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# The analysis of policy convergence, or: how to chase a black cat in a dark room

Thomas Plümper and Christina J. Schneider



**ABSTRACT** Political science research on policy convergence has largely remained inconclusive. While many studies found support for the convergence hypothesis, an almost equally large number of studies rejected it. Convergence thus could be a less general phenomenon than many theorists believe. This article identifies a second possible explanation. The variance approach, which dominates political science research on policy convergence, is likely to lead to wrong inferences. Analysing various artificially generated convergence processes, we find that neither the variance approach nor the coefficient of variation detects convergence when it is conditional or when theoretically unidentified convergence clubs exist. Our analysis suggests that researchers should estimate rather than measure convergence. By estimating convergence researchers may (a) test the causal relationship, (b) account for conditional convergence, (c) control for the existence of convergence clubs, and (d) examine convergence to an equilibrium level of a policy.

**KEY WORDS** Beta convergence; convergence; European Union; policy convergence; variance approach.

## 1. INTRODUCTION: WITH GLOBALIZATION CAME CONVERGENCE ... OR DIDN'T IT?

Recent empirical accounts of policy convergence report inconclusive results. Of 27 political science studies that we review in this article, 18 analyses find convergence whereas 13 reject the convergence hypothesis.[1] This article offers a possible explanation for the diverse findings in the convergence literature. We argue that the validity and reliability of empirical results in the literature on convergence are compromised by a theoretical under-specification of the convergence process on one hand and researchers' reliance on testing convergence as some measure of variance on the other hand.

The variance approach (which is frequently dubbed as the sigma approach after the Greek letter used for variance) interprets convergence as a decline in the variance of observations.[2] The sigma approach reliably identifies convergence processes if the process is unconditional and researchers know or make correct guesses about the convergence club.[3] However, it is unlikely to detect convergence, however, when researchers fail to sample on the right convergence club.

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We offer two simple remedies for these two problems: in order to improve convergence theories, we propose a set of questions that guide scholars in achieving more theoretical clarity about the expected convergence process and in matters of case selection and model specification. To improve the choice of methods we discuss various specifications of relatively simple regression models as an alternative to the variance approach. Our proposed regression specifications have at least four advantages: First, researchers can use the regression approach to model the causal mechanism that theorists identify. Second, the regression method appropriately accounts for conditional convergence processes. Third, the regression approach can test predictions on the equilibrium outcome of the convergence process or, alternatively, forecast the equilibrium outcome of the convergence process. Finally, as all regression analyses, our proposed specifications eliminate noise such as unsystematic measurement error.



## 2. CONVERGENCE THEORIES AND EMPIRICAL RESEARCH

In this section we briefly discuss theories of convergence and compare the theoretically derived expectations to the quantitative empirical tests of these theories. The comparison reveals a surprisingly large gap between the relatively rich theoretical convergence literature and the existing empirical analyses.

In political science, convergence is broadly defined as an increasing similarity over time (Knill 2005; Holzinger 2006). The concept of convergence can be applied to policies, political institutions, constitutions, political preferences, policy outcomes, and so on. For the purpose of our argument, it is important to stress the differences between convergence and convergence processes. Convergence itself is an observable outcome and exists if and only if some observable dissimilarity between independent units of observation declines. Processes of convergence, on the other hand, may be at work even if convergence is not observed directly, because, for example, other factors at the same time cause a trend to dissimilarity. In the latter case, researchers must control for these offsetting processes when they analyse theories of convergence processes or otherwise they fail to detect existing convergence processes.

Theorists highlight at least four broad factors that drive convergence: competition, learning, cooperation, and common responses to shocks.[4] These factors contribute to an increasing similarity of policies across countries and over time. Yet, none of these causal mechanisms provides clear statements on the nature, the dynamics, and the limits of the convergence process. However, theorists developed (more or less implicitly) two analytical distinctions which characterize the convergence process: complete versus incomplete convergence and conditional versus unconditional convergence.

Complete convergence implies that no variance is left among the cases to which the theory applies. Incomplete convergence suggests a declining but still existing variance across observations.[5] Sometimes, scholars disagree on whether complete or incomplete convergence ought to be expected as a result of a particular convergence process. Most first generation models of tax

competition predict complete convergence of tax rates on fully mobile capital to zero. Contrary to this claim, second generation models predict that the implemented tax rate on fully mobile capital crucially depends on domestic governmental restrictions.[6] These political constraints point to important (but definitely not the only) obstacles to convergence. Partial convergence may also result from weak convergence pressure and from institutional, policy specific, economic, or political constraints.[7] The forces underlying convergence at times affect a relatively small subset of countries and crucially depend on the existence of structural factors. Conditional convergence limits the application of an existing theory to a convergence club.[8] Bouget (2003: 676), for example, finds that convergence of national social expenditure occurs solely in welfare systems.



The empirical convergence literature applies identical methods for all these types of convergence processes, with the variance and the regression approach being the two convergence tests most commonly used. The regression approach (or beta convergence) analyses for given steady-state values whether the speed of convergence is higher the lower the starting level of the policy under examination. Whereas the regression approach relies on *estimating* convergence, the variance approach, which dominates empirical research on convergence in the political sciences, *measures* convergence. Scholars typically employ one of two measures of variance. The first computes the change in sample variance (or in the standard deviation) in each period. A declining variance implies convergence whereas an increase in variance notifies divergence. The second measure – the coefficient of variation – divides the sample variance in a given period by the sample mean of this period. Again, a declining coefficient of variation is interpreted as convergence whereas an increasing value typically indicates divergence.

Table 1 presents an overview of political science articles on policy convergence and reveals three important patterns. First, half of the convergence studies (13 out of 27 articles) do not employ analytical methods but present single and comparative case studies, or simply report some descriptive statistics. In all these cases, researchers state that they observe the presence or the absence of convergence without testing their beliefs. Second, if researchers use analytical approaches to convergence, they dominantly rely on the variance approach (10 out of 14 analytical articles). Whereas the regression approach dominates convergence research conducted by economists, it clearly does not have the same significance for political science research. Third, studies analysing convergence with descriptive statistics, case studies, and regression analyses typically find convergence (14 do, 5 do not), but the majority of studies employing the variance approach do not find support for the convergence hypothesis (5 positive results, 8 negative results). These findings are astonishing given the strong theoretical priors in favor of convergence particularly in the research on convergence in European Union (EU) member countries.

Yet, the latter finding of course does not imply that the variance approach leads to wrong inferences. The existing patterns could simply mirror a selection process. For example, researchers conducting research on environmental policies are more likely to rely on the variance approach. If convergence is absent in environmental politics but present in most other fields of research, the apparent

*Table 1* A summary of the convergence literature

| *Author* | *Journal* | *Main method* | *Main finding* |
|---|---|---|---|
| Albrecht and Arts 2005 | JEPP | descriptive statistics | Some convergence in climate output. |
| Bennett 1991 | GOV | descriptive (variance) | Limited convergence of data protection policy in UK, Sweden, USA, Germany, and Austria. |
| Bennett 1997 | GOV | descriptive (timing of adoption) | Cross-national diffusion of the institution of the Ombudsman, freedom of information legislation and data protection laws embrace a number of distinct processes of transnational learning and communication. |
| Bernauer and Achini 2000 | EJIR | variance | No convergence of the size of the public sector and even divergence in OECD countries. |
| Botcheva and Martin 2001 | ISQ | comparative case studies | Convergence through international institutions is most likely when states create institutions that respond to standard collective-action dilemmas and when states delegate adequate monitoring capabilities. |
| Bouget 2003 | SPA | variance | Convergence of social expenditure across EU countries, no convergence of non-EU OECD countries. |
| Busch and Jörgens 2005 | JEPP | descriptive statistics | Convergence through diffusion in international environmental regulation. |
| Cappelen *et al.* 2003 | JCMS | regression | Convergence in per capita income amongst EU members is fostered by EU regional support policies after 1990. |
| Cornelisse and Goudswaard 2002 | ISSR | variance | Strong convergence in social protection systems among EU-15 members, but not only caused by the EU. |
| Dyson 2007 | WEP | case study | Geographically clustered response of Central and East European countries to EMU membership. |
| Eyre and Lodge 2000 | JEPP | descriptive (variation) | No convergence towards the European model of competition law due to continued national diversity. |

(*Continued*)

*Table 1* Continued

| *Author* | *Journal* | *Main method* | *Main finding* |
|---|---|---|---|
| Gornick and Meyers 2001 | JCPA | variance (and regression-only graph) | No top-down process of social spending in Europe and USA. |
| Hallerberg 1996 | WP | variance (box-plots) | Tax rates in Germany converged between 1873 and 1914 for mobile capital and labor, but the change in burden was not in the expected direction. |
| Harrison 2002 | GOV | case study (variance) | No convergence in Canadian, Swedish, and American policies regarding chlorinated organic discharges from the pulp and paper industry. |
| Helliwell 1994 | BJPS | regression | Convergence of economic growth. |
| Henderson and White 2004 | JEPP | variance (number of places/months) | Some convergence of maternity leave and child care program design, coverage and government funding over time in EU, Norway, Canada; differences due to domestic constraints. |
| Kerwer and Teutsch 2001 | JEPP | case study | EU membership did not lead to convergence of transport policies in France, Germany, and Italy. |
| Marcussen 2005 | JEPP | case study | Geographical and temporal patterns in the emergence of (independent) central banks. |
| Murillo 2002 | WP | case study | Convergence in privatization policies in Latin America, but variation in implementation of these policies. |
| Neumayer 2001 | JCMS | variance (cov) | No convergence in environmental outcome variables (emissions) in the EU. |
| Neumayer 2005 | JCR | variance (cov) (regression) | No convergence in asylum recognition rates. |
| O'Connor 1988 | EJPR | variance | Convergence of welfare measures between OECD countries until 1973 but not thereafter. |

| | | | |
|---|---|---|---|
| Potoski and Prakash 2004 | JOP | regression | ISO 14001 registrations are conditioned by trade linkages and membership in governmental and non-governmental international organizations. |
| Randall 2000 | JEPP | descriptive statistics | Some convergence in child care policies across EU member states, limits in convergence due to lack of influence of EU institutions. |
| Tews *et al*. 2003 | EJPR | variance (adoption) | Increasing adoption of environmental policies in OECD countries and Eastern Europe over time. |
| True and Minstrom 2001 | ISQ | regression event history (adoption) | Diffusion of gender-mainstreaming mechanisms has been facilitated by the role played by transnational networks, in particular by the transnational feminist movement. |
| van Waarden and Drahos 2002 | JEPP | descriptive statistics | Convergence in competition policies across EU members (mainly attributed to the diffusion of ideas). |

*Abbreviations*: EJIR: European Journal of International Relations; EJPR; European Journal of Political Research; GOV: Governance; ISSR: International Social Security Review; ISQ: International Studies Quarterly; JCMS: Journal of Common Market Studies; JCPA: Journal of Comparative Policy Analysis: Research and Practice; JCR: Journal of Conflict Resolution; JEPP: Journal of European Public Policy; JOP: Journal of Politics; SPA: Social Policy and Administration; WEP: West European Politics; WP: World Politics. EMU: European Monetary union; OECD: Organization for Economic Cooperation and Development.

over-representation of negative results in studies using the variance approach is spurious. It is thus impossible to assess the quality of the variance approach from this simple comparison. To derive more conclusive results about the performance of the variance approach, and thus the patterns of policy convergence in general, we have to systematically examine whether the variance approach detects typical convergence processes. In the following section, we artificially generate convergence processes to analyse systematically how well the variance approach fares in detecting typical convergence processes.

## 3. THE VARIANCE APPROACH AND CONVERGENCE PROCESSES

To explore the performance of the variance approach in uncovering convergence processes we examine whether the variance approach correctly identifies various artificially generated convergence processes.

### 3.1. The data-generating process

Our data-generating process consists of two periods with 30 observations in each period. In each of the eight experiments the level of convergence is identical in the first period $t_0$ but differs in the second period. In a first set of experiments, we examine unconditional convergence processes in which the convergence dynamic affects all countries. Yet, the degree to which countries experience change in the variable of interest depends on their initial distance from the equilibrium. We have graphed these ideal-types of unconditional convergence in Figures 1–4. Figure 1 displays the ideal-type of unconditional and incomplete convergence to the sample minimum. Figure 2 illustrates the process of

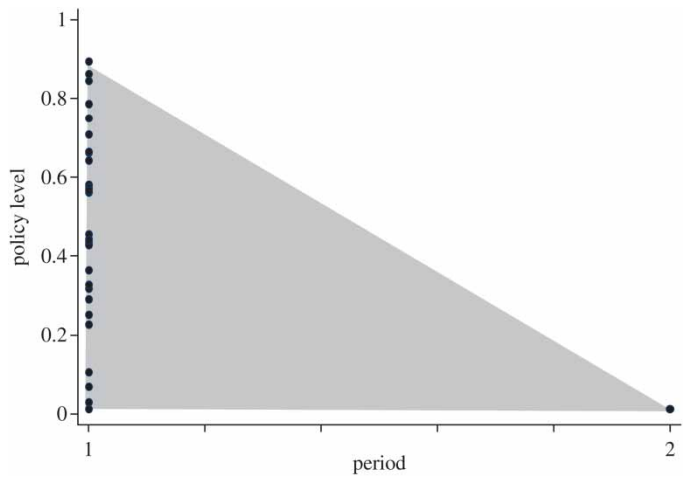


*Figure 1* Unconditional complete convergence (UC) towards the sample minimum

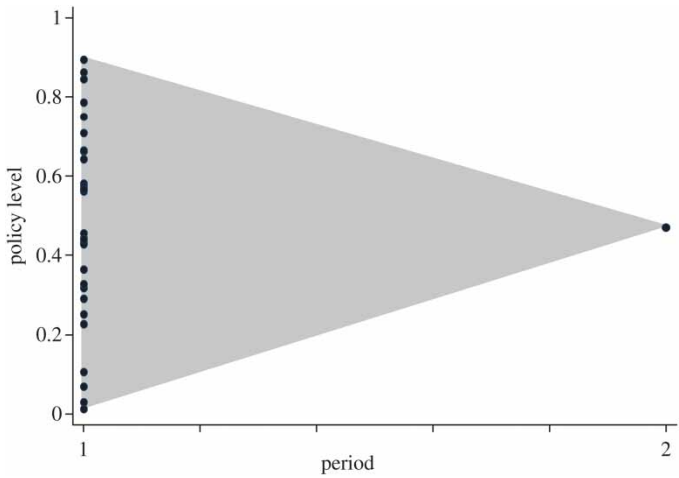


*Figure 2* Unconditional complete convergence (UC) towards the sample mean

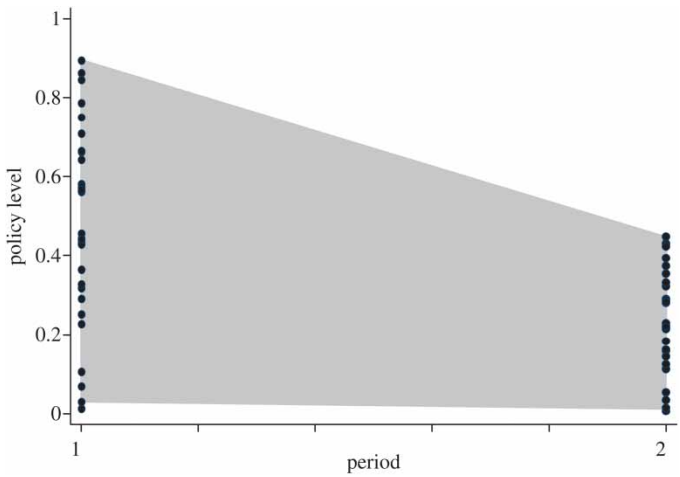


*Figure 3* Unconditional incomplete convergence (UI) towards the sample minimum

unconditional complete convergence to a common policy, here the sample mean. Figures 3 and 4 describe the same convergence process. Yet, whereas the convergence process is complete in Figures 1 and 2, the processes underlying Figures 3 and 4 remain incomplete.

In the second set of experiments (Figures 5–8) we model very similar processes, but now we assume the existence of two convergence clubs $N_1$ and $N_2$, with each subgroup consisting of 15 cases. These two subgroups converge to different equilibria. Again, processes 5 and 6 reach the equilibrium; processes 7 and 8 do not.

Various alternatives exist. Conditional convergence occurs if one group converges while another group of countries experiences no convergence or even

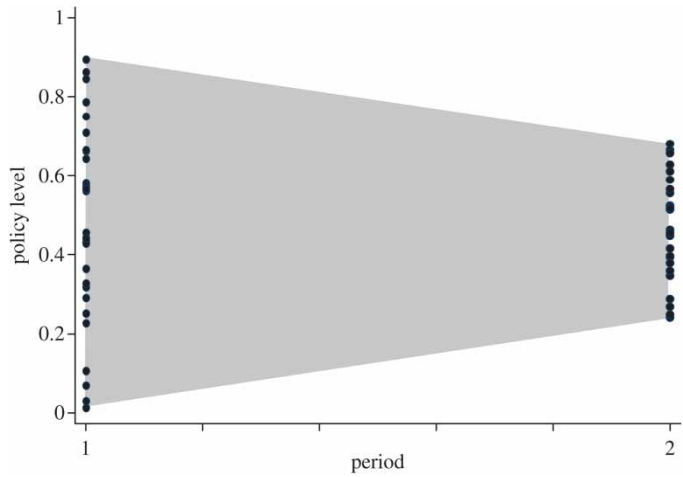


*Figure 4* Unconditional incomplete convergence (UI) towards the sample mean

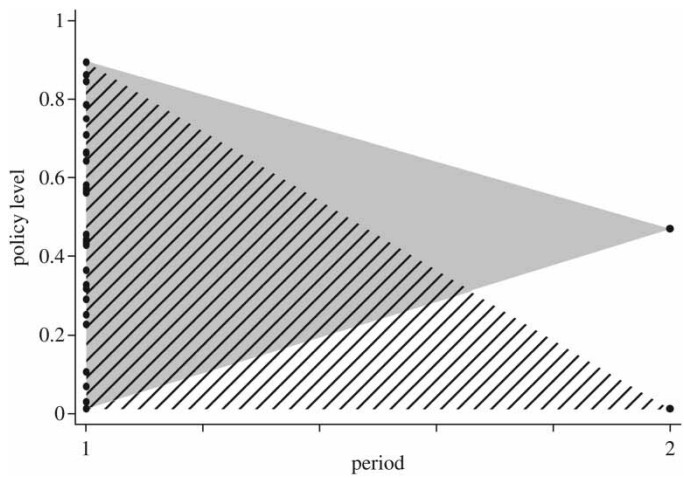


*Figure 5* Conditional complete convergence (CC) towards the sample minimum and the sample mean



divergence. We do not attempt to be comprehensive at this point, but to examine the most typical convergence processes in the political sciences.

### 3.2. Analysis of the variance approach

The data-generating processes represented by Figures 1–8 describe different types of policy convergence. From this ideal-type data, we can assess how well standard variance approaches capture these processes. Since our data-generating

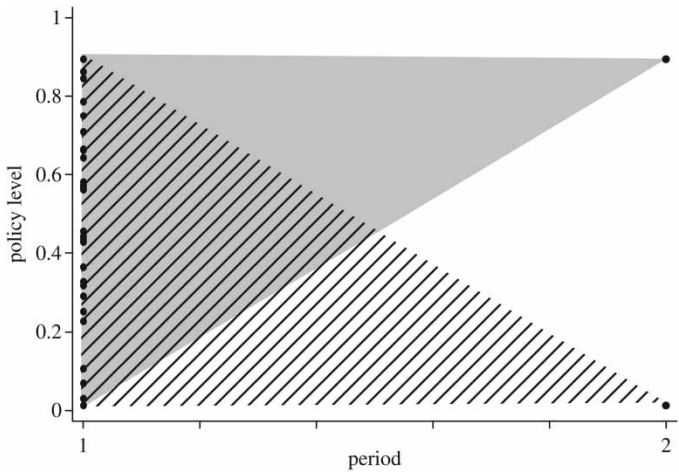


*Figure 6* Conditional complete convergence (CC) towards the sample extremes

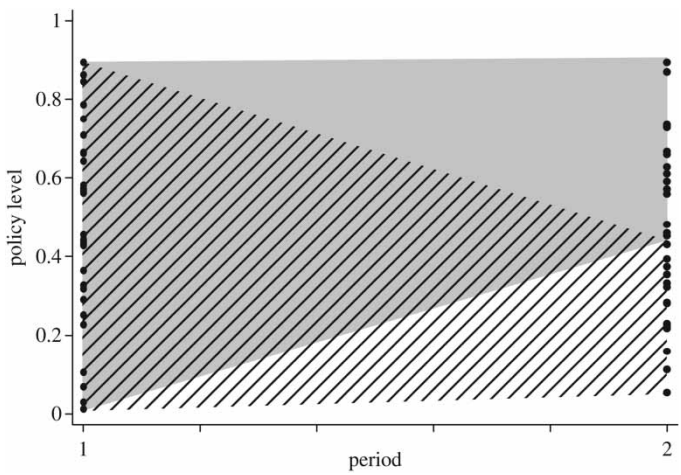


*Figure 7* Conditional incomplete convergence (CI) towards the sample extremes

process incorporates two periods, we measure dispersion as the variance of observations in the last period minus the variance of observations in the first period. Convergence is observed for a negative convergence coefficient, implying declining dispersion. Table 2 summarizes the results.

The variance approach has difficulties in detecting many convergence processes and indeed most conditional convergence processes. At times, both measures suggest divergence even though two convergence clubs exist. On average, the coefficient of variation seems to be a slightly less valid measure than the standard deviation, but the differences remain small. The interpretation

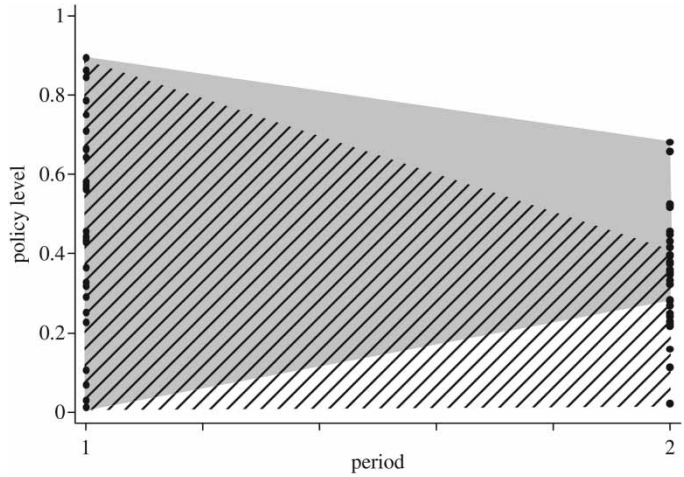


*Figure 8* Conditional incomplete convergence (CI) towards the sample mean and sample minimum, respectively

of our analysis is straightforward: neither of the two measures can reliably test theories of conditional convergence. The variance approach also shows significantly lower convergence rates for conditional convergence. Hence, even if the variance approach reveals convergence, the magnitude of the processes might still be underestimated. Given these results, the contradictory findings of the empirical literature are no longer surprising. Conditional convergence processes and small variations in the sample or the period under observation may yield inconsistent results when scholars rely on the variance approach.

In addition to the methodological problems of the variance approach, empirical tests often remain weak due to the existence of under-specified theories. Convergence researchers have identified a plausible set of causes and at the same time developed an appropriate classification scheme for different types

*Table 2* The performance of the variance approach

| | *Standard Deviation* | | *Coefficient of Variation* | |
|---|---|---|---|---|
| DGP 1: UC to the min | −0.25 | + | −0.53 | + |
| DGP 2: UC to the mean | −0.25 | + | −0.53 | + |
| DGP 3: UI to the min | −0.13 | + | 0.00 | − |
| DGP 4: UI to the mean | −0.13 | + | −0.27 | + |
| DGP 5: CC to min/mean | −0.02 | − | 0.44 | − |
| DGP 6: CC to extremes | 0.20 | − | 0.46 | − |
| DGP 7: CI to extremes | −0.03 | − | −0.05 | − |
| DGP 8: CI to min/mean | −0.11 | + | −0.13 | + |

*Note*: + represents a correct result, – represents an incorrect result.

of convergence. Unfortunately, there are still relatively few theories elaborating on the causes for convergence *and* the convergence process itself. Indeed, empiricists often find little theoretical advice on the nature of the convergence processes because theorists hardly identify the group of countries for which the causal mechanism applies, the conditions under which convergence takes place, the factors determining the speed and scope of adjustment, and the expected equilibrium of the convergence process. These limitations prevent empirical researchers from appropriately testing convergence theories. Fortunately, both problems are (at least partly) solvable. In the next section, we recommend various measures to bridge the gap between convergence theories and their empirical analyses.



## 4. WHAT CAN BE DONE TO IMPROVE CONVERGENCE RESEARCH?

The discussion above suggests that scholars have to be aware of (a) the development of a full and explicit theory of the convergence process and (b) the specification of appropriate methods to fully test the empirical implications of the theoretical model. We will discuss possible solutions to both problems in turn.

### 4.1. Theory development

The first problem of the empirical tests of convergence hypotheses – the lack of empirical guidance provided by the theoretical literature – has a straightforward solution. Theoretical accounts should address the underlying causal mechanism leading to convergence and they should be explicit about the expected *process* of convergence. More specifically, a comprehensive theory of convergence or divergence should offer answers to the following questions:

1 What are the causal mechanisms of convergence?
2 How do countries cope with the forces striving for convergence? In particular, is adjustment an incremental process or do countries 'jump' to a new equilibrium outcome?
3 Which factors (political, social, economic, institutional, etc.) influence the speed and scope of adjustment?
4 Is there a convergence club and what influences the boundaries of this club?
5 If convergence clubs exist, how many of them can be identified and which factors determine the composition of convergence clubs?
6 Is the convergence or divergence process concluded or is it ongoing? If it is ongoing, when or under what conditions will the convergence or divergence process come to a halt?
7 What is the final equilibrium of the convergence process?

The results of the artificially generated convergence processes show that answering these questions is indispensable for specifying appropriate tests of any convergence theory. Empirical approaches to policy convergence or

divergence need this additional information to model the theoretically predicted convergence processes. Once theorists provide more guidance, empirical analyses are more likely to offer valid answers.

### 4.2. Estimation – a superior alternative to the measurement of convergence

Our second recommendation addresses the problems of the variance approach to detect typical convergence processes and to test for the causal mechanisms underlying convergence theories. To solve these problems, we recommend estimating rather than measuring convergence processes.

Estimating convergence has several important advantages. First, scholars can account for the conditionality of the convergence process, that is, they can account for various explanatory factors that inhibit or strengthen convergence. Second, the estimation of convergence allows testing causal hypotheses of convergence directly. Third, scholars can directly model quasi-automated processes versus causal convergence processes. Fourth, the regression approach can easily be applied to various policy areas. Estimation finally allows researchers to control for various other explanatory factors and it eliminates unsystematic measurement errors.

In what follows we discuss various interrelated specifications of typical convergence processes.

### 4.3. Specification of the basic model of convergence

We start with a very basic model that examines whether convergence occurs while holding constant various additional factors. The simplest model estimates

$$\Delta y_{i,t} = \alpha + \beta y_{i,t-1} + \sum_{k=1}^{K} \gamma_k x_{i,t,k} + \varepsilon_{i,t} \tag{1}$$

where $\Delta y_{i,t}$ is observation $i$'s change in the converging variable (say, a change in the level of carbon dioxin emissions),[9] $y_{i,t-1}$ is the country's level of the policy in either the previous period or the first period under observation, $x_{i,t}$ are k control variables, $\varepsilon_{i,t}$ is an error process assumed to be independent and identically distributed, and $\alpha$ is the intercept. For clarification purposes, we distinguish between $\beta$, which is the coefficient of the convergence variable and $\gamma_k$, which are the coefficients of the $k$ control variables. A negative convergence coefficient $\beta$ implies convergence of policies.

As for the variance approach, we artificially generated convergence processes to systematically test whether the regression approach detects the convergence processes sketched in Figures 1–8. For the artificial convergence processes, we calculate the difference in levels $\Delta y_{it} = y_{it} - y_{it-1}$ of all data-generating processes and add a stochastic idiosyncratic error $\varepsilon_{i,t}$, which is white noise and drawn from

*Table 3* The performance of the simple regression approach

| | $\alpha$ | $\beta$ |
|---|---|---|
| DGP 1: UC to the min | 0.01 | −1.00 (0.29) |
| DGP 2: UC to the mean | 0.47 | −1.00 (0.30) |
| DGP 3: UI to the min | −0.00 | −0.50 (0.29) |
| DGP 4: UI to the mean | 0.22 | −0.48 (0.29) |
| DGP 5: CC to min/mean | 0.38 | −1.30 (0.34) |
| DGP 6: CC to extremes | 0.72 | −1.57 (0.43) |
| DGP 7: CI to extremes | 0.36 | −0.79 (0.34) |
| DGP 8: CI to min/mean | 0.19 | −0.65 (0.30) |

*Note*: Standard errors in parentheses.



a normal distribution. Subsequently, we estimate the regression models and save the estimated intercept, beta, and its standard error. This procedure is repeated 1,000 times. The means of these estimates are reported in Table 3.

Table 3 demonstrates that the simple regression approach performs better than the variance approach. If the model is correctly specified, the regression approach detects convergence processes and also correctly estimates the adjustment speed and the equilibrium outcome. If the convergence process is conditional and either the adjustment speed or the equilibrium outcome varies in the sample, the simple model may still find convergence 'on average'. However, we cannot expect that the adjustment speed and/or the equilibrium outcome are correctly estimated. Fortunately, we can easily improve on the basic convergence model in equation 1.

### 4.4. Flexible specifications

*Modeling conditional convergence:* If the theory imparts further information on structural factors influencing the *rate* of adjustment, empirical researchers can (and should) model this explicitly. Let $z$ be the variable on which the speed of adjustment depends. The appropriate estimation is

$$\Delta y_{i,t} = \alpha + \beta_0 y_{i,t-1} + \beta_1 z_{i,t} + \beta_2 y_{i,t-1} z_{i,t} + \sum_{k=1}^{K} \gamma_k x_{i,t,k} + \varepsilon_{i,t}. \qquad (2)$$

Equation 2 uses interaction effects to model whether certain factors exert an impact on the speed of adjustment. Additionally, we can assess whether the rate of convergence partly or entirely depends on constraint $z$. If $\beta_0 = 0$ and $\beta_2 \neq 0$, the speed of adjustment depends entirely on the constraint to adjustment. If $\beta_0, \beta_2 \neq 0$, the adjustment speed partly depends on the constraint. We nevertheless experience some convergence independent of $z$. If $\beta_0 \neq 0$ and $\beta_2 = 0$, the rate of adjustment does not depend on other factors.

*Modeling convergence clubs:* Sometimes, researchers do not know which factors condition the speed of adjustment and the equilibrium outcome. In these cases, they may want to distinguish between different convergence clubs. In contrast to the variance approach, the regression approach allows us to explicitly *test* for convergence clubs within the full sample. Let $g^1$ and $g^2$ define two convergence clubs (i.e. the EU and non-EU member states). We can generate dummy variables for these two groups, create an interaction of these dummies with the initial level, and estimate

$$\Delta y_{i,t} = \alpha + \beta_0 y_{i,t-1} + \beta_1 y_{i,t-1} g_i^1 + \beta_2 y_{i,t-1} g_i^2 + \sum_{k=1}^{K} \gamma_k x_{i,t,k} + \varepsilon_{i,t}. \quad (3)$$

Equation 3 distinguishes between two different convergence clubs. The group interaction effects provide additional information on whether the specified club converges or not. If $\beta_0 = 0$ and $\beta_2$ and/or $\beta_3 \neq 0$, convergence only applies for one or both convergence clubs. If $\beta_0 \neq 0$ and $\beta_1, \beta_2 = 0$, there is convergence but $g^1$ and $g^2$ are not convergence clubs. However, this does not dismiss the existence of other convergence clubs. Finally, if $b_1 \neq b_2$ and $b_1, b_2 \neq 0$, the two convergence clubs have different speeds of adjustment and may approach different levels in equilibrium.

Table 4 reports the results of the analysis based on equation 3. The estimated coefficients become somewhat better if we allow for group-dependent coefficients. Further improvements are possible if the intercept is assumed to vary across groups.

$$\Delta y_{i,t} = \alpha_g + \beta_0 y_{i,t-1} + \beta_1 y_{i,t-1} g_i^1 + \beta_2 y_{i,t-1} g_i^2 + \sum_{k=1}^{K} \gamma_k x_{i,t,k} + \varepsilon_{i,t}. \quad (4)$$

There is no need to report the simulated results. Estimating group-specific intercepts along with group-specific beta coefficients gives unbiased estimates of the convergence process if the groups are defined correctly and the empirical model does not suffer from other misspecifications.

*Table 4* The performance of the grouped regression approach

| | $\alpha$ | $\beta_1$ | $\beta_2$ |
|---|---|---|---|
| DGP 1: UC to the min | 0.02 | −1.00 (0.31) | −1.01 (0.36) |
| DGP 2: UC to the mean | 0.48 | −1.00 (0.31) | −1.01 (0.35) |
| DGP 3: UI to the min | 0.01 | −0.52 (0.31) | −0.50 (0.35) |
| DGP 4: UI to the mean | 0.23 | −0.49 (0.31) | −0.49 (0.35) |
| DGP 5: CC to min/mean | 0.34 | −1.53 (0.32) | −0.76 (0.37) |
| DGP 6: CC to extremes | 0.63 | −1.99 (0.34) | −0.53 (0.39) |
| DGP 7: CI to extremes | 0.31 | −0.99 (0.31) | −0.26 (0.36) |
| DGP 8: CI to min/mean | 0.16 | −1.76 (0.31) | −0.37 (0.35) |

*Note*: Standard errors in parentheses.

It is generally possible to apply the regression approach to various other convergence scenarios which we cannot present in full detail here. In the following we just discuss some further specifications which might be of special interest for research on policy convergence.

### 4.5. Equilibrium convergence outcomes

*Convergence to specific equilibria:* Our previous estimations applied to cases in which policies converge to a maximum or minimum. Nevertheless, the estimation approach is not limited to these cases. Researchers can also constrain the estimation if the theory predicts the equilibrium outcome.[10]

$$\Delta y_{i,t} = \alpha + \beta\left(y^e - y_{i,t-1}\right) + \sum_{k=1}^{K} \gamma_k x_{i,t,k} + \varepsilon_{i,t} \tag{5}$$

Where $y^e$ denotes the predicted equilibrium outcome of the convergence process such as a certain level of converged tax rates above zero. The larger the difference between the equilibrium level of the policy and the policy in period $t-1$, the faster and stronger the convergence process.

In estimating convergence processes, it is even possible to compute out of sample predictions of the equilibrium convergence outcome and to predict the existence of and membership in different convergence clubs.

*Forecasting the convergence equilibrium:* Although the equilibrium outcome of the convergence process is oftentimes unknown, we can empirically predict it if we set the rate of adjustment to zero. Suppressing the error process, for equation 1 we get

$$\alpha + \beta y_{i,t-1} + \sum_{k=1}^{K} \gamma_k x_{i,t,k} = 0 \tag{6}$$

which after some simple transformations gives

$$y_{i,t-1} = \frac{-\alpha - \sum_{k=1}^{K} \gamma_k x_{i,t,k}}{\beta} \tag{7}$$

and standard errors are

$$\begin{aligned} eqbm = \frac{x'\beta}{\rho} \Rightarrow V(eqbm) &\approx \left[\nabla_{\beta,\,\sigma}\left(\frac{x'\beta}{\rho}\right)\right] V\begin{pmatrix}\beta\\ \rho\end{pmatrix}\left[\nabla_{\beta,\,\sigma}\left(\frac{x'\beta}{\rho}\right)\right] \\ &= \left[\frac{x}{\rho} - \frac{x'\beta}{\rho^2}\right]\begin{pmatrix} V(\beta) & C(\beta,\rho) \\ C(\beta,\rho) & V(\rho)\end{pmatrix}\left[\frac{x}{\rho} - \frac{x'\beta}{\rho^2}\right]. \end{aligned} \tag{8}$$

*A test for the existence of convergence clubs:* Finally, researchers can test whether different convergence clubs exist (and also forecast their equilibria). Such a test for convergence clubs is based on a variant of seemingly unrelated regression (SUR) models or on the random coefficients model advocated by Beck and Katz (2007). A SUR model estimates a system of equations assuming an interrelation of the errors across equations. It generalizes the idea of convergence clubs in which the existence of convergence is a possible outcome of the estimate rather than a restriction that is added to the estimation process:

$$\Delta y_{i,t} = \alpha + \beta_1 y_{i=1,t-1} + \beta_2 y_{i=2,t-1} + \ldots + \beta_N y_{i=N,t-1} + \sum_{k=1}^{K} \gamma_k x_{i,t,k} + \varepsilon_{i,t}. \quad (9)$$

Once we have obtained coefficients of the variable of interest for each case (e.g. country) in the data set, we can predict the equilibrium level for each single case by computing a variant of equation 7, namely

$$y_{i,t-1} = \frac{-\alpha - \sum_{k=1}^{K} \gamma_k x_{i,t,k}}{\beta_i}. \quad (10)$$

The only difference between equation 7 and equation 9 is index *i*, which refers to the unit-specific coefficient of the convergence variable. Countries with 'sufficiently similar' equilibrium levels of the outcome belong to the same convergence club. Of course, this exercise incorporates data-mining and should *not* replace careful theoretical analysis. It only serves as a test whether convergence clubs exist and which countries jointly belong to the same convergence club. Consequently, those findings can at maximum stimulate further theoretical investigations.

The random coefficients model allows coefficients to vary across cases. Compared to the SUR approach the random coefficients model requires a fairly large number of time periods. If researchers analyse a sufficiently large panel data set, the random coefficient model is more efficient than the SUR model and thus superior.

### 4.6. The spatial econometric analysis of convergence processes

The spatial econometric analysis of convergence processes provides an alternative to the estimation procedure we have discussed so far. In contrast to the estimation of the convergence parameter, spatial analyses look at dependency. These models analyse whether the policy of one country *i* depends on policies in all other countries $-i$ (or in a subset of countries).

Accordingly, researchers estimate

$$y_{i,t} = \alpha + \beta y_{i,t-1} + \rho w y_{-i,t} + \sum_{k=1}^{K} \gamma_k x_{i,t,k} + \varepsilon_{i,t} \tag{11}$$

where $\rho$ is the coefficient of the spatial lag, $w$ is a weighting matrix that accounts for variation in the importance of the $-i$ units for $i$ and $y_{-i}$ denominates the spatial-y (i.e. the dependent variable in all other countries).

Spatial econometrics is a fast-growing field and these models are not easy to estimate and to specify. For example, if policy $y$ in country $i$ depends on policy $y$ in all other countries $-i$, then the policies $y$ in countries $-i$ also depend on $y_i$. The problem is known as the classical endogeneity problem. Franzese and Hays (2007) suggest estimating these models with spatial maximum likelihoods methods and using the control variables as instruments for the endogenous spatial-y. However, it is worthwhile to note that spatial analyses require important choices of the weighting matrix, its functional form, whether or not to row-standardize, whether or not to account for spatial clustering and how to account for temporal dependence (Plümper and Neumayer, forthcoming).

We do not argue here that the convergence regression approach is superior to spatial analyses. Rather, we believe that both methods have advantages and disadvantages. The beta-convergence approach is more robust to moderate changes in the model specification whereas the spatial analysis of convergence processes allows modeling the causal mechanism directly by using appropriate weighting matrices. For example, if convergence clubs depend on trade relations, trade flows would serve as appropriate weight; if convergence processes are conditioned by social interactions, some form of social processes would be better suited as spatial weight.

## 5. CONCLUSION

Despite more than a decade of convergence research, results remain contradictory and inconclusive. Our paper analysed various artificially generated convergence processes. We demonstrated that empirical research is likely to reject convergence hypotheses if the true convergence process is conditional, if different convergence clubs exist, or if empirical researchers have chosen a sample incorporating countries of more than one convergence club.

We made two interrelated recommendations: first, a lack of theoretically derived predictions on the existence of convergence (or divergence) clubs, conditional convergence, and the dynamics of the convergence process can cause flawed results. Theorists therefore need to explicitly model the underlying convergence process. We identified a set of questions which guide scholars in developing a more fully specified theory. Second, we recommended researchers to estimate convergence rather than measure it and discussed how to specify typical convergence processes. The regression approach has several decisive

advantages. Most importantly – and in contrast to the variance approach – it enables researchers to test their causal theory. In addition, the regression approach provides a parsimonious framework to analyse all possible characteristics of the convergence process within a single estimation. Estimating convergence eventually enables the detection of conditional convergence and the existence of different convergence clubs.

On a higher plane, we hope that our paper triggers an intensified debate about the link between theoretical and empirical models of convergence thereby contributing to more conclusive findings in the literature. We are confident that more explicit theories and the right analytical tools will allow for a more balanced account of the importance of policy convergence and diffusion.

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## NOTES

1 Similarly, a recent review of the convergence literature, including also unpublished manuscripts and articles in non-Social Science Citation Index journals, found that 33 analyses detected convergence, 15 studies rejected the existence of convergence or even reported divergence, and 26 studies remained undecided (Heichel *et al.* 2005).
2 Alternatively, scholars use the coefficient of variation which is the variance divided by the mean.
3 The label 'conditional convergence' has been used for three similar but not identical types of processes: First, conditional convergence takes place if researchers can observe convergence once they control for influential factors which push countries apart. Second, conditional convergence has been used interchangeably with the concept of convergence clubs such as the European Union (EU), where membership is dependent on the acceptance of an *acquis communautaire*, whose implementation

leads to policy convergence (Plümper *et al.* 2006). And third, the strength of convergence could depend on another variable, i.e. on trade relations.

4 Genschel and Plümper 1997; Holzinger and Knill 2005; Mattli and Plümper 2004; Knill and Lenschow 2005; Meseguer 2005; Swank 2005 Plümper and Troeger 2006, 2008.

5 For example, Hallerberg 1996; Oberthür and Tänzler 2002; Neumayer and Perkins 2004.

6 Hays 2003; Basinger and Hallerberg 2004; Plümper *et al.* 2009.

7 Neumayer 2001; Harrison 2002; Wolf 2002; Bouget 2003; Sanz and Vélazquez 2003; Henderson and White 2004; Radaelli 2005; Swank 2005.

8 The existence of convergence clubs is nothing new for economists dealing with economic growth (Barro and Sala-i-Martin 1992, 1999).

9 We focus our discussion on continuous dependent variables implying ordinary least squares (OLS) specification. The estimation can be adapted to account for limited dependent variables.

10 Some scholars refer to this type of convergence as delta convergence (Heichel *et al.* 2005; Holzinger 2006).



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