Shadow Economy, Transaction Sector, and Economic Convergence: Evidence from a Global Panel of Countries

Ivan D. Trofimov & Ahmed Sharaan

This study examines GDP per capita convergence by adjusting the official data by the size of the shadow economy and the transaction sector. The findings demonstrate the reduction of income per capita absolute distance from the relevant benchmarks and smaller income per capita dispersion in a global panel and sub-groups. The intra-distributional mobility of economies and the gamma convergence were absent. The stochastic convergence was observed in all specifications, both vis-à-vis the world average or the high-income economies. With regard to club convergence, the stability of the relative transition paths and the club composition were indicated (hence, little convergence across the clubs and more substantial convergence within the clubs).

Keywords: Shadow economy, transaction activities, convergence

JEL Classification: O17; O47

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I. Introduction

The officially published gross domestic product (GDP) tends to provide an incomplete picture of the true size of an economy's production sphere (North, 1987: 427; Kravis *et al.*, 1978). Although GDP is conventionally viewed as a measure of the value added created through the production of goods and services in a country during a certain period, a substantial part of the services include adjacent activities to support exchange and functioning of the economy. The distinction is made (North, 1987; Dollery, Leong, 1998) between non-transaction activities associated with the transformation of inputs into outputs (in the national accounting scheme: manufacturing, agriculture, and certain services), and transaction activities that are tangential to the actual production of output and that have a role to deliver or facilitate delivery (in the broad sense) of the output to the consumer and to ensure the smooth functioning of the production sphere (transportation, trade, finance, but also public services).[1]

In national accounting treatment, these transaction activities have dual nature. On one hand, the transaction services add value to the product (*e.g.* through transportation or trade margin) and create incomes (*e.g.* brokerage fees in finance), warranting their inclusion in GDP. On the other hand, these transaction activities and services are costly, bearing in mind that alternatives to decentralized market exchange are available (such as personal exchange or transactions within the firm/organization). In a similar vein, while public administration and services sector assists and facilitates trade and exchange, it equally creates negative effects (reflected in corruption, protection of vested interests, and inefficiencies of various sorts, as has been long demonstrated by the public choice literature). Thus, transaction services and activities are not only the creators of the

[1] A related distinction between productive and unproductive sectors is made in heterodox (Marxist) economics, based on the concept of different categories of productive labour, and the position of the workers / industries in the economy (activities that produce use values, *i.e.* output that serves a real function and satisfies a real need or want, and activities that maintain a given distribution or set of rights to these use values). The respective analysis is contained in Paitaridis and Tsoulfidis (2012), and Wolff (1987).

values but also sources of costs: the cornerstone premise of economic theory that specialization and division of labor give rise to costless trade and exchange is thus countered by the argument that exchange and trade are not costless (Coase, 1960; North, 1987).[2]

As elaborated by North (1987), "primitive" societies that rely on personal exchange in a narrow circle of agents may minimize transaction activities and costs but may afford only a limited scale of production. Likewise, the centrally planned economies (organized as one giant firm) may not only minimize transaction activities and costs and ensure a large scale of production but also create additional problems of misaligned incentives and poor coordination. By contrast, modern market economies ensure a large scale of production and extended interactions across a large number of agents in the absence of central planning only through the presence of a large "transaction sector" (and also the public sector with limited roles to facilitate, but not direct and manage, the exchange). The transaction activities and associated costs are thus inevitable. North (1984) lists a number of transaction costs: the costs of signing and enforcing the contracts, establishing property rights; dealing with cheating, shirking, and opportunism; setting the rules of exchange, measuring what is exchanged and traded; providing guarantees and insurance; and paying for specialized services that facilitate the trade and exchange.

These activities necessarily have a cost dimension. First, many of these activities, albeit designed to serve everyone, serve only the few, *e.g.* rules benefiting and giving advantage to vested interests and lobby groups. This constitutes the social cost (while at the same time being a benefit for an individual agent). Second, the complexity of modern society (and diverse behaviors and preferences) gives rise to conflicts (over the business transactions), in turn requiring the creation of structures and institutions that resolve or moderate these conflicts.

[2] Similar duality logic underpins the inclusion of other activities in GDP. For instance, the reconstruction activities following the natural disaster create value and thus need to be added into the GDP, but the very nature of these activities is associated with a prior destruction of the value during the disaster (*i.e.* while from formal point of view there is a growth of GDP, in a genuine sense, these activities do not represent growth). Likewise, the production of demerit goods or goods with externalities (*e.g.* tobacco) represents the addition to GDP, simultaneously the creation of new cost for the consumer and society.

These activities are necessarily the costs, rather than value, from the perspective of an individual agent. Third, the creation of new rules or mechanisms to facilitate the transactions does not automatically translate into stable forms of behavior and does not preclude mistakes/errors in individual decision-making. The rise of transaction activities may thus be associated with learning, adjustment, and immeasurable psychological costs for individual decision-makers.

Therefore, in the existing national accounting systems, the size of GDP as a measure of production would be inaccurate because the costs (outlays) to support the exchange of goods and services are added together with the value of produced goods and services, rather than subtracted from GDP (Fuess, Van Den Berg, 1998: 973-4). Thus, the official GDP figures tend to overestimate the size of the economy and the level of productivity (given that many of the services have lower productivity than other sectors, *e.g.* manufacturing).

In a related vein, the official publications of GDP capture only those activities that are not hidden, deliberately or accidentally, from official authorities for a variety of reasons, *e.g.* tax avoidance, excessive regulatory burden, corruption, weak rule of law, and outright criminal activities (Medina, Schneider, 2019: 4). These activities constitute the shadow economy, whereas missing economic activities that are defined more broadly also include do-it-yourself and household production and other non-market productive activities. Although attempts are made to ensure good quality of national accounts by capturing missing economic activities in general and the shadow economy in particular, thereby achieving exhaustive GDP measures, the methods to achieve the maximum inclusion of missing activities are not standardized (uniform) across the economies and in many respects are *ad hoc* (UNECE, 2008: 9-10). Specifically, countries may have started accounting for missing activities at different time points and may have defined and treated missing activities differently: thus, specific changes in the sizes of these activities may be due to actual changes in the activities or improvement in the national accounting methods, or both. Overall, as a general rule, the shadow economy and missing activities are not adequately captured, and thus the official GDP figures under-estimate the true size of the economy.

The aforementioned distortions (omissions) are typical in all economies. Arguably, in developed economies, due to the greater share of services in the GDP, the over-estimation of GDP through inclusion, rather than deduction, of transaction activities (costs) would be more common. By contrast, the developing economies, due to a less developed statistical infrastructure and greater size of shadow economies, the under-estimation of GDP would be more likely (Kuznets, 1965; Fuess, Van Den Berg, 1998). These two phenomena will affect the aggregate GDP as well as GDP per capita levels and would be reflected in the growth and convergence processes. The purpose of this paper is to examine whether controlling for the transaction and shadow economy size would alter the GDP per capita convergence across a panel of developed, developing, and emerging market economies. To this end, we consider several specifications for the empirical analysis: official GDP per capita data, that is further augmented by the size of the shadow economy and cleared of the transaction activities, as well as shadow economy GDP and transaction sector GDP per capita (altogether five specifications, as outlined further in Section 3). The shadow and transaction economy data for the adjustment are obtained from the previously made estimates of the shadow economy size or from the value-added data in the input–output tables for individual sectors and economies.

This paper considers five aspects of convergence: the scale of convergence in absolute terms (Clark's coefficient of divergence), sigma-convergence that concerns the evolution of the cross-country distribution of GDP per capita over time, stochastic convergence that relates to the deviations of individual economy's GDP per capita from the world average or other benchmarks and the unit root properties of the deviation, gamma-convergence that represents intra-distributional mobility of economies in terms of their GDP per capita levels, and club convergence that indicates heterogeneity in the convergence process.

Given the large number of economies included in the study and the limited time dimension (stretching a period of either 20 or 27 years), we used panel data methods to examine the convergence process, *i.e.* the panel unit root tests (including the methodology proposed by Ben-David, 1993, and Konya, 2011) and the club convergence in the panel setting proposed by Phillips and Sul (2007), alongside more descriptive methods.

The rest of the paper is organized as follows. The next section summarizes the economic convergence literature and examines the studies that attempt to integrate the convergence and structural economic issues. The third section introduces the methodology and explains the data used in the paper. The fourth section presents the empirical findings. The last section concludes and discusses the study's limitations, policy implications, and avenues for further research.

II. Literature review

The theoretical and empirical research on income per capita convergence at the economy-wide level is extensive and, given the paper's limits, is reviewed in a cursory fashion. The empirical findings are generally conflicting, given the different definitions of convergence, diverse range of study settings, and econometric methodologies.

The beta-convergence analysis, as the earliest approach to the problem, rests on the hypothesis that an economy with a lower income per capita level will grow faster than an economy with a higher income per capita level and consequently will catch up with the latter and reach steady state per capita level in the long-run: to a single steady state with absolute beta-convergence or own country-specific steady state with conditional beta convergence (Boyle, McCarthy, 1997, 1999; Konya, 2011; Hamit-Haggar, 2013: 591-2). The necessary assumption is that the countries have the same savings and investment rates, rate of technological change, population growth, and depreciation, and that the driving force of the process is the dissemination of productivity-enhancing technologies from the technological leaders to the followers (in turn requiring that the latter economies are able to adopt them, Abramovitz, 1986). Empirically, the catch-up hypothesis was typically verified by regressing the GDP per capita growth rate on the initial level of GDP per capita (Barro, 1991), where convergence is indicated if the respective coefficient (β) is negative and statistically significant. While the absolute convergence finds support only in a narrow set of the like economies, further research tended to make beta-convergence process conditional on the endowment levels of human capital, institutional, and policy factors (Barro, 1991). Conditional beta-convergence was identified in 24 OECD and 80 non-OECD economies over the 1960–1995 period (Mello, Perrelli, 2003), 54 developed and developing economies over the 1950–1990 period (Evans, Karras, 1996), and 22 OECD economies during the 1960–1985 period (Nonneman, Vanhoudt, 1996), to name a few. By contrast, no beta convergence was detected in 37 African countries in 1960–1985 (Murthy, Upkolo, 1999) or OECD economies in 1960–1990 (Murthy, Chien, 1997; Andres *et al.*, 1996).

Quah (1993), Paschaloudis and Alexiadis (2006) and Konya (2011: 60) note the shortcomings of the approach, such as the presence of Galton's paradox results (where negative β is the evidence of regression to the mean rather than true convergence), the overall convergence for a group of economies accompanied by individual divergence or country-specific acceleration or deceleration of convergence process), and the t-test bias in favor of convergence (given the null hypothesis of no convergence, $\beta = 0$, and the alternative hypothesis of convergence, $\beta < 0$). In this regard, the analysis of dispersion of per capita income for a cross-section of economies over time was seen as a more appropriate method of establishing convergence (Friedman, 1992). Sigma-convergence implies that dispersion attenuates over time, whereas divergence takes place when dispersion increases. The empirical studies tended to analyze the inter-temporal change in the standard deviation or the coefficient variation of the cross-country distribution of the GDP per capita but also considered higher order moments (skewness and kurtosis) and applied non-parametric methods (estimation of probability density functions). The sigma-convergence takes place when a downward trend occurs in standard deviation, coefficient of variation, skewness, and kurtosis or when the distribution (represented by kernel density plot) becomes more compact (with higher peak and shorter tails). Generally, evidence supporting sigma-convergence has been limited, with cross-country income per capita dispersion on a global scale growing steadily since the 1960s (Barro, Sala-i-Martin, 1992; Mendez, 2019). A more recent phenomenon was a reduction in dispersion globally in the late 2000s, likely driven by the growth slowdown in the high-income economies, and the resurgence in growth in middle- and certain low-income economies with solid institutional capacity and governance and high degrees of political stability (Johnson, Papageorgiou, 2020).

Quah (1995) and Boyle and McCarthy (1997: 258) noted that although beta-convergence is necessary but not sufficient for sigma convergence, sigma-convergence is sufficient but not necessary for beta-convergence. The growth of economies at different speeds and resulting catch-up (that are implied by beta-convergence) may be accompanied by reduction or constant dispersion. The presence of random shocks or convergence to different steady-states may result in a situation when growth at different speed may not bring reduction of dispersion. Thus, gamma-convergence (associated with higher intra-distributional mobility and change in ranks) and stochastic convergence (associated with temporary effects of random shocks on income per capita differences between countries) necessarily come to the fore.

Boyle and McCarthy (1997, 1999) and Glodowska and Pera (2019) recommended complementary sigma- and gamma-convergence analysis as a predictor of beta-convergence (or its absence), particularly when contradiction occurs between beta- and sigma-convergence. They identified a number of relationships, *e.g.* reduction in dispersion measure and increase in rank mobility, reduction of dispersion with no rank mobility, no or little change in both measures, and asynchronous movement in measures. The empirical analysis of gamma-convergence typically relied on binary or multi-annual Kendall indexes of rank concordance, the latter being more likely to identify the association between the ranks. The gamma convergence has been slow and not widely observed: Boyle and McCarthy (1999) note the absence of convergence in the 1960–1970s, limited convergence starting from the 1980s in the high and middle-income economies, and virtually no change in the ranks for the low-income economies. Glodowska and Pera (2019) likewise observed very limited change in the GDP per capita ranks of Central and Eastern European economies in 1995–2016.

As to stochastic convergence, the analysis typically examined whether the shocks to the GDP per capita differences attenuated or persisted over time, the former case attesting to the presence of stochastic convergence (the latter to divergence). Thus, the empirical research applied unit root tests in a time series or panel settings (Islam, 1995; Koo, Lee, 2000), with stochastic convergence indicated when output per capita differentials contain no unit roots. No stochastic convergence was identified by Bernard and Durlauf (1995) in their study of 15 developed economies in the 20th century, McCoskey (2002) in their study of Sub-Saharan African economies (where South Africa is a benchmark economy), Tunali and Yilanci (2010) in their analysis of MENA economies (convergence to MENA average). When accounting for the possibility of structural beaks, the stochastic convergence was present in the output differentials of OECD economies over the 1870–1994 period (Strazicich *et al.*, 2004) and African economies over the 1950–1999 period (Cunado, Garcia, 2006). The mixed evidence of stochastic convergence was present between Latin American economies and the US during the 1950–2011 period (Ayala *et al.*, 2013), and in the UK–US and US–Canada pairs, even when allowing for structural breaks (Cellini, Scorcu, 2000). Regarding stochastic convergence, the results were generally sensitive to the sample length and the coverage of economies, the modeling of structural instabilities and nonlinearities, and the presence of fractional unit roots (Ayala *et al.*, 2013: 3221).

Given the substantial heterogeneity across the economies in terms of economic, structural, institutional, and policy factors, and differences in the adjustment to economic shocks, the assumption of convergence to a single steady-state appeared unjustified (Hay, 2004; Rapacki, Prochniak, 2009). The club convergence concept thus assumes that the absence of similarities across the economies would result in their clustering and formation of convergence clubs and hence the existence of multiple steady-state equilibria (Quah, 1996). To ascertain club convergence, empirical analysis used non-parametric methods (Krause, 2016), classification and regression trees/CART analysis (De Siano, D'Uva, 2006), and applied club convergence algorithms (Phillips, Sul, 2007).

The analysis of the effects of structural economic factors on income has been limited and generally concerned the estimation of the "correct" value of GDP by making adjustments for the transaction activities. Wallis and North (1986), using decadal data for the US over the 1870–1970 period estimated the size of the transaction sector, but did not estimate its effects on productivity. Fuess and Van Den Berg (1992) used post-WWII data for the US and established the significant overestimation of productivity growth if the size of the transaction sector is not accounted for. The ensuing paper (Fuess, Van Den Berg, 1998) focused on Mexico: the authors recalculated the GDP for the 1961–1990 period and confirmed the misstatement of the country's GDP as a result of not accounting for transaction activities and non-market sector. The over- or under-statement of the true size of the economy varied across the three decades (1960–1990). Lastly, regarding the effects of structural factor on convergence, Caselli and Coleman (2001) considered the regional economic performance in the USA during the 1880–1980 period: the analysis linked the decline of agriculture as principal driver of structural change and wage convergence between Southern and Northern states. Based on a country model with multiple locations, goods and production factors, and specification of regional production technology functions, the authors showed that most of the regional wage convergence was attributed to the labour reallocation from agriculture to other sectors.

The above research focused on a single economy or regions within one economy. This paper adds another dimension to the problem by first estimating GDP per capita adjusted for transaction sector and shadow economy size for a maximum possible number of economies, and second, considering the convergence process across these economies using the adjusted data.

III. Methodology

A. Model

The paper examines convergence in real GDP per capita, based on the officially published figures that are further adjusted for the size of the shadow economy and the transaction sector.

Based on Medina and Schneider's (2018: 4) approach, the shadow economy is defined to include all economic activities that are hidden from the official authorities for the following reasons: monetary (tax and social security payments' evasion), regulatory (economic activities that arise in response to the growth of government bureaucracy and excessive regulatory burden) and institutional (economic activities that proliferate as a result of corruption, poor quality of political institutions or the lack of rule of law). The Medina–Schneider study therefore excludes illegal and criminal activities, household production, and other household activities.

The transaction sector, following Fuess and Van Den Berg (1998), includes the economic activities related to the enforcement and protection of property rights and functioning of institutions that are necessary for the market economy, the activities related to exchange (as opposed to production) of goods and services, and activities that support the functioning of the product markets. These are financial intermediation (in turn including real estate activities), public administration and defense, and wholesale and retail trade. The productive sector of the economy comprises agriculture (crop and animal production, fishing, forestry), mining and quarrying, all manufacturing industries, construction, utilities, transport, and productive services (accommodation and food services, administrative and support services, education, health and social work, professional, technical and scientific services, other community, social and personal services). Some of the service categories fall outside the market economy sphere but are nonetheless considered productive, given their indispensable role in the economy.

The officially published real GDP per capita figures tend to exclude or under-estimate the size of the shadow economy, hence the official figures are adjusted upwards (multiplied) by the share of the shadow economy in GDP. By contrast, based on the consideration that published GDP includes the activities that belong to the non-productive sphere of the economies or activities that facilitate the functioning of the economy but are not the representation of the created value added (both included under the umbrella of "transaction economy"), the official real GDP per capita figures are adjusted downwards (divided) by the share of "transaction economy" in GDP. To obtain the "true" size of GDP per capita, the two adjustments are combined. There are no a priori reasons to hypothesize that the shadow economy is larger or smaller than the transaction sector for a particular economy, hence the adjusted real GDP per capita figures may (or may not) be larger than the official figures. As a general rule, however, developing or transition economies tend to have larger shadow economies, whereas developed capitalist economies tend to have a more sizeable transaction sector.

The official GDP data arguably already incorporates the adjustment for the shadow economy size. This has been the case, but the statistical treatment of shadow economy activities has been typically inconsistent. The UNECE (2008) survey of the treatment of non-observed economy in the national accounts demonstrates that non-observed activities are diverse (non-registration of activities due to their underground or outright illegal character or due to the lack of requirement to register them; misreporting; exclusion or omission from the survey; statistical deficiencies, such as incorrect compiling, handling, or processing the data). Importantly, the adjustments performed by the statistical bodies tended to address some (but not all) of these problems, the resulting size of the adjustment (as percent of GDP) ranging substantially (from 1% of GDP in the Netherlands in 1995 to 3%-4% of GDP in neighboring Belgium in 2002). Lastly, the adjustments to national accounts were not performed by all economies included in the study. As a result, we recourse to adjusting the official GDP data by the shadow and transaction economy size data from the secondary sources.

For modeling purposes, we consider the following seven specifications. In Specification 1, the officially published GDP per capita data is augmented by the size of the shadow economy, according to the formula $GDP_{pc}^{adj} = GDP_{pc}^{off}(1 + SE)$, where SE is the shadow economy share of GDP, expressed in percentage terms, and GDP_{pc}^{adj} and GDP_{pc}^{off} are adjusted and official figures. In Specification 2, the shadow economy GDP per capita is estimated as a product of official GDP per capita and the shadow economy share of GDP, $SE_{pc} = GDP_{pc}^{off} \times SE$. For the sake of comparison, in Specification 3, the convergence analysis is performed on unadjusted GDP data for the 1991–2007 period. Specification 4 estimates GDP per capita net of transaction sector, $GDP_{pc}^{adj} = GDP_{pc}^{off} / (1 + TS)$, where *TS* is the size of the transaction sector as a share of GDP. Specification 5 includes transaction sector GDP per capita, defined as a product of official GDP per capita and the transaction sector share of GDP, $TS_{pc} = GDP_{pc}^{off} \times TS$. In Specification 6, the convergence of unadjusted data for the 1995–2004 period is considered. Lastly, in Specification 7, the GDP per capita adjusted for both shadow economy and transaction sector is obtained as $GDP_{pc}^{adj} = GDP_{pc}^{off}(1 + SE)/(1 + TS)$.

The convergence process was also examined for the specific groups of economies: low, low-middle, upper-middle, and high-income economies, based on the World Bank analytical classification. The classification puts the economies in the relevant group according to the level of gross national income (GNI) per capita in US dollars (Atlas method). The economy was considered to belong to a particular group, if during the 1987–2019 period (for which the classification data is available), the economy stayed in the group for more than half of the period (*i.e.* more than 16 or 17 years). We also considered fast and slow-growing economies (that respectively experienced GDP per capita growth of 200% and more or 150% and less over the whole period).

B. Data

The shadow economy size was estimated by Medina and Schneider (2018) and is available for the 1991–2017 period for 156 economies (the Appendix includes the full list of the economies). Medina and Schneider acknowledge the deficiencies of the standard multiple indicators multiple causes approach for the estimation of shadow economy size: the use of GDP as both cause and indicator variable, the need to calibrate to estimate the shadow economy size as percentage of GDP, and the sensitivity of results to alternative specifications, country panels and time periods (Medina, Schneider, 2018: 19-20). The authors therefore use light intensity as a variable that captures the extent of economic activity, and also apply predictive mean matching method to tackle the missing data problem in the economies for which the survey-based estimates of the size of the shadow economy are not available (Medina, Schneider, 2018: 21).

The transaction sector size is estimated from the World Input–Output Database (WIOD) that contains observations for 39 economies over the 1995–2014 period (as outlined in the Appendix). The WIOD contains data for 56 industries belonging to primary sector, industry, and services. In WIOD, certain productive activities (*e.g.* repair of goods) are included under "wholesale and retail trade" categories. Therefore, when adjusting for transaction sector size we remove only one half of the "wholesale and retail trade" from the official GDP figures, an approach and assumption adopted by Fuess and Van Den Berg (1998: 975).

Consequently, although the official GDP data stretches the 1970–2019 period, the adjusted GDP per capita figures are constructed only for a shorter period (1991–2017 in Specifications 1 and 2, and 1995–2014 in Specifications 4, 5, and 7). This clearly limits the choice of econometric methods: we respectively conduct panel unit root tests and club convergence analysis instead of using time series methods. The official GDP per capita is presented at constant 2015 prices in US dollars and is obtained from the UN National Accounts database ("Per Capita GDP at Constant 2015 Prices in US Dollars – All Countries for All Years, Sorted Alphabetically").

C. Econometric method

As a first step, we describe the extent of differentiation of GDP per capita (with or without adjustment for the size of the shadow economy and transaction sector) across the economies and at different time periods, specifically by looking at the size of the shadow economy and transaction sector as a percentage of GDP. In addition, we examine more formally the distance and divergence between the economies under different specifications by estimating the Clark coefficient of divergence as follows (Clark, 1952; Glodowska, Pera, 2019: 6-7):

$$d_{cl} = \left(\frac{1}{p} \sum_{t=1}^{p} \left(\frac{y_{it} - y_{lt}}{y_{it} + y_{lt}} \right)^2 \right)^{\left(\frac{1}{2}\right)} \tag{1}$$

where t is the number of years till the end of the study period, y_{it} is the mean value of the level of GDP per capita in a particular group of the economies, y_{it} is the mean value of the GDP per capita level in the reference group (in relation to which the GDP per capita in a particular group is compared), and p = 1,...,27 or p = 1,...,20 is the set of GDP per capita values. The estimated coefficients belong range from 0 to 1, the former corresponding to the absence of difference in the GDP per capita level, the latter to the persistence of the difference (*i.e.* divergence).

Second, for the purpose of sigma- and gamma-convergence analyses, we respectively calculate the coefficient of variation and derive the index of rank concordance (Boyle, McCarthy, 1999: 344):

$$\sigma_t = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(y_{it} - \overline{y_t}\right)} \,/\, \overline{y_t} \tag{2}$$

and

$$RC_t = \frac{Var\sum_{t=0}^{T} AR(y)_{it}}{Var((T+1)\times AR(y)_{i0}} \tag{3}$$

where $\bar{y}$ is a cross-sectional mean GDP per capita; $AR(y)_{it}$ and $AR(y)_{i0}$ are the actual ranks of economy i GDP per capita in years t and 0; and $T+1$ are the number of years for which data is used to construct rank concordance index. The value of the index belongs to (0,1) interval and faster gamma-convergence (rank mobility) is represented by a smaller value of the index. The sigma convergence is observed when $\sigma_{t+T} < \sigma_t$.

Third, we perform the stochastic convergence test on the GDP per capita deviations. The deviation is defined as the difference between the GDP per capita in a respective country and the reference group (whole world or the high-income economies). Given a short time-series dimension, we adopt the panel data approach for testing stochastic convergence that was developed by Ben-David (1993) and complement it with other first-generation panel unit root tests. Ben-David's test involves estimation of the first-order autoregressive model with no constant as follows:

$$\ln y_{i,t+1} - \overline{\ln y_{t+1}} = \theta\left(\ln y_{i,t} - \overline{\ln y_t}\right) + \varepsilon_{i,t+1} \tag{4}$$

Coefficient θ indicates convergence when $0 < \theta < 1$ and divergence when

$\theta > 1$. The speed of convergence is inferred from the half-life of the convergence process, $T = \ln 0.5/\ln\theta$, with the small number of years T representing faster convergence (Konya, 2011: 60).

As a last step, we conduct club convergence analysis by applying Phillips-Sul log*t* test that is suitable for the analysis of linear, non-linear, stationary, and non-stationary processes (Phillips, Sul, 2007; Apergis *et al.*, 2011: 9-10; Blanco *et al.*, 2020; Barrios *et al.*, 2019: 1549-51). The test is based on a non-linear time-varying factor model that represents the GDP per capita variable (y_{it}) in terms of common stochastic trend μ_t and country-specific idiosyncratic component φ_{it} that captures the deviation of the country i for the common path:

$$y_{it} = \varphi_{it}\mu_t \tag{5}$$

The convergence will be achieved when all countries in the panel converge to a common or club-specific steady state, *i.e.* $\lim_{k\to\infty} \varphi_{it+k} = \varphi$ for $i = 1,\ldots,N$ at some point in time. The number of clubs may differ (including the possibility of a single club), as may the country-specific transition paths, whereas some countries may be located closer to the steady state than others.

Given that φ_{it} cannot be directly estimated, the individual values of y_{it} are compared with the panel average, and the variance of the resulting relative measures are calculated as follows:

$$h_{it} = \frac{y_{it}}{\sum_{i=1}^{N} y_{it} / N} \tag{6}$$

and

$$H_t = \frac{\sum_{i=1}^{N} \left(h_{it} - 1\right)^2}{N} \tag{7}$$

The relative transition path (h_{it}) is thus specified, the common component μ_t is eliminated, and further testing is conducted on h_{it} and H_t. For formal convergence testing, the semi-parametric form of φ_{it} is defined as

$$\varphi_{it} = \varphi_i + \sigma_{it}\xi_{it} \tag{8}$$

where φ_i is fixed, σ_{it} is a country-specific scale parameter $\sigma_{it} = \sigma_i / L(t)\, t^{\alpha}$ with $\sigma_i > 0$, $t \geq 0$, ξ_{it} is *i.i.d*(0,1) over *i*, but weakly dependent over *t*, $L(t) = \log(t+1)$, and α is the speed of convergence parameter.

The log*t* test is then conducted based on the OLS regression with robust covariance matrix:

$$\log\left(\frac{H_1}{H_t}\right) - 2\log\left(\log\left(t\right)\right) = c + b\log\left(t\right) + u_t \tag{9}$$

where $t = [rT],[rT]+1,\ldots,T$.

For sample sizes with $T \leq 50$, Phillips and Sul recommend setting $r = 0.3$, *i.e.* one third of observations are removed to reduce sensitive of the results on the initial conditions. The null hypothesis of convergence for all economies ($\varphi_i = \varphi$, $\alpha \geq 0$) is contrasted with an alternative hypothesis of convergence for some of the economies ($\varphi_i \neq \varphi$, $\alpha < 0$). With coefficient $\hat{b}$ being the scaled estimator of α, the null hypothesis is rejected when $t_{\hat{b}} < -1.645$(the 5% significance level for a one-sided t-test). In case the null is rejected, the clustering algorithm is applied to determine individual clubs: 1). Member economies are first ordered according to the last observation. 2). The core group of size k^* is formed, the log*t* test is conducted to determine the core group size by maximizing t_k with $t_k > -1.65$. 3). The remaining economies not belonging to the core group are then added one at a time to it based on log*t* test (as long as t-statistic is greater than critical value) and when adding an economy is no longer possible, the first club is formed. 4). The test is then run for un-selected economies, and if convergence is established, the second club is formed. 5). If in Step 4 no convergence is indicated, Steps 1 to 3 are repeated.

IV. Empirical results

Table 1 in the Appendix provides a summary of GDP per capita (in level form) with and without adjustment for the size of shadow and transaction economies. Looking at the 1991–2017 and 1995–2014 periods as a whole as well as sub-periods, the aggregate group of the economies and the sub-groups all experienced GDP per capita growth, no matter what specification is concerned. The exceptions were low-income economies during the 1991–1999 sub-period in Specifications 1 and 2, and the aggregate of all economies and the high-income economies prior to the 2008 global financial crisis (GFC) in

Specification 2. For Specifications 1 to 3, a growth slowdown occurred during the period prior to the GFC (2000–2008) in certain groups of economies (high-income, fast-growing economies, and the aggregate of all economies), while other groups experienced GDP per capita growth acceleration (low, low-middle, and high-middle economies). In the post-GFC period (2009–2017) there was a deceleration of growth in all groups except the low-income economies. In Specification 2, the shadow economy GDP per capita grew slower across the periods; however, the pattern was not uniform. The fast-growing economies witnessed the progressive decline in shadow economic activities, whereas the low-income ones experienced the progressive increase in such activities across the periods. For middle-income economies, an increase was identified in shadow economy GDP per capita during the 2000–2008 period. Specifications 4 to 7 relate to the shorted period (1995–2014) and its respective sub-periods. Nonetheless, the growth of unadjusted GDP per capita as well as of the transaction activities was experienced in all economic groups and in the aggregate of all economies. When two sub-periods of approximately equal length (1995–1999 and 2009–2014) are compared, the growth reduction is experienced in all cases, except fast-growing economies and low, low-middle, and high-middle economies. The growth failure in the least developed economies in the 1990s was documented by scholars such as Jerven (1999) and Collier and Gunning (1999) and was attributed to governance and institutional failure, vulnerability to external (*e.g.* terms of trade) shocks, human, and physical capital constraints. The sluggish growth in the developed economies prior to the GFC was identified, among others, by Cette *et al.* (2016) and was explained by factors such as productivity slowdown, structural rigidities in product and labor markets, and sluggish manufacturing growth.

The adjustment for the shadow economy size results in smaller cumulative GDP per capita growth than without adjustment (irrespective of the sub-periods or groups of economies) meaning that the shadow economy expands at a slower rate than the “official” economy (also implying the decline in shadow economy share of GDP). The expansion of the transaction sector was greater than the growth of the whole economy and non-transaction sectors in all economic groups, except for the slow-growing developed economies, demonstrating that the structural transformation in these economies (toward the greater role of the services sector) took place earlier than in other economic groups.

Across the sub-periods, the expansion of the transaction sector was generally the fastest prior to GFC. Net of the transaction activities the GDP per capita growth was slower than without adjustment, particularly in the 2000–2008 period. The adjustment for both shadow economy and the transaction sectors (Specification 6) indicates smaller cumulative growth than without adjustment (no matter what group or sub-period is concerned), suggesting that the slower growth of the shadow economy dominated the expansion of the transaction sector.

However, investigating whether the adjustment affected the distance among the economies in terms of income per capita levels is more instructive. We use the data in levels (with no logarithmic transformation) and present Clark coefficient estimates (Table 2). The absolute value of the coefficient was the smallest for the high-middle income group, and the highest for the low-income economies, both at the beginning and at the end of the period.

If no shadow economy adjustment is performed (Specification 3), over the 1991–2017 period the distance reduction (convergence) is observed in all instances: both in terms of convergence to the world average and to the high-income economies. The fastest distance reduction was observed for the low-middle, high-middle, and fast-growing economies to the world average (10.5%, 10.3%, and 44.3%) and for the fastest-growing economies to the high-income economies (10.7%). The slowest distance reduction was indicated for the low-income economies (to the world average and to the high-income group, respectively 3.3% and 1.2%) and in the case of high-middle income group versus high-income group, 2.8% (the well-known “middle-income trap phenomenon”).

As far as GDP per capita with the shadow economy is concerned (Specification 1), the reduction of distance was more marked than without adjustment (for all groups except low-income economies). The distance reduction was even stronger for shadow economy GDP per capita (Specification 2): with the exception of high-middle income economies that had a positive 6.8% increase in the distance, all groups experienced reduction in the distance, likely a reflection of the reduction of the shadow economy share of GDP in prior periods. The largest distance reduction (relative to the world average) was observed for the fastest-growing and low-middle economies that experience the largest expansion of the shadow economy during the period. We also note a greater number of positive values of Clark coefficient in a number of groups in the post-GFC period, an indication of convergence slowdown.

Regarding GDP per capita net of the transaction economy sector (Specification 4), the distance reduction was larger than without adjustment, indicating that transaction activities negatively affect the convergence process. This regularity held for all groups, except for the slow-growing economies (distance reduction of 15.6% and 19.4% with and without adjustment). Regarding GDP per capita in Specification 7 (with shadow economy and net of transaction sector), the convergence process (reduction of the distance) was also observed for all groups, except for slow growing economies group. Similarly to the adjustment for the shadow economy, the largest reductions were indicated in the 2001–2008 sub-period.

Figure 1 presents the coefficient of variation of the levels of GDP per capita for the aggregate panel of economies. In all specifications except Specification 5, the coefficient of variation decreased, indicating that over the study period, countries experienced larger relative dispersion and relative standard deviation (and greater heterogeneity within the group) for the transaction economy GDP per capita, and smaller relative variation (and greater homogeneity as a group) for the shadow economy GDP per capita, adjusted and unadjusted GDP per capita. This specific result for the transaction economy GDP per capita can be attributed to the structure of the dataset that contains a small number of economies (compared with other specifications) that differ substantially in terms of income levels and the salience of transaction sector for the economy. The largest decrease in the coefficient was experienced in the 2000–2008 period, while the divergence or convergence slowdown tendencies were respectively observed in the 1990s or the 2010s. The adjustment for the size of the shadow or transaction economies did not affect sigma convergence (particularly in the timing of the break in the early 2000s and the general evolution pattern of the series), with a coefficient of variation plots in all cases except Specification 5 looking virtually identical.

Group-wise, the results were quite uniform. The fast-growing economies experienced reduction of the coefficient value (small in Specifications 1 to 3 and significant in other specifications). The similar pattern was present for the low-middle, high-middle, and high-income groups (however, in the latter case, the differences in transaction economy GDP per capita in this group increased slightly). The low-income and slow-growing economies experienced sigma divergence or had stable coefficient of variation. To conserve space, we present the

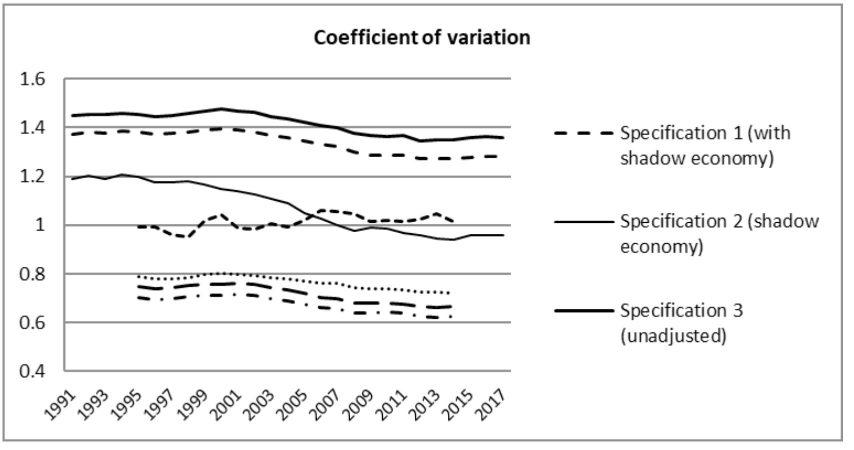

Figure 1
Sigma convergence (the aggregate of economies)

individual group plots for Specification 7 (Figure 2 in the Appendix). [3]

The gamma convergence was virtually absent and the intra-distributional mobility was extremely slow. Figure 2 contains the plots of the rank concordance index that takes the value of 1 at the beginning of the study period and is smaller than one in every subsequent year. In every specification, the value of the index decreased only slightly and at all times was above 0.99. When economies were becoming similar in the GDP per capita levels, they were unlikely to experience "leapfrogging" when a particular economy moves up or down dramatically in the ranks. This result falls in line with the findings by Boyle and McCarthy (1999: 346) who examined an earlier period (1960–1992) but denoted gamma convergence "painfully slow." For the low-income and slow-growing economies, the result also implies the absence of beta-convergence (that requires the reduction in both the coefficient of variation and rank concordance index).

Regarding stochastic convergence, the Ben-David panel data testing procedure has been applied to the GDP per capita deviations. The relevant deviation was defined as the logarithm of the GDP per capita

[3] The estimates were also performed for the logs of the GDP per capita. The general pattern and trends in the coefficient remained similar, albeit the fluctuations in the coefficient became less drastic.

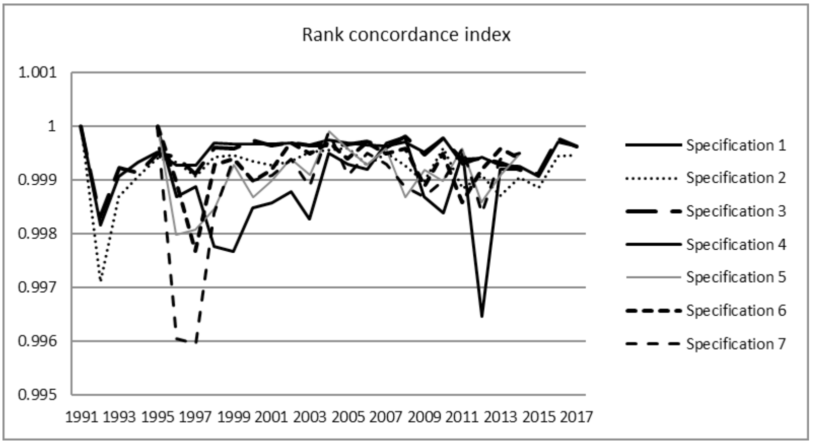

FIGURE 2
EVOLUTION OF THE RANK CONCORDANCE INDEX

of an individual economy minus the logarithm of GDP per capita in the reference group of economies. The two reference groups were the aggregate of all economies or the high-income economies (the logarithm of their average GDP per capita being the reference series). The testing procedure was performed for the panel of deviations of all 156 or 39 economies, with Tables 3 and 4 containing results for each of the seven specifications. The group-specific results (*e.g.* the GDP per capita deviations of the fast-growing or low-middle income economies from the world average or the high-income average) were also obtained. Given that they were similar in terms of convergence patterns to those in the aggregate panel of deviations, we do not present them to conserve space. In all instances, the deviations fluctuated around zero. Thus, the Ben-David procedure and other panel unit root tests were implemented with no constant or trend deterministic terms. Given the limited time span in the study, the procedure's alternative lags were set at either one or two.

In all specifications, the theta coefficient (θ) was highly significant (as indicated by t-statistics and p-values) and smaller than unity, indicating stochastic convergence to the benchmark. In the case of the Specification 2 (shadow economy GDP per capita, the deviation from the average GDP per capita of the high income economies), the cross-sectional mean value of the deviation was negative (as opposed to zero in other specifications), reflecting the small size (as percentage of GDP) in the high-income economies and respectively the large distance between this group and the rest of the world. In this case, the Ben-David procedure and the panel unit root tests were implemented with the constant. The model fitted the data well in all cases, with R2 ranging from 0.993 to 0.999. The Wald test null hypothesis of no convergence ($\theta = 1$) was rejected in most cases (columns 6 and 7 of Tables 1 and 2). The specifications differed in terms of the speed of convergence and the estimated half-life measure. Between 28 years in Specification 2 (shadow economy GDP per capita, and world average benchmark) and 418 years

Table 1

Ben-David testing procedure results (world average GDP per capita as a benchmark)

Specification	Theta	t-stat	p-value	R^2_{adj}	t-stat (Theta=1)	p-value	Half-life
GDP per capita with shadow economy							
Lag=1	0.9978	1511.15	(0.000)	0.998	11.00	(0.001)	316.16
Lag=2	0.9946	927.74	(0.000)	0.995	25.45	(0.000)	127.80
Shadow economy							
Lag=1	0.9959	1222.34	(0.000)	0.997	25.47	(0.000)	168.22
Lag=2	0.9908	777.53	(0.000)	0.994	52.34	(0.000)	74.85
GDP per capita - no adjustment							
Lag=1	0.9978	1526.80	(0.000)	0.998	11.05	(0.001)	318.78
Lag=2	0.9946	936.93	(0.000)	0.996	25.48	(0.000)	129.00
GDP per capita - only transaction economy							
Lag=1	0.9878	557.29	(0.000)	0.998	47.51	(0.000)	56.39
Lag=2	0.9754	346.85	(0.000)	0.994	76.66	(0.000)	27.80
GDP per capita - net of transaction economy							
Lag=1	0.9896	832.99	(0.000)	0.999	76.99	(0.000)	66.15
Lag=2	0.9788	482.97	(0.000)	0.997	109.55	(0.000)	32.33
GDP per capita - no adjustment							
Lag=1	0.9893	906.57	(0.000)	0.999	96.85	(0.000)	64.20
Lag=2	0.9783	511.15	(0.000)	0.997	129.04	(0.000)	31.53
GDP per capita - with shadow and no transaction economy							
Lag=1	0.9896	830.73	(0.000)	0.999	76.72	(0.000)	66.08
Lag=2	0.9788	486.61	(0.000)	0.997	110.59	(0.000)	32.42

Note. p-values are in parentheses.

in Specification 1 (GDP per capita with the shadow economy, and high-income economies average benchmark) were needed to halve the gap between the individual economies and the benchmark.

The principal shortcoming of Ben-David's testing procedure is the restrictive assumption that all deviations are characterized by the same autocorrelation coefficient, so that convergence (if detected) pertains to all of them (Konya, 2011: 62). The two panel unit root tests (ADF-Fisher and PP-Fisher) address this shortcoming. Table 3 demonstrates that in the majority of specifications (except for the shadow economy GDP per capita series and the high-income economies average as a benchmark)

Table 2

Ben-David testing procedure results (high-income economies average GDP per capita as a benchmark)

Specification	Theta	t-stat	p-value	R^2_{adj}	t-stat (Theta=1)	p-value	Half-life
GDP per capita with shadow economy							
Lag=1	0.9983	2412.374	(0.000)	0.998	16.02	(0.000)	418.22
Lag=2	0.9957	1473.15	(0.000)	0.995	39.57	(0.000)	162.67
Shadow economy							
Lag=1	0.9955	1129.31	(0.000)	0.997	25.96	(0.000)	153.99
Lag=2	0.9901	730.37	(0.000)	0.993	52.94	(0.000)	69.92
GDP per capita - no adjustment							
Lag=1	0.9979	2570.43	(0.000)	0.998	29.07	(0.000)	330.83
Lag=2	0.9950	1563.76	(0.000)	0.995	62.04	(0.000)	137.95
GDP per capita - only transaction economy							
Lag=1	0.9879	630.77	(0.000)	0.998	59.52	(0.000)	57.02
Lag=2	0.9757	392.76	(0.000)	0.994	95.35	(0.000)	28.22
GDP per capita - net of transaction economy							
Lag=1	0.9952	907.37	(0.000)	0.999	18.97	(0.000)	144.75
Lag=2	0.9898	525.86	(0.000)	0.996	29.11	(0.000)	67.90
GDP per capita - no adjustment							
Lag=1	0.9971	1110.12	(0.000)	0.999	10.16	(0.001)	241.84
Lag=2	0.9938	622.13	(0.000)	0.997	14.96	(0.000)	111.83
GDP per capita - with shadow and no transaction economy							
Lag=1	0.9958	1039.37	(0.000)	0.999	19.50	(0.000)	163.48
Lag=2	0.9910	603.83	(0.000)	0.997	29.83	(0.000)	76.98

Note. As per Table 3. N/A indicates the absence of convergence.

Table 3

Panel unit root test results

Convergence to the average			Convergence to the highest income economy		
GDP per capita - with shadow economy					
	Stat.	p-value		Stat.	p-value
LLC	-7.113	(0.000)	LLC	-6.976	(0.000)
ADF - Fisher	524.606	(0.000)	ADF - Fisher	519.666	(0.000)
PP - Fisher	719.129	(0.000)	PP - Fisher	708.788	(0.000)
Shadow economy					
	Stat.	p-value		Stat.	p-value
LLC	-6.867	(0.000)	LLC	-7.225	(0.000)
ADF - Fisher	501.178	(0.000)	ADF - Fisher	374.612	(0.000)
PP - Fisher	600.996	(0.000)	PP - Fisher	424.084	(0.000)
GDP per capita - no adjustment					
	Stat.	p-value		Stat.	p-value
LLC	-7.258	(0.000)	LLC	-7.414	(0.000)
ADF - Fisher	515.962	(0.000)	ADF - Fisher	494.193	(0.000)
PP - Fisher	677.104	(0.000)	PP - Fisher	694.581	(0.000)
GDP per capita - only transaction economy					
	Stat.	p-value		Stat.	p-value
LLC	-6.616	(0.000)	LLC	-4.958	(0.000)
ADF - Fisher	149.797	(0.000)	ADF - Fisher	129.561	(0.000)
PP - Fisher	268.553	(0.000)	PP - Fisher	213.331	(0.000)
GDP per capita - net of transaction economy					
	Stat.	p-value		Stat.	p-value
LLC	-6.402	(0.000)	LLC	-3.844	(0.000)
ADF - Fisher	136.671	(0.000)	ADF - Fisher	97.756	(0.065)
PP - Fisher	234.235	(0.000)	PP - Fisher	137.480	(0.000)
GDP per capita - no adjustment					
	Stat.	p-value		Stat.	p-value
LLC	-6.342	(0.000)	LLC	-3.298	(0.001)
ADF - Fisher	135.506	(0.000)	ADF - Fisher	85.244	(0.269)
PP - Fisher	272.338	(0.000)	PP - Fisher	129.960	(0.000)
GDP per capita - with shadow and no transaction economy					
	Stat.	p-value		Stat.	p-value
LLC	-6.175	(0.000)	LLC	-4.050	(0.000)
ADF - Fisher	132.501	(0.000)	ADF - Fisher	94.659	(0.097)
PP - Fisher	224.459	(0.000)	PP - Fisher	136.064	(0.000)

Note. As per Table 3.

the deviations were stationary around zero intercept, the respective tests' statistics being highly significant. The stochastic convergence is therefore indicated in most instances.

Regarding the club convergence analysis, the log*t* test indicates the rejection of the null hypothesis of the overall convergence in every specification (panel), with beta coefficient being significant at a 1% significance level and t-statistics being smaller than −1.645 (5% level) and −2.326 (1% level). Therefore, the clustering procedure is performed and the clubs are identified. As indicated in Table 6, the number of clubs ranged from three in Specification 2 to nine in Specifications 1 and 3. The last club in the list typically included the smallest number of economies. As to the composition of the clubs (Table 7), the first club in the list usually included the higher income economies, while the last club usually included the least developed economies (the exceptions to this pattern were nonetheless present, *e.g.* China in Club 1 in Specification 6 or Angola in Club 1 in Specification 2). The countries that diverged and did not belong to any of the clubs were outliers in terms of GDP per capita (Luxembourg, the country with one of the highest per capita levels, Burundi and Solomon Islands, the countries with the lowest levels).

The examination of relative transition paths reveals the following. First, the high-income economies generally maintain their position with the paths for the first four or five clubs being quite flat (*i.e.* no convergence or divergence to the world average GDP per capita), particularly in Specifications 1 to 3. In Specifications 5 to 7 (that concern the transaction economy), the convergence in the transitions paths of Clubs 1 to 3 is observed (suggesting the convergence of the high- and high-middle income economies); additionally, in all cases, the paths of the clubs that contain high-income or high-middle income economies never cross the paths of other clubs. Second, in most specifications (and particularly in Specifications 1 to 3), the low-income economies (that form the last two or three clubs in the respective lists) demonstrate divergence from the world average. The slowdown of divergence for these clubs is observed in Specifications 5 and 6, but it pertains to the second half of the study period (the 2010s) and is not sufficient to close the gap with the higher or middle-income economies. In Specification 4, India and Indonesia (that form Club 6) demonstrate convergence towards the world average; these economies, however, were characterized by high economic growth during the

TABLE 4
CLUB CONVERGENCE RESULTS

A. Log t-test			
	Beta	t-value	p-value
Panel 1	-0.499	-20.781	0.000
B. Club statistics			
	# of units	Beta	t-value
Club 1	26	0.256	5.717
Club 2	48	0.160	3.398
Club 3	28	0.302	4.488
Club 4	16	0.089	1.619
Club 5	9	0.081	2.286
Club 6	15	0.654	6.090
Club 7	7	0.088	1.112
Club 8	3	0.213	3.934
Club 9	2	0.374	2.891

A. Log t-test			
	Beta	t-value	p-value
Panel 2	-0.507	-24.781	0.000
B. Club statistics			
	# of units	Beta	t-value
Club 1	93	-0.010	-0.291
Club 2	61	-0.241	-6.738
Club 3	2	0.320	2.665

A. Log t-test			
	Beta	t-value	p-value
Panel 3	-0.474	-18.458	0.000
B. Club statistics			
	# of units	Beta	t-value
Club 1	24	0.212	4.976
Club 2	34	0.167	3.300
Club 3	18	0.156	3.207
Club 4	22	0.289	4.199
Club 5	25	0.089	1.646
Club 6	8	0.085	2.642
Club 7	12	0.61	5.502
Club 8	6	0.116	0.782
Club 9	4	1.412	7.097

A. Log t-test			
	Beta	t-value	p-value
Panel 4	-0.346	-9.981	0.000
B. Club statistics			
	# of units	Beta	t-value
Club 1	6	0.212	2.908
Club 2	7	0.022	0.447
Club 3	8	0.114	2.088
Club 4	10	0.032	0.525
Club 5	3	0.240	12.709
Club 6	2	1.437	10.545

A. Log t-test			
	Beta	t-value	p-value
Panel 5	-0.362	-10.564	0.000
B. Club statistics			
	# of units	Beta	t-value
Club 1	4	0.105	1.673
Club 2	6	0.404	5.583
Club 3	5	0.043	0.927
Club 4	10	0.160	2.603
Club 5	5	0.305	3.205
Club 6	3	0.830	8.956

A. Log t-test			
	Beta	t-value	p-value
Panel 6	-0.361	-10.442	0.000
B. Club statistics			
	# of units	Beta	t-value
Club 1	8	0.143	2.163
Club 2	3	0.011	0.250
Club 3	2	0.921	3.107
Club 4	2	0.380	1.033
Club 5	9	0.178	3.220
Club 6	4	0.009	0.138
Club 7	6	0.021	0.281

A. Log t-test			
	Beta	t-value	p-value
Panel 7	-0.376	-11.295	0.000
B. Club statistics			
	# of units	Beta	t-value
Club 1	4	0.095	1.529
Club 2	6	0.192	2.607
Club 3	6	0.022	0.507
Club 4	10	0.172	2.815
Club 5	7	0.261	2.874
Club 6	3	0.553	8.370

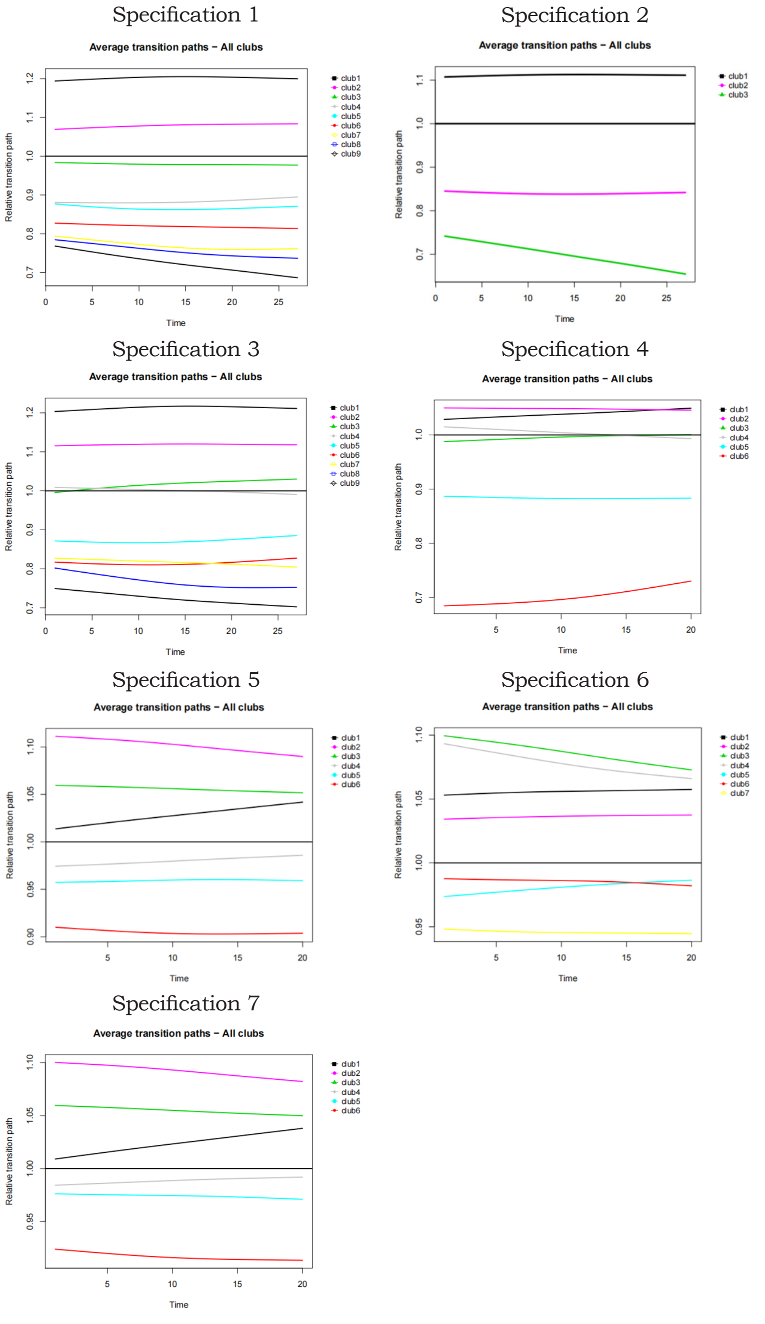

Figure 3

Club convergence relative transition paths

2000–2010s, and this pattern is thus not surprising. Overall, the club convergence analysis provides a richer picture of the convergence. The sigma convergence that pertained to the aggregate panel of economies indicated the reduction of heterogeneity and dispersion across all economies. This, however, masks more specific dynamics, where countries form stable clubs with limited convergence across the clubs and greater convergence within individual clubs (*e.g.* Specification 7 results in Figure 3).

V. Conclusion

The paper examined GDP per capita convergence for two groups of economies (consisting of 156 and 39 countries, respectively, over the 1991–2017 and 1995–2014 periods), as well as a number of subgroups based on income level. The specific purpose of the paper was to adjust the officially published GDP per capita data by the size of the shadow economy and the transaction sector and to verify whether 1) convergence takes place and 2) the adjustment affects the convergence process or alters the convergence patterns. In line with previous studies, the four dimensions of the convergence were considered: sigma, gamma, stochastic and club convergence. The methods ranged from a more descriptive (distance/divergence coefficient) to more formal methods (panel unit root tests or convergence algorithms).

The coefficient of divergence analysis generally indicated reduction of the distance between the groups of economies and the relevant benchmark (the world average or the high-income economies' average GDP per capita), albeit the extent of the reduction varied depending on the type of group (the slowest/smallest reduction in the low- and middle-income economies, as identified in the "poverty trap" and "middle-income trap" literature, Pritchett, 1997; Ito, 2017).

The sigma convergence analysis indicated reduction of the GDP per capita relative dispersion (as measured by the coefficient of variation) across the economies, suggesting that economies become more homogenous as a group in terms of income per capita levels. This pattern was observed for both adjusted and unadjusted data, except for the case when transaction economy GDP per capita is concerned. Group-wise, the reduction of the coefficient of variation was observed for most groups, except the slow-growing economies that experienced greater heterogeneity as a group. The sigma convergence masks however the individual economies' convergence dynamics, the dimension that was addressed in the club convergence analysis.

The gamma convergence pointed to the virtual absence of intra-distributional mobility, with economies retaining their GDP per capita rank during the study period.

With regard to stochastic convergence, both methods (Ben-David procedure and panel unit root tests) indicated the stationarity of the deviations (of economies' GDP per capita from the world average or the high-income economies' average GDP per capita) in all cases. The speed of convergence was not high, with the fastest time to half GDP per capita gap being 28 years.

The club convergence tests rejected the hypothesis of convergence to a single GDP per capita level, suggesting instead the need to examine the convergence to club-specific levels. The specific composition of the clubs differed; however, as a general pattern, irrespective of the type of adjustment performed, distinction was found between clubs containing high- or low-income economies. The relative transition pathways demonstrated the remarkable stability of the convergence pathways during the study period: most of the clubs retained their position with respect to the world average income level and to other clubs. Although the transition paths were not perfectly flat and there was a certain degree of convergence/divergence, the drastic changes in club positions (that correspond to leapfrogging or "economic miracle" cases) were not witnessed. This is in line with limited gamma convergence identified in this study and the previous research on this convergence aspect (Boyle and McCarthy, 1997, 1999). The divergence of the club containing the least developed economies was also observed.

The comparison of results across the specifications reveals similar convergence patterns: reduction of dispersion in GDP per capita (except for the case of transaction economy), stationary GDP per capita deviations, and clear stochastic convergence in all specifications; the stability of economies' per capita ranks; the reduction of the absolute distance (as measured by Clark coefficient of divergence); little convergence across the clubs and more substantial convergence within clubs; and, more generally, a more pronounced convergence when GDP per capita is adjusted by the size of the shadow economy (than when it is adjusted by the size of transaction activities).

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Appendix

The economies considered in this study are as follows (the adjustment of GDP per capita for the size of transaction sector is conducted for economies highlighted in bold).

Albania, Algeria, Angola, Argentina, Armenia, **Australia**, **Austria**, Azerbaijan, Bahamas, Bahrain, Bangladesh, Belarus, **Belgium**, Belize, Benin, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, **Brazil**, Brunei Darussalam, **Bulgaria**, Burkina Faso, Burundi, Cabo Verde, Cambodia, Cameroon, **Canada**, Central African Republic, Chad, Chile, **China**, Colombia, Comoros, Congo Democratic Republic, Congo, Costa Rica, Cote d'Ivoire, Croatia, **Cyprus**, **Czech Republic**, **Denmark**, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, **Estonia**, Ethiopia, Fiji, **Finland**, **France**, Gabon, Gambia, Georgia, **Germany**, Ghana, **Greece**, Guatemala, Guinea, Guinea Bissau, Guyana, Haiti, Honduras, Hong Kong, **Hungary**, Iceland, **India**, **Indonesia**, Iran, **Ireland**, Israel, **Italy**, Jamaica, **Japan**, Jordan, Kazakhstan, Kenya, **Korea**, Kuwait, Kyrgyzstan, Laos, **Latvia**, Lebanon, Lesotho, Liberia, Libya, **Lithuania**, **Luxembourg**, Madagascar, Malawi, Malaysia, Maldives, Mali, **Malta**, Mauritania, Mauritius, **Mexico**, Moldova, Mongolia, Morocco, Mozambique, Myanmar, Namibia, Nepal, **Netherlands**, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Papua New Guinea, Paraguay, Peru, Philippines, **Poland**, **Portugal**, Qatar, **Romania**, **Russian Federation**, Rwanda, Saudi Arabia, Senegal, Sierra Leone, Singapore, **Slovakia**, **Slovenia**, Solomon Islands, South Africa, **Spain**, Sri Lanka, Suriname, Swaziland, **Sweden**, Switzerland, Syrian Arab Republic, Tajikistan, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, **Turkey**, Uganda, Ukraine, United Arab Emirates, **United Kingdom**, **United States**, Uruguay, Venezuela, Vietnam, Yemen, Zambia, Zimbabwe.

Table A1

GDP per capita dynamics

Country groups/ Periods	1991	1999	2008	2017	1991-2017	1991-1999	2000-2008	2009-2017
	$US				% relative to the start of the period			
GDP per capita with shadow economy								
All	11363	13166	15623	16626	146.3	115.9	115.0	109.1
Low income	999	998	1220	1588	159.0	99.9	121.2	125.7
High income	33248	39605	45108	47699	143.5	119.1	110.0	109.4
Low-middle income	3717	3870	5325	6284	169.1	104.1	134.8	117.8
High-middle income	10029	10651	14240	14578	145.4	106.2	130.5	104.9
Fast growing	4927	7372	10656	12679	257.3	149.6	137.6	122.4
Shadow economy								
All	2044	2233	2210	2418	118.3	109.3	98.3	101.5
Low income	290	284	310	375	129.1	97.9	108.1	114.1
High income	4942	5570	5048	5507	111.4	112.7	89.8	100.6
Low-middle income	1067	1075	1284	1478	138.5	100.7	118.0	109.2
High-middle income	2405	2514	2736	2871	119.4	104.5	108.8	98.0
Fast growing	1001	1425	1785	2048	204.5	142.3	121.0	109.3
GDP per capita - no adjustment								
All	9320	10933	13414	14208	152.5	117.3	118.3	110.6
Low income	950	979	1236	1602	168.6	103.0	123.6	128.3
High income	28306	34035	40061	42192	149.1	120.2	113.2	110.7
Low-middle income	2649	2795	4041	4805	181.4	105.5	141.1	120.7
High-middle income	6756	7225	10186	10386	153.7	106.9	136.7	106.6
Fast growing	3926	5947	8872	10632	270.8	151.5	141.5	125.2

TABLE A1
(CONT)

Country groups/ Periods	1995	1999	2008	2014	1995-2014	1995-1999	2000-2008	2009-2014
	$US				% relative to the start of the period			
GDP per capita - net of transaction economy								
All	14859	16909	20739	20828	140.2	113.8	117.6	106.1
Low, low-middle, high-middle income	3566	3926	6146	6913	193.8	110.1	149.1	118.8
High income	20506	23401	28036	27785	135.5	114.1	114.9	104.7
Fast growing	4258	4927	8481	9583	225.1	115.7	161.9	120.1
Slow growing	20112	22569	26312	25930	128.9	112.2	112.3	104.3
GDP per capita - only transaction economy								
All	4792	5359	6867	6880	143.6	111.8	122.9	104.0
Low, low-middle, high-middle income	1073	1203	1930	2099	195.7	112.1	152.6	115.7
High income	6652	7436	9336	9270	139.4	111.8	120.4	102.9
Fast growing	1190	1461	2654	2901	243.8	122.8	168.7	116.0
Slow growing	6256	6786	7878	7788	124.5	108.5	113.0	100.8
GDP per capita - no adjustment								
All	19651	22268	27607	27708	141.0	113.3	118.9	105.6
Low, low-middle, high-middle income	4639	5130	8075	9012	194.3	110.6	150.0	118.1
High income	27157	30837	37373	37055	136.4	113.5	116.3	104.2
Fast growing	5448	6387	11134	12484	229.2	117.3	163.5	119.1
Slow growing	26368	29356	34191	33718	127.9	111.3	112.4	103.4
GDP per capita - with shadow and no transaction economy								
All	17347	19691	23519	23617	136.1	113.5	114.7	104.5
Low, low-middle, high-middle income	4707	5147	7642	8464	179.8	109.3	141.9	115.0
High income	23667	26963	31458	31193	131.8	113.9	112.1	103.2
Fast growing	5455	6276	10335	11490	210.6	115.1	154.8	116.4
Slow growing	23164	25937	29393	29027	125.3	112.0	109.3	102.8

TABLE A2

CLARK COEFFICIENT AND ITS DYNAMICS

Country groups/Periods	1991	1999	2008	2017	1991-2017	1991-1999	2000-2008	2009-2017
	Value of the coefficient				% change			
GDP per capita with shadow economy								
Low income	0.849	0.848	0.836	0.826	-2.7	-0.1	-1.3	-1.0
Low-middle income	0.507	0.497	0.466	0.451	-10.9	-1.9	-5.7	-2.5
High-middle income	0.080	0.076	0.054	0.066	-18.0	-4.5	-27.0	18.8
Fast growing	0.247	0.204	0.166	0.135	-45.4	-17.1	-16.6	-17.5
Low to high	0.946	0.945	0.939	0.936	-1.1	-0.1	-0.5	-0.3
Low-middle to high	0.798	0.792	0.774	0.767	-3.9	-0.7	-2.1	-0.7
High-middle to high	0.548	0.543	0.522	0.532	-2.9	-1.0	-3.4	1.8
Fast to high	0.652	0.627	0.599	0.580	-11.0	-3.8	-4.0	-2.9
Shadow economy								
Low income	0.758	0.755	0.741	0.731	-3.5	-0.4	-1.7	-1.0
Low-middle income	0.305	0.289	0.255	0.241	-21.0	-5.3	-10.7	-4.9
High-middle income	0.080	0.085	0.094	0.086	6.8	5.4	10.2	-7.9
Fast growing	0.190	0.139	0.100	0.083	-56.4	-26.7	-25.4	-16.0
Low to high	0.891	0.887	0.877	0.872	-2.0	-0.4	-1.1	-0.4
Low-middle to high	0.633	0.618	0.586	0.577	-8.9	-2.4	-4.7	-1.4
High-middle to high	0.343	0.332	0.307	0.315	-8.2	-3.0	-7.0	2.3
Fast to high	0.546	0.509	0.470	0.458	-16.1	-6.8	-6.7	-2.4
GDP per capita - no adjustment								
Low income	0.824	0.823	0.810	0.797	-3.3	-0.2	-1.5	-1.3
Low-middle income	0.553	0.542	0.510	0.495	-10.5	-1.9	-5.5	-2.4
High-middle income	0.173	0.167	0.143	0.155	-10.3	-3.3	-13.4	8.2
Fast growing	0.259	0.217	0.178	0.144	-44.3	-16.0	-16.0	-17.8
Low to high	0.938	0.937	0.932	0.927	-1.2	-0.1	-0.6	-0.4
Low-middle to high	0.826	0.820	0.802	0.796	-3.7	-0.7	-2.0	-0.6
High-middle to high	0.622	0.616	0.596	0.605	-2.8	-0.9	-3.0	1.5
Fast to high	0.669	0.646	0.618	0.597	-10.7	-3.5	-3.8	-3.0

Table A2
(cont)

Country groups/Periods	1995	1999	2008	2014	1995-2014	1995-1999	2000-2008	2009-2014
	Value of the coefficient				% change			
GDP per capita - net of transaction economy								
Low, low-middle, high-middle income	0.576	0.566	0.525	0.502	-12.9	-1.6	-6.6	-3.9
Fast growing	0.477	0.458	0.398	0.370	-22.4	-4.0	-11.7	-6.2
Slow growing	0.129	0.124	0.115	0.109	-15.6	-3.8	-6.1	-5.1
Low,low-middle, high-middle to high	0.670	0.661	0.624	0.602	-10.2	-1.3	-5.2	-3.1
Fast to high	0.586	0.569	0.515	0.487	-16.9	-2.9	-8.6	-4.7
Slow to high	0.027	0.030	0.032	0.035	27.3	9.2	5.5	8.1
GDP per capita - only transaction economy								
Low, low-middle, high-middle income	0.595	0.585	0.553	0.532	-10.5	-1.7	-4.9	-3.5
Fast growing	0.504	0.481	0.429	0.407	-19.3	-4.6	-9.5	-4.8
Slow growing	0.098	0.087	0.070	0.062	-36.6	-10.6	-17.2	-12.4
Low, low-middle, high-middle to high	0.687	0.678	0.650	0.631	-8.2	-1.3	-3.7	-2.8
Fast to high	0.611	0.591	0.545	0.523	-14.3	-3.2	-6.9	-3.6
Slow to high	0.066	0.073	0.082	0.087	30.8	9.2	11.0	6.4
GDP per capita - no adjustment								
Low, low-middle, high-middle income	0.580	0.571	0.532	0.509	-12.3	-1.6	-6.2	-3.8
Fast growing	0.483	0.463	0.406	0.379	-21.6	-4.1	-11.1	-5.9
Slow growing	0.121	0.115	0.105	0.098	-19.4	-5.0	-8.0	-6.2
Low,low-middle, high-middle to high	0.674	0.665	0.630	0.609	-9.7	-1.3	-4.8	-3.0
Fast to high	0.592	0.574	0.522	0.496	-16.2	-3.0	-8.2	-4.4
Slow to high	0.037	0.040	0.044	0.047	29.1	9.2	8.2	7.3
GDP per capita - with shadow and no transaction economy								
Low, low-middle, high-middle income	0.541	0.532	0.494	0.472	-12.7	-1.5	-6.5	-4.0
Fast growing	0.446	0.428	0.371	0.345	-22.6	-4.1	-11.8	-6.2
Slow growing	0.029	0.031	0.034	0.036	24.6	9.0	5.2	6.5
Low,low-middle, high-middle to high	0.638	0.630	0.594	0.573	-10.1	-1.2	-5.1	-3.2
Fast to high	0.557	0.540	0.487	0.462	-17.1	-3.0	-8.7	-4.7
Slow to high	0.029	0.031	0.034	0.036	24.6	9.0	5.2	6.5

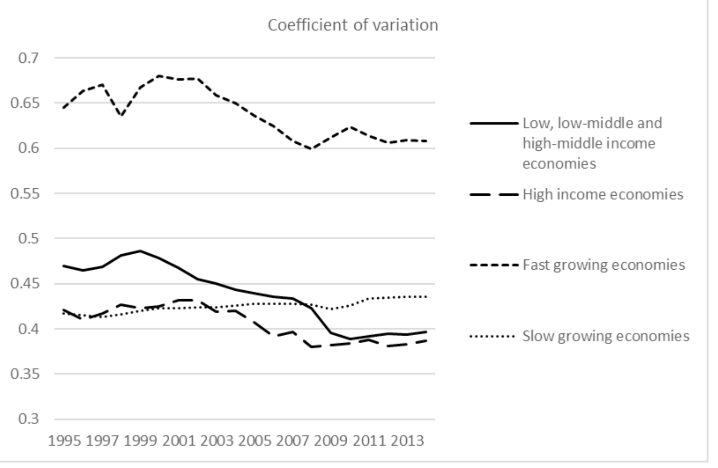

FIGURE A1

SIGMA CONVERGENCE (INDIVIDUAL GROUPS)

TABLE A3

COMPOSITION OF CLUBS

Specification 1	Club 1	Qatar, Ireland, Singapore, Iceland, United States, Denmark, Switzerland, Norway, Australia, Sweden, Hong Kong, Netherlands, Finland, United Kingdom, Canada, Austria, Belgium, Germany, Israel, New Zealand, Korea Rep., Lithuania, Equatorial Guinea, Kazakhstan, China, Azerbaijan
	Club 2	United Arab Emirates, France, Bahamas, Brunei Darussalam, Japan, Italy, Kuwait, Spain, Cyprus, Malta, Slovenia, Bahrain, Trinidad and Tobago, Saudi Arabia, Greece, Portugal, Uruguay, Estonia, Czech Republic, Slovak Republic, Argentina, Latvia, Chile, Poland, Hungary, Croatia, Turkey, Costa Rica, Russian Federation, Malaysia, Romania, Mauritius, Maldives, Suriname, Peru, Dominican Republic, Bulgaria, Belarus, Thailand, Guyana, Bosnia Herzegovina, Georgia, Sri Lanka, Albania, Armenia, Mongolia, Bhutan, Myanmar
	Club 3	Venezuela,, Mexico, Brazil, Gabon, Lebanon, Botswana, Oman, Ecuador, Colombia, Paraguay, South Africa, Fiji, Iran Islamic Rep., Namibia, Angola, Tunisia, Libya, Swaziland, Indonesia, Nigeria, Cabo Verde, Philippines, Morocco, Lao PDR, Moldova, Vietnam, India, Cambodia
	Club 4	Belize, Jamaica, Algeria, Guatemala, El Salvador, Jordan, Bolivia, Egypt Arab Rep., Ghana, Zimbabwe, Bangladesh, Lesotho, Tajikistan, Mali, Rwanda, Ethiopia
	Club 5	Papua New Guinea, Honduras, Congo Rep., Ukraine, Nicaragua, Cote d'Ivoire, Zambia, Chad, Liberia

Specification 1	Club 6	Mauritania, Pakistan, Senegal, Kenya, Cameroon, Comoros, Kyrgyz Republic, Benin, Tanzania, Syrian Arab Republic, Yemen Rep., Nepal, Sierra Leone, Uganda, Mozambique
	Club 7	Haiti, Guinea, Gambia, Togo, Burkina Faso, Congo Dem Rep., Malawi
	Club 8	Guinea-Bissau, Niger, Madagascar
	Club 9	Central African Republic, Burundi
	Divergent	Luxembourg, Solomon Islands
Specification 2	Club 1	Qatar, Norway, Luxembourg, Bahamas, Brunei Darussalam, United Arab Emirates, Korea Rep., Belgium, Israel, Iceland, Cyprus, Denmark, Uruguay, Italy, Ireland, Singapore, Trinidad and Tobago, Australia, Hong Kong, Spain, Sweden, Kuwait, Canada, Malta, Finland, Greece, Switzerland, Slovenia, France, United Kingdom, Germany, Netherlands, Equatorial Guinea, Kazakhstan, New Zealand, Estonia, Japan, Russian Federation, Gabon, United States, Venezuela, Argentina, Portugal, Bahrain, Turkey, Austria, Lithuania, Peru, Azerbaijan, Malaysia, Suriname, Brazil, Croatia, Saudi Arabia, Mexico, Thailand, Latvia, Poland, Hungary, Costa Rica, Oman, Belarus, Maldives, Romania, Slovak Republic, Lebanon, Chile, Czech Republic, Georgia, Dominican Republic, Belize, Mauritius, Ecuador, Paraguay, Bulgaria, Colombia, Botswana, Bolivia, Guatemala, Angola, Guyana, Sri Lanka, South Africa, El Salvador, Bosnia Herzegovina, Swaziland, Armenia, Nigeria, Tunisia, Albania, China, Cambodia, Myanmar
	Club 2	Jamaica, Libya, Algeria, Fiji, Namibia, Egypt Arab Rep., Philippines, Honduras, Congo Rep., Ukraine, Morocco, Cabo Verde, Iran Islamic Rep., Papua New Guinea, Moldova, Indonesia, Nicaragua, Zimbabwe, Bhutan, Cote d'Ivoire, Ghana, Mongolia, Jordan, Lao PDR, Zambia, Senegal, Tanzania, Solomon Islands, Benin, Mauritania, Pakistan, Tajikistan, Cameroon, Bangladesh, Haiti, Kenya, Kyrgyz Republic, Lesotho, India, Comoros, Chad, Vietnam, Gambia, Mali, Guinea, Nepal, Liberia, Yemen Rep., Rwanda, Sierra Leone, Syrian Arab Republic, Togo, Burkina Faso, Mozambique, CongoDemRep., Uganda, Ethiopia, Madagascar, Guinea-Bissau, Niger, Malawi
	Club 3	CentralAfricanRepublic, Burundi
Specification 3	Club 1	Qatar, Ireland, Singapore, United States, Iceland, Denmark, Switzerland, Norway, Australia, Sweden, Netherlands, Hong Kong, Austria, United Kingdom, Finland, Canada, Germany, Korea Rep., Lithuania, Latvia, Equatorial Guinea,

Specification 3		Kazakhstan, China, Azerbaijan
	Club 2	Belgium, New Zealand, Israel, France, United Arab Emirates, Japan, Bahamas, Brunei Darussalam, Italy, Kuwait, Spain, Malta, Cyprus, Slovenia, Saudi Arabia, Estonia, Trinidad and Tobago, Czech Republic, Slovak Republic, Uruguay, Argentina, Chile, Poland, Costa Rica, Turkey, Russian Federation, Mauritius, Romania, Belarus, Guyana, Mongolia, Georgia, Armenia, Myanmar
	Club 3	Bahrain, Portugal, Greece, Hungary, Croatia, Malaysia, Maldives, Suriname, Bulgaria, Dominican Republic, Peru, Thailand, Bosnia Herzegovina, Albania, Sri Lanka, Bhutan, Lao PDR, Vietnam
	Club 4	Venezuela,, Mexico, Brazil, Lebanon, Botswana, Oman, Gabon, Colombia, Ecuador, South Africa, Paraguay, Iran Islamic Rep., Fiji, Namibia, Angola, Tunisia, Libya, Indonesia, Cabo Verde, Morocco, India, Cambodia
	Club 5	Jamaica, Belize, Jordan, Algeria, Guatemala, Swaziland, El Salvador, Egypt Arab Rep., Bolivia, Philippines, Nigeria, Papua New Guinea, Ukraine, Nicaragua, Moldova, Ghana, Zimbabwe, Zambia, Bangladesh, Lesotho, Tajikistan, Mali, Rwanda, Ethiopia, Liberia
	Club 6	Honduras, Congo Rep., Cote d'Ivoire, Kyrgyz Republic, Benin, Tanzania, Chad, Mozambique
	Club 7	Mauritania, Pakistan, Kenya, Cameroon, Senegal, Comoros, Syrian Arab Republic, Yemen Rep., Nepal, Uganda, Burkina Faso, Sierra Leone
	Club 8	Guinea, Haiti, Togo, Gambia, Guinea-Bissau, Congo Dem Rep.
	Club 9	Niger, Madagascar, Malawi, Central African Republic
	Divergent	Luxembourg, Solomon Islands, Burundi
Specification 4	Club 1	Netherlands, Australia, Denmark, Ireland, Republic of Korea, China
	Club 2	Canada, Belgium, United Kingdom, Sweden, Cyprus, Slovakia, Lithuania
	Club 3	France, Finland, Austria, Japan, Estonia, Latvia, Russian Federation, Bulgaria
	Club 4	Portugal, Greece, Malta, Slovenia, Germany, Italy, Spain, Czech Republic, Poland, Brazil
	Club 5	Mexico, Turkey, Romania
	Club 6	Indonesia, India
	Divergent	Luxembourg, United States, Hungary
Specification 5	Club 1	Luxembourg, Sweden, Republic of Korea, China
	Club 2	Denmark, Australia, Ireland, United States, Finland, Austria
	Club 3	United Kingdom, Germany, Netherlands, Canada, Lithuania

Specification 5	Club 4	Japan, Italy, Slovenia, Malta, Estonia, Czech Republic, Slovakia, Latvia, Poland, Romania
	Club 5	Cyprus, Greece, Hungary, Turkey, Russian Federation
	Club 6	Mexico, Brazil, Bulgaria
	Divergent	Belgium, France, Spain, Portugal, Indonesia, India
Specification 6	Club 1	Denmark, Australia, Sweden, Ireland, United States, Finland, Republic of Korea, China,
	Club 2	Netherlands, Austria, Lithuania
	Club 3	United Kingdom, Canada
	Club 4	Belgium, Germany
	Club 5	Japan, Italy, Slovenia, Malta, Estonia, Slovakia, Latvia, Poland, Russian Federation
	Club 6	Spain, Cyprus, Czech Republic, Romania
	Club 7	Greece, Portugal, Hungary, Turkey, Brazil, Bulgaria
	Divergent	Luxembourg, France, Mexico, Indonesia, India
Specification 7	Club 1	Luxembourg, Sweden, Republic of Korea, China
	Club 2	Denmark, Australia, Ireland, Finland, United States, Austria
	Club 3	United Kingdom, Canada, Germany, Netherlands, Belgium, Lithuania
	Club 4	Italy, Japan, Spain, Malta, Slovenia, Estonia, Slovakia, Latvia, Poland, Russian Federation
	Club 5	Portugal, Czech Republic, Cyprus, Greece, Hungary, Turkey, Romania
	Club 6	Mexico, Brazil, Bulgaria
	Divergent	France, Indonesia, India

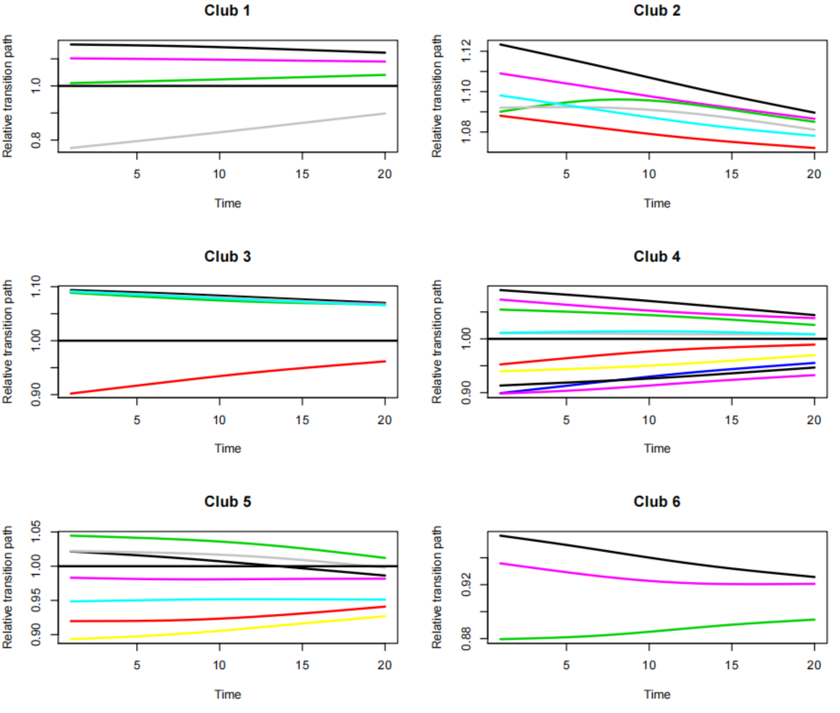

Figure A2

Convergence within clubs (Specification 7)

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