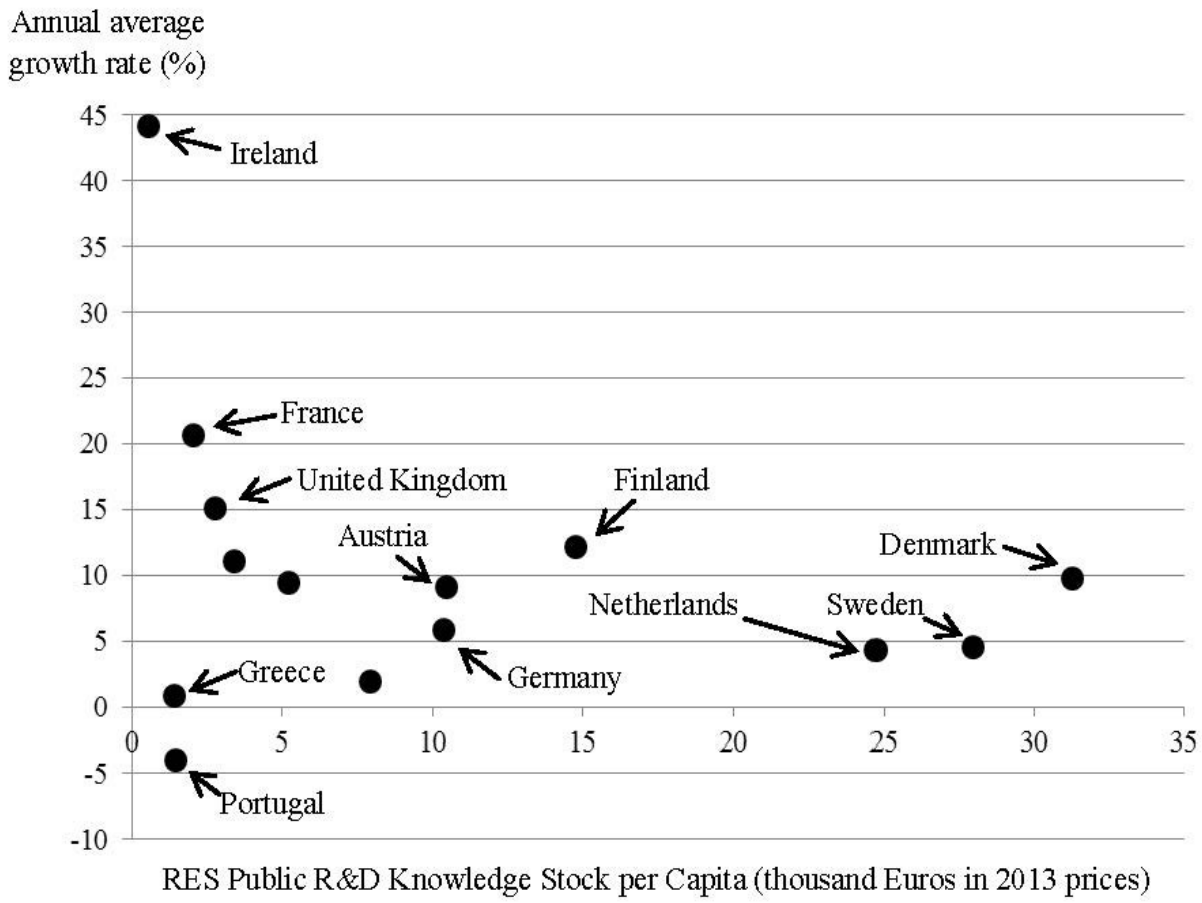

Figure 4b: Per capita Knowledge Stock based on Public Subsidies to Renewable Energy R&D: Annual Average Growth Rates in 14 EU Countries over the Period 2004-2013 versus the Initial Level in 2004

1 Throughout the paper „RES“ stands for electricity from renewable energy sources.

2 http://ec.europa.eu/eurostat/documents/38154/4956088/The_average_share_of_electricity_from_RES-2004-2014.pdf/df494f3c-6bea-4dab-b767-5d8f9ad2b007

3 Moreover, Member States sometimes employ separate policy instruments in addition to what has been agreed on the EU level, as, for instance, the UK's carbon floor price as add-on to the EU emissions trading scheme demonstrates.

4 For instance, Figure 1 does not elaborate on the role of stakeholder involvement in policy formulation.

5 Certainly, there may be cases where policy convergence is viable without economic convergence – namely if policies are of a mostly symbolic nature and without major economic implications.

6 There are also wider notions of diffusion to be found in the literature that allow for top-down mechanisms, but we focus on a narrower concept of diffusion as bottom-up process to make the matter not overly complex.

7 From 2005 on, the number of support schemes exceeds the number of EU Member States because many of the latter are combining elements of different support schemes. Hence, one could conclude that a "meta-trend" consists in increasing complexity of individual support schemes. This trend also implies ambiguity in counting: to see this, consider the number of tenders for 2015. We arrive at 8 Member States that employ tenders but considerably lower counts might be equally justified. One crucial question is whether to include schemes, which use auctions within more complex mechanisms (such as Denmark of the Netherlands) or whether to focus on tenders as main instrument. As more and more countries are experimenting with tenders, and as the Commission's guidelines intend to foster this development, we maintain a rather inclusive perspective.

8 This is not meant to imply, however, that the free-riding countries see no reasons to invest in own public R&D support to RES. For instance, there is often a need to adapt the new technology to local conditions (e.g., research on the icing of wind turbines in northern Europe). Moreover, in order to benefit from previous R&D efforts societies must also invest in own R&D since it contributes absorptive capacity, i.e., the ability to recognize and make use of the information generated through others' development activities.

9 http://ec.europa.eu/eurostat/statistics-explained/index.php/GDP_per_capita,_consumption_per_capita_and_price_level_indices.