University of Cyprus
Department of Economics

Working Paper 02-2016

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This Draft: March 18, 2016

Abstract

This paper investigates the existence of convergence clubs in the cross-country price mechanism for 96 individual goods retail price levels across 40 countries available semi-annually for 1990-2010, using a nonlinear factor model and threshold regression tools. To our knowledge, this is the first paper to find strong evidence for club convergence of retail prices. These clubs emerge due to the interaction of traded and non-traded factors. For example, countries that are physically closer to potential trade partners converge faster than countries in the high distance regime as long as they have low initial labor productivity or low initial income. Moreover, being behind the technology frontier appears to be more conducive to price convergence for countries with relatively small physical distance from potential trade partners. We interpret our findings as evidence of a local law of one price due to barriers to price convergence that influence the duration of the effect of price shocks.

Keywords: convergence clubs, micro prices, nonlinear factor model, threshold regression, law of one price, local convergence.

JEL Classification Codes: F4

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1 Introduction

This paper contributes to the long-standing debate about price convergence by investigating the existence of club convergence in prices using semi-annual micro price level data for 40 countries and 96 goods and services over the period 1990-2010. To our knowledge, this is the first study to find evidence of meaningful convergence clubs in the cross-country price mechanism. This means that there exists a tendency for prices across countries with identical structural characteristics to converge to one another if their initial prices are in the basin of attraction of the same steady-state equilibrium.[1] In our context, we find that this tendency is induced by the interaction of traded and non-traded input components of retail prices. Hence, our goal is to answer the following set of questions. Do retail prices for individual goods across countries globally converge to a single price or diverge? Do countries form price convergence clubs? If yes, how do these convergence clubs vary across industries? What are the factors that determine these clubs and act as barriers to global price convergence?

At the heart of the debate about price convergence is the Law of One Price (LOP) which asserts that, as a result of arbitrage, identical goods sold in different locations will have identical prices when expressed in terms of the same currency. Empirical evidence in favor of the LOP is mixed. According to one strand of the literature the LOP does hold in the long run, conditional on cross-country structural heterogeneity including transport costs and other barriers to trade. During the last decade, a number of studies have utilized micro price levels to assess the rate of price convergence and understand the mechanisms that determine cross-country price convergence and real exchange rate dynamics. This includes Goldberg and Verboven (2005) who use European car prices, Crucini and Shintani (2008) who use Economist Intelligence Unit (EIU) annual price level data for 1990-2005, Broda and Weinstein (2008) and Burstein and Jaimovich (2009) who use barcode prices, Cavallo, Neiman, and Rigobon (2014) who use daily online prices of traded goods for four major retailers aggregated on a weekly basis from October 2008 to May 2013 in 85 countries, and Andrade and Zachariadis (2016) who find relatively low half-lives in part due to the use of semi-annual EIU prices. Typically, the micro-prices literature provides evidence of faster convergence rates than the ones in older studies using aggregate data and finding half-lives of several years as described in the survey by Obstfeld and Rogoff (2001). This recent evidence

[1] By structural characteristics we usually mean preferences, technology, institutions, and government policies, etc., see, Galor (1996).

suggests that the persistence of LOP deviations is sharply reduced and convergence across countries appears to be relatively fast when based on micro prices with higher comparability across locations.

One particular line of empirical research departs from the linear model and draws on Dumas (1992) and Sercu, Uppal, and Van Hulle (1995) who suggest the presence of threshold nonlinearities in the cross-country good price process. The threshold nonlinearities may arise due to transactions costs in international arbitrage that create a "band of inaction" within which the marginal cost of arbitrage exceeds the marginal benefit and hence prices behave as a random walk. In contrast, outside the no-arbitrage band, arbitrage acts as a convergence force to the LOP. These transaction costs should be interpreted more broadly as "market frictions" which capture sunk costs of international arbitrage so that traders enter the market only when large enough opportunities arise (Dixit (1989), Krugman (1989)), or costs associated with changes in preferences and technology (O'Connell and Wei (2002)). Lee and Shin (2010) argue that the introduction of non-traded goods can magnify the effect of transaction costs. Finally, Midrigan (2007) builds and empirically tests a model where the "inaction bands" are not only functions of the trade cost and the elasticities of substitution, but also of the volatility of the environment.[2]

However, nonlinearities can occur for other reasons. For example, they can occur due to heterogeneity in agents expectations because of differences in factors such as risk aversion and constraints due to laws, regulations and institutions (e.g., Brock and Hommes (1997)), or due to incomplete or gradual reforms since individuals or local governments can engage in rent-seeking behavior leading to market fragmentation (Young (2000)). Furthermore, multiple equilibria can arise due to asset market imperfections (Corsetti and Dedola (2005)), search frictions (Alessandria (2009) and Alessandria and Kaboski (2011)),[3] or endogenous

[2]As the volatility of the nominal exchange rate increases, firms find it optimal to pay the menu cost and reprice more frequently, whereas in environments in which this volatility is small, prices adjust infrequently. Here, the firm allows its price to deviate away from its optimum, as long as the deviation is within the S-s bounds, and charges a price that approximately ensures that the LOP holds otherwise.

[3]Alessandria (2009) builds a model where international price dispersion arises in the presence of costly non-traded non-market search effort that leads firms to price-to-market based on the opportunity cost of their customers time which in turn depends on local wages, so that the distribution of prices will differ across countries whenever local wage differs. Along similar lines, Alessandria and Kaboski (2011) develop a model where costly consumer search generates a role for local wages in the price-setting behavior of firms as the latter endogenize the fact that consumers in low-income countries have a comparative advantage in producing non-traded non-market search activities and are thus more price elastic than consumers in high-income countries. This complements the Balassa-Samuelson story as it relies on low-income countries having a comparative advantage in producing non-traded goods (shopping activities) that in this case affect the

currency choice with price stickiness (Gopinath (2015)).

While it is easy to see that the price theory that departs from the LOP naturally implies threshold-like structures for price convergence, the existing empirical literature is silent as to whether lack of global convergence to the LOP is associated with convergence clubs (groups of countries that converge locally but not globally) and if it is, what factors generate those clubs. Most empirical studies that depart from linear models employ threshold-type autoregressive models to uncover the "band of inaction" within which no trade takes place. Specifically, these studies have focused on a particular form of threshold regression model, namely the three regime threshold autoregressive (TAR), to uncover threshold effects of the lagged log price on log price differences when the lagged log price is above or below a particular lagged price threshold value; e.g., Obstfeld and Taylor (1989), Michael, Nobay, and Peel (1997), Taylor, Peel, and Sarno (2001), Imbs, Mumtaz, Ravn, and Rey (2003), Sarno (2004), and Choi, Murphy, and Wu (2015). The hypothesis is that, inside the band, price deviations from the LOP are persistent while above or below this band arbitrage takes place and deviations from the LOP are mean-reverting. The alternative hypothesis that has been considered is simply that there is no nonlinearity and hence, ignores other possible reasons for nonlinearities.

Therefore, in this paper, we contribute to the literature of price convergence by testing for convergence clubs and providing estimates of convergence rates to a Local Law of One Price (LLOP). By local, we refer to the idea that the LOP applies to meaningful subsets of countries and varies across these groups due to group-specific structural heterogeneity.[4] In particular, considering any final good as being comprised of a traded and a non-traded input component as in the retail pricing model of Crucini, Telmer, and Zachariadis (2005), the price level for any individual final good should be determined by a variety of factors pertaining to its respective traded and non-traded components. Its traded component is influenced by trade costs and the ability to exploit arbitrage opportunities, while its non-traded component by local input costs and productivity. Thus, theory would suggest that, in addition to productivity and local input costs, physical distance from potential trade partners and initial price levels might characterize different regimes. In this sense, we posit that countries which converge to different LLOPs depending on differential degrees

prices of all goods.

[4]The identification of meaningful clubs is not a trivial issue as it requires countries to remain in a club for a long-enough time.

of physical remoteness from potential trade partners, could belong in different price level regimes. Similarly, countries with differences in local input costs or productivity would be expected to form different price level regimes.[5]

Our work is closely related to Chen, Choi, and Devereux (2008) who test for σ-convergence, β-convergence, and stochastic-convergence allowing for club convergence using a clustering algorithm originally proposed by Hobijn and Franses (2000). This algorithm identifies groups of converging countries based on a multivariate test for stationarity. Using historical price levels since 1890 for eleven developed economies, they find that global σ-convergence and β-convergence of price levels occurs later and to a lesser extent than is the case for income. Importantly, they do not find any evidence of price convergence within meaningful clubs, in contrast to what has been found in the empirical growth literature regarding income convergence. Our paper differs in several important dimensions including data and methods. Notably, we employ a large panel of disaggregate data for a large number of goods and countries at the semi-annual frequency in order to alleviate cross-sectional aggregation biases (Imbs, Mumtaz, Ravn, and Rey (2005)).[6]

In spirit, our work is also related to the recent empirical economic growth literature. This literature has provided ample evidence of multiple regimes and nonlinearities in the cross-country growth process, consistent with the existence of club convergence (e.g., Durlauf and Johnson (1995), Liu and Stengos (1999), Durlauf, Kourtellos, and Minkin (2001), Masanjala and Papageorgiou (2004), Canova (2004), Tan (2010)). If price convergence clubs were solely driven by economic development, there would be limited scope for investigating price convergence clubs given the large existing literature on club convergence in economic growth. However, as argued by Chen, Choi, and Devereux (2008), income and price levels convergence differ in a number of ways. Importantly, certain factors that determine different price regimes might be distinct from those that determine income regimes. This makes price convergence clubs a potentially distinct and interesting topic of study.

We start by investigating the existence of convergence clubs using the nonlinear time-varying heterogeneous factor model proposed by Phillips and Sul (2007, 2009). An appealing feature of this nonlinear factor model is that it distinguishes between economies that

[5]In the latter case, however, price level regimes would plausibly be similar to income level regimes that have been the focus of the relevant growth literature.

[6]Moreover, our data do not suffer from the type of temporal aggregation shown by Taylor (2001) to introduce severe biases in the estimation of convergence parameters.

have converged and economies that are converging, by explicitly addressing the question of invariance of the time-series process for prices. Moreover, as argued by Phillips and Sul (2009), this methodology circumvents various problems associated with the validity of conventional price convergence tests. Using the concept of "relative" convergence, we find ample evidence of lack of global convergence in the form of convergence clubs for nearly all 96 goods. This heterogeneity in the cross-country price process generally carries over to the industry level. Interestingly, the results suggest that the latent factor that determines these clubs is associated with differences in the traded and non-traded components of the goods.

Next, we proceed to examine the evidence for convergence clubs further in order to shed more light on the determinants of convergence clubs using the threshold regression model proposed by Hansen (2000). In this context, differences in the degree of price convergence between regimes are interpreted as evidence of convergence within regimes rather than across regimes. The threshold regression model provides an appealing way to study the determinants of convergence clubs because it classifies observations into regimes depending on whether the value of an observed (rather than latent) threshold variable is above (or below) a data-driven sample split value. We consider a range of threshold variables that influence the traded and non-traded components of a final good. Using income or labor productivity as threshold variables, we examine whether poorer countries behind the technology frontier tend to exhibit faster price convergence leading to price convergence via the non-traded component of final prices, consistent with the Balassa-Samuelson hypothesis. Using physical distance as a threshold variable we examine whether countries with smaller distance from potential trade partners exhibit relatively faster price convergence via the traded inputs channel. Similarly, using initial prices as a threshold variable we investigate whether countries that are more able to exploit arbitrage opportunities,[7] exhibit relatively faster price convergence via the traded inputs channel.

We find no evidence of global conditional β-convergence, yet importantly, we find strong evidence for club convergence as implied by the presence of local β-convergence of countries within meaningful groups in our sample. Our results show that countries are organized into price convergence clubs according to traded factors such as physical distance from potential trade partners and non-traded factors such as labor productivity, local input costs, and

[7]Intuitively, we would expect less resistance to exporting (the case of initially cheap countries) than to importing (the case of initially expensive countries) so that resistance to international trade and the resulting ability to arbitrage away price differences could be asymmetric, with countries in the low initial price regime facing less resistance and thus better able to exploit arbitrage opportunities via international trade.

economic development. In particular, we find that clubs are formed due to the interaction of these traded and non-traded factors. For example, trade appears to be conducive to price convergence for countries that also have the non-traded Balassa-Samuelson catch up process operating in full force given low initial productivity, labor cost or income. Moreover, being behind the technology frontier appears to be more conducive to price convergence for countries with small physical distance from potential trade partners as compared to countries in the high-distance regime. In addition, we find an asymmetry in the extent that arbitrage opportunities related to international trade are exploited, with low initial price regime countries exhibiting faster convergence from below than high initial price regime countries exhibit from above, consistent with less resistance to exporting than to importing due to political economy considerations. Finally, convergence is significantly faster for countries with low initial productivity (income) as compared to high initial productivity (income) countries, in the case of countries associated with high control of corruption but not for those associated with low corruption control. This suggests that the catch up process operating via the Balassa-Samuelson channel is present for countries that are successful in controlling corruption via appropriate institutions but not for countries with low control of corruption.

The rest of the paper proceeds as follows. In the next section, we describe the data we use. Section 3 describes the nonlinear factor model of prices that we use to identify price convergence clubs, and reports the corresponding results. Section 4 describes the threshold regression methodology and discusses the findings. Section 5 briefly concludes.

2 Data

The retail price data are drawn from the Economist Intelligence Unit (EIU) and described extensively in Bergin, Glick, and Wu (2013) and Andrade and Zachariadis (2016). The price data for each item is collected for supermarkets or chains, and for mid-priced outlets. To alleviate possible measurement error, we choose to average prices across stores where possible and obtain one representative price per item. The EIU survey covers 140 cities in 90 countries, but availability of data varies across locations. In order to analyze price convergence across countries, we choose the city with the largest available set of data for each country. Moreover, to be able to apply the Phillips and Sul (2007) analysis we utilize only prices of items that are available in all time periods. For the purpose of comparability, we use goods available in more than two-thirds of the countries. We end up with a sample of 96 unique product items in 40 countries available semiannually from 1990H1 to 2010H1. A list of the 96 product items is available in Table 1, while the 40 countries are shown in Table 3.

We organize goods in groups using industry classification ISIC rev 2. Our price dataset contains different numbers of items for different industries, with the largest number in food manufacturing (a total of 41 items) and the smallest number of items in tobacco manufactures (just 3 items). To allow sufficient cross-industry variation, we exclude countries with less than two thirds of the goods of an industry available. At the same time, we exclude industries with small numbers of goods (less than 5 items). The excluded industries are Tobacco Manufactures (3 items), Soft Drinks (4 items), Manufacture of Motor Vehicles (4 items), and Electricity, Gas and Steam (4 items). Similarly, we exclude Manufacture of Alcohol Beverages, Transport, Storage and Communication, and Real Estate, since retention of these would lead to the exclusion of nine countries[8] with insufficient data for these items.

In Section 4 we utilize data for control of corruption and democratic accountability to detect the institutional determinants of price convergence. These data were obtained from the International Country Risk Guide from the PRS group for 1990-2010. For these variables, higher score means lower risk. As a measure of initial economic performance of the country we use lagged log real GDP per capita and lagged labor productivity data, obtained from the Penn World Tables 7.1 for 1989-2010. We calculate average distance from each city to all other cities in the sample as a measure of geographic isolation from potential trade partners. We also utilize data for labor cost obtained from the EIU for 1990-2010, available for only 31 countries. More details about all data are given in Table (A10) of the Online Appendix.

[8]Canada, Germany, Guatemala, Kenya, Mexico, New Zealand, Philippines, Poland and the U.S..

3 Price convergence clubs

3.1 A Nonlinear factor model for prices

We assume that for each good j the logarithm of prices p_{ijt} in country i at time t is described by a nonlinear factor model proposed by Phillips and Sul (2007). This model includes a price growth component and a time varying idiosyncratic component that allows for general heterogeneity across countries and over time and takes the form of

$$p_{ijt} = \delta_{ijt}\mu_{jt}, \tag{1}$$

where μ_{jt} is a good specific common trend, which can be deterministic and/or stochastic, with time-varying factor loading coefficients δ_{ijt} that include both country and good specific permanent and transitory components.[9] δ_{ijt} is a vector of weights that describes the transition path of good j in economy i to the common steady state price growth path determined by μ_{jt}. Put differently, these weights can be interpreted as the price gap between the price p_{ijt} and the common trend μ_{jt}.

Following Phillips and Sul (2007) we define the concept of "relative" long-run equilibrium or convergence between two series as follows.[10] Specifically, relative price convergence for each good j means

$$\lim_{k\to\infty} \frac{p_{ijt+k}}{p_{ljt+k}} = 1, \quad \text{for all} \;\; i \text{ and } \; l. \tag{2}$$

In the case of the nonlinear factor model in equation (1) the above condition can be expressed in terms of the factor loading coefficients

$$\lim_{k\to\infty} \; \delta_{ijt+k} = \delta_j. \tag{3}$$

Relative convergence is related to standard convergence definitions used in the empirical growth literature (e.g., Bernard and Durlauf (1995, 1996) and Evans and Karras (1996)). While relative convergence in the discrete time series implies price growth convergence in

[9]Equation (1) can be derived from an additive panel model, $\delta_{ijt} = \frac{g_{ij}+\varepsilon_{ijt}}{\mu_{jt}}$, where g_{ij} and ε_{ijt} are the permanent and transitory components, respectively.

[10]While the cointegration literature considers the difference or linear combinations between the variables of interest, the idea here is to use their ratio to define a convergence statistic.

the long-run, it does not generally imply level convergence. Specifically, when the weight δ_{ijt} converges faster than the divergent rate of the common component μ_{jt} in equation (1), then relative convergence implies absolute or level convergence, but otherwise relative convergence does not imply level convergence.

3.2 Transition curves

One difficulty is the presence of deterministic and stochastic elements in δ_{jt} that makes its modeling impossible. Phillips and Sul (2007) proposed the relative transition curve, h_{ijt}, that eliminates the common growth component by standardizing the transition element by the cross sectional average

$$h_{ijt} = \frac{p_{ijt}}{N^{-1}\sum_{i=1}^{N} p_{ijt}} = \frac{\delta_{ijt}}{N^{-1}\sum_{i=1}^{N} \delta_{ijt}}. \tag{4}$$

The relative transition curve is a useful tool in understanding the transition dynamics. While these curves may exhibit heterogeneity across countries in the short-run, they allow for convergence in the long-run. In particular, a transition curve measures the price behavior of country i for good j in relation to other economies, and at the same time describes the relative departures of economy i from the common steady-state price growth path μ_{jt}.[11] This means that the presence of divergence from μ_{jt} is reflected in the transition paths h_{ijt}. For example, in the case of global convergence, the price of good j in all countries moves towards the same trend, $h_{ijt} \to 1$ for all i as $t \to \infty$ and the cross-sectional variance of h_{ijt} converges to zero so that the sample transition distance

$$D_{jt} = \frac{1}{N}\sum_{i=1}^{N}(h_{ijt} - 1)^2 \to 0, \text{as } t \to \infty. \tag{5}$$

By contrast, when an economy diverges from others the transition path can measure the extent of the divergent behavior and assess whether or not this is transient.

[11] Following Phillips and Sul (2007, 2009) we first use the Whittaker-Hodrick-Prescott smoothing filter to remove the business cycle component before we apply the log t test.

3.3 The log t test

For each good j, we test for the null of relative convergence versus the alternative of no-relative convergence using the log t test of Phillips and Sul (2009) based on the auxiliary least-squares regression

$$\log\left(\frac{D_{1j}}{D_{tj}}\right) - 2\log\log t = \lambda_{0j} + \lambda_{1j}\log t + u_{tj}, \tag{6}$$

for $t = [rT], [rT]+1, ..., T$ with some trimming percentage $r > 0$. For the null of global convergence the test takes the form of a sign restriction on the slope coefficient of $\log t$, $H_0 : \lambda_{1j} \geq 0$ vs. $H_1 : \lambda_{1j} < 0$, which can be tested using a conventional one-sided t-test constructed with a heteroskedasticity and autocorrelation-consistent (HAC) estimator from the residuals of equation (6).

The magnitude of the coefficient $\lambda_{1j} = 2\alpha_j$ measures the convergence speed of δ_{ijt} since the parameter denotes the rate at which the cross-sectional variation across the transition paths decays to zero over time.[12] Under the condition that the common component δ_{ijt} follows a random walk with drift or a trend stationary process, we have growth convergence if $0 \leq \lambda_{1j} < 2$ and level convergence in log prices if $\lambda_{1j} \geq 2$.

3.4 Club convergence procedure

Rejecting the null of global convergence leaves open the possibility of convergence within some clubs of countries. Following Phillips and Sul (2009), we employ the above test sequentially in subgroups of observations to uncover multiple price regimes. The procedure comprises of four steps: (1) observations are sorted from the latest to the earliest time period of the panel; (2) using the log t test, a primary convergence club is formed against which other countries may be compared; (3) sieving through countries one at a time to check for possible membership of the primary convergence club using the log t regression; (4) repeat steps 2 and 3 and if no further convergence clubs emerge, classify the remaining observations as displaying divergent behavior. In the Online Appendix we provide a detailed description

[12] To see this, note that under the null of growth convergence, Phillips and Sul (2007) showed that the (sample) mean square transition distance D_{jt} converges to $A/(log(t))^2 t^{2a}$, where $A > 0$ is a positive constant. This yields auxiliary equation (6).

of this clustering procedure.

3.5 Results

3.5.1 Price convergence clubs

We first document the substantial evidence for lack of global convergence and provide evidence for club convergence by investigating 96 individual goods. Table 1 presents results for the log t-test and for the club convergence procedure, described in sections 3.3 and 3.4 respectively.[13] The first column of Table 1 shows the global convergence coefficient for the whole sample of countries. We find that the null hypothesis of global convergence is rejected for 92 of the 96 goods.[14]

In the next four columns of Table 1 we present results of the local convergence coefficients for each club. Our results show the existence of up to four different convergence clubs and that this number varies across goods.[15] For some goods there is a set of countries that do not form any club. We label such subsets of countries for particular goods as divergent, and report the estimated coefficient for such divergent groups of countries in the last column of Table 1. Using the definition of relative convergence, for the majority of goods we find evidence for price growth convergence within clubs since $0 \leq \lambda_{1j} < 2$. Price level convergence occurs only within the third club and for merely three goods: "White rice", "Tea bags" and "Socks, wool mixture", for which the third club is comprised of just two countries.[16]

Next, we qualify the above convergence clubs in three alternative ways. First, in the first column of Table 2, we present average prices by good across all countries in the sample, followed by average prices across countries within each club in the remaining columns of the

[13] Phillips and Sul (2009) suggest the log t test for $t = [rT], [rT] + 1, ..., T$ and show that the choice of a trimming percentage r equal to 0.3 is appropriate for samples less than 50 time-series observations. Thus, we start from the 13th time-series observation which leaves 29 time-series observations for the log t test.

[14] The exceptions are "Personal computer", "Peanut or corn oil", "Potatoes" and "Olive oil". For "Personal computer", λ_{1j} exceeds two thus we can infer that price level, not just price growth, convergence occurs.

[15] The fourth club exists for nine items: "Peas, canned", "Instant coffee", "Dry cleaning, trousers", "Laundry detergent", "Toothpaste with fluoride", "Men's business shirt", "Laundry", "Kodak color film", and "Razor blades". For "razor blades" we actually find a fifth club but opt to ignore this in the Tables since it does not arise for any other good or service in our sample.

[16] A detailed description of convergence club classifications for every good in our sample is available upon request from the authors, and will also be made available in an Online Appendix.

table. As we can see, the first club is characterized by the highest price level for each good, the second club by the second highest price and so on. Hence, in what follows, we will refer to the first, second, third, and fourth clubs as high-price, medium-price, low-price, and cheap clubs, respectively.

Second, in Table 3 we present the frequency of belonging to each club for each country, i.e., the share of goods for which the country lies in the high-, medium-, low-price, and cheap clubs. We find that a number of developed economies e.g., Denmark, Germany, Finland, Spain, Switzerland, Norway, Belgium, Luxembourg, Australia, Japan, France, UK, Italy, Austria, Sweden, and the US lie in the high-price club for the great majority (for more than 60%) of the goods while lying in the low-price club for less than ten percent of the goods. This is also the case for Turkey and Poland. Figure 1 shows a heatmap for these shares for each country. Here, color defines club (blue for the high-price club, orange for the medium-price club, green for the low-price club, red for the cheap club, and grey for the divergent group) and depth of color represents frequency of belonging in a certain club.

Third, in Table A1 of the Online Appendix we take a closer look at the high-price club, distinguishing between low, medium, and high income countries forming the first club, and present average prices over the period 1990-2010 across the subset of countries in each of these three income groups for each good. We observe that average prices vary substantially for some goods within the same club depending on income group. For the sake of brevity we do not provide similar information for the medium, low-price and cheap clubs for each individual good but do undertake this at the industry-level in the next subsection.

3.5.2 Industry level analysis

We now discuss our findings using aggregated prices at the industry level as a way to summarize the information across the various goods. This type of analysis will also allow us to discern whether convergence patterns observed at the individual good level carry over to the industry level. In particular, we aggregate prices up to the industry level and proceed to define clubs for eight separate industries. We organize goods in groups using industry classification ISIC rev 2, calculate the median price across goods in each industry for every country, and use these data to define clubs at the industry level. Then, as in the good level analysis, for each industry we test for global convergence and club convergence.

Table 4 shows that the industry level results are generally consistent with the good-level analysis. Specifically, while the null hypothesis of global convergence is rejected for all industries, we do find evidence of club convergence. For half of the industries, the maximum number of formed clubs equals two (manufacture of food, textile, chemicals and metal products), and for other industries this number equals three (agriculture, paper products, hotel and restaurants, and other services). Moreover, for agriculture and manufacture of paper products there is a set of countries that do not form any club with any other country, thus we also have a divergent group for these industries. Figure 2 presents the set of countries in each convergence club by industry. Table A2 of the Online Appendix provides a detailed description of the convergence club classification for each industry.

Figure 3 presents the transition path for each industry and club over time. The relative transition path shows the time variation of the average transition coefficient defined by equation (4) across the countries forming each club for each industry over the period 1990-2010.[17] Overall, we find no evidence of global convergence, since we do not observe monotonic convergence to unity for all three clubs for any industry. On the contrary, there is an apparent divergent path for clubs at the end of the period. Moreover, the transition curves shown in Figure 3 illustrate that the first club, irrespective of industry, includes countries with relatively higher prices, while the second and third clubs have smaller prices. For some industries, countries forming different clubs have similar initial states, e.g., agriculture (the second and third club), manufacture of food (the first and second club) and hotel and restaurants (the first and second club), but exhibit transitional divergence starting at some later point in time. For other industries like manufacture of textile or community, social and personal services, transitional divergence appears from the beginning of the period. Interestingly, for most industries, clubs are characterized by converging transitional paths till the middle of the period after which transition paths start to diverge. These time series patterns could then be used to identify factors behind the existence and formation of clubs, e.g., due to specific physical or technological events related to certain industries, that occur at some point in time and affect countries and industries differently. Moreover, the results are consistent with the good-level transition curves presented in Figure A1 of the Online Appendix, albeit the latter are a lot more noisy.

The convergence clubs formed at the industry level generally appear to share the same

[17] The average transition curve for each club k and each industry h is calculated as $\widehat{h}_{kht} = \frac{1}{N_k}\sum_{i=1}^{N_k} h_{iht}$, where $h_{iht} = \frac{p_{iht}}{N^{-1}\sum_{i=1}^{N} p_{iht}}$.

characteristics as the ones formed using the individual good level data. For example, the first club is always associated with the highest average price and the third club with the lowest price, as we show in Table A3 of the Online Appendix where we present average prices over the countries and period under study, for each industry in each club. Furthermore, when we distinguish between low, medium, and high income countries that form each club we have identified, we now see that average prices over the period 1990-2010 across the subset of countries in each of these three income groups for each industry do not always decline with income. Evidently, for some industries, price convergence clubs are highly associated with country income level while it is clearly not the case for other industries.

Figure 4 shows the relationship between average prices and average real GDP per capita (averaged over the period of study) for each of the eight industries. We mark the clubs different countries belong in by different colors. Once again, blue is for the first club, orange for the second club, and green for the third club. We can see that for some industries like agriculture and social and personal services, price convergence clubs are highly associated with country income level, while it is clearly not the case for other industries, e.g., manufacture of food or chemicals. We can infer that income might potentially play a role in the formation of different clubs, at least in the case of some categories of goods.

In the next section, we investigate more systematically the role income and other factors might play in determining the convergence clubs.

4 Determinants of convergence clubs

4.1 Threshold regressions and club convergence

In this section, we investigate the factors that sort the countries into price convergence clubs. While the nonlinear factor model in equation (1) allowed us to identify convergence clubs using very weak assumptions, it did not allow us to identify the sources of this heterogeneity as this is latent. To do so, we use a threshold regression model, which classifies the countries into price convergence clubs depending on whether the observed value of a threshold variable is above or below a sample split value estimated from the data.

As threshold variables q_{sit}, $s = 1, ..., p$ we use a set of variables that relate to the non-traded or traded components of final goods prices. As proxies for the non-traded component we use initial log real GDP per capita, initial labor productivity, control of corruption and democracy, while for the traded component we use distance and initial prices. The first set of threshold variables, helps us examine whether poorer countries behind the technology frontier tend to exhibit faster price convergence leading to price convergence via the non-traded component of final prices in line with the Balassa-Samuelson hypothesis. The second set of threshold variables helps us examine whether countries with smaller distance from potential trade partners or more able to exploit arbitrage opportunities due to lower resistance to trade, exhibit relatively faster price convergence via the traded inputs channel.

Using the growth of price in period t for good j in country i, $g_{ijt} = p_{ijt} - p_{ijt-1}$, we specify the following threshold model, which is based on a panel of semiannual price data for 96 goods from 1990 to 2010 across 38 countries.[18]

$$g_{ijt} = \mu_{s1t} + \alpha_{s1i} + \eta_{s1j} + \beta_{s1} p_{ijt-1} + \pi'_{s1} z_{it} + \varepsilon_{ijt} = \theta'_{s1} x_{ijt} + \varepsilon_{ijt}, \; q_{sit} \leq \gamma_s, \tag{7}$$

$$g_{ijt} = \mu_{s2t} + \alpha_{s2i} + \eta_{s2j} + \beta_{s2} p_{ijt-1} + \pi'_{s2} z_{it} + \varepsilon_{ijt} = \theta'_{s2} x_{ijt} + \varepsilon_{ijt}, \; q_{sit} > \gamma_s, \tag{8}$$

where $x_{ijt} = (d'_i, d'_j, d'_t, p_{ijt-1}, z'_{it})'$, with d_i, d_j and d_t country, good, and time dummies. γ_s is the scalar threshold parameter or sample split value, μ_{1st}, α_{1si}, and η_{s1j} are time, country and good fixed effects respectively, p_{ijt-1} is the lagged price level, q_{sit}, $s = 1, .., p$, are threshold variables, and z_{it} is a vector of observable traded and non-traded related explanatory variables that belong to the vector $\underline{q} = [q_{1it}, ..., q_{pit}]$ of threshold variables, $z_{it} \in \underline{q}$. This vector includes initial income, initial productivity, distance, control of corruption, democracy, and initial prices. The term ε_{ijt} is the regression error. The slope coefficients β_{s1} and β_{s2} are related to the idea of conditional β-convergence or "catching up" in terms of prices, i.e., the higher the initial absolute price level the lower the price growth rate. Specifically, when $\beta_{s1} < 0$ and $\beta_{s2} < 0$ we say that we have club β-convergence for both regimes.

It is convenient to write the above threshold regression model in a single equation using the indicator variable $I(q_{sit} \leq \gamma_s) = 1$ if $q_{sit} \leq \gamma_s$ and $I(q_{sit} \leq \gamma_s) = 0$ if $q_{sit} > \gamma_s$. This

[18] Hong Kong and Singapore are excluded as data on our threshold variables are not available for these. In models with labor cost as threshold variable, the sample of countries is down to 31 due to limited labor cost data availability.

yields

$$g_{ijt} = \theta_s' x_{ijt} + \delta_s' x_{ijt} I(q_{sit} \leq \gamma_s) + e_{ijt}, \tag{9}$$

where $\delta_s = \theta_{s1} - \theta_{s2}$ is the threshold effect and $\theta_s = \theta_{s2}$. When $\delta_s = 0$, the threshold regression model in equation (9) yields the linear model, which Chen, Choi, and Devereux (2008) use to test for β-convergence. The statistical theory for the above model is provided by Hansen (2000) who proposed a concentrated least squares method for the estimation of the threshold parameter.

Our test for club convergence involves testing for the presence of threshold effects and unit roots. First, we test for threshold effects using the hypothesis $H_0 : \delta_s = 0$ vs. $H_1 : \delta_s \neq 0$, i.e., the null hypothesis of a linear model (no threshold effects) against the alternative of a threshold regression model. To do so, we use a heteroskedasticity-autocorrelation consistent Lagrange multiplier (LM) test and compute the p-values by a bootstrap method proposed by Hansen (1996). Second, we test whether the countries converge or diverge using a threshold autoregressive unit root test proposed by Caner and Hansen (2001) and extended for the panel-data model by Beyaert and Camacho (2008). In model (9), if $\beta_{s1} = \beta_{s2} = 0$ then we say that the countries diverge. If both parameters are negative, then we have club β-convergence for both regimes. If the countries converge under one regime but not under the other then partial convergence occurs. Finally, we employ the above tests sequentially by testing for threshold effects and unit roots within each of the two subsamples.

4.2 Evidence from threshold regression models

4.2.1 Testing for threshold effects and unit root

Consistent with the evidence from the non-linear factor model in section 3, we proceed to investigate the presence of up to four convergence clubs using our baseline threshold model which includes initial prices as well as country-, good-, and time-fixed effects as explanatory variables in Table 5. The first two columns of Table 5 describe the threshold variables that define the threshold regression models. In particular, level 1 threshold variables (q_1) are used in the two-regime model while level 2 threshold variables (q_2) are used in the second-level of the four-regime model. The next six columns present the estimated threshold parameters and the corresponding 95% confidence intervals for the two-regime and four-regime models.

The results of the threshold and unit root tests are presented as superscripts to the threshold estimate by a significance star and dagger, respectively. The last column reports the Akaike information criterion (AIC).

We start by documenting the global divergence of prices, which emerges as a result of the interaction of traded and non-traded factors in the form of threshold effects. Specifically, using sequential testing for the presence of threshold effects as in Hansen (1999), we uncover the presence of four regimes, which we call clubs, in almost all models by rejecting the linear model most of the times at the 1% and in some cases at the 5% significance level. The only exception is when democracy is used as a threshold variable for both levels. Nevertheless, even in this case we find strong evidence for a three-regime model. We also reject the null of unit roots in the context of the threshold regression in all cases at the 1% significance level.

According to AIC the strongest evidence for a threshold split occurs when distance is one of the threshold variables. Specifically, the top three models with the lowest AIC values use democracy/distance, distance/initial productivity, and distance/initial income as level 1/level 2 threshold variables. For example, the second best model organizes the countries in four clubs: (C1) distance below 8.798 and initial productivity below 10.861; (C2) distance below 8.798 and initial productivity above 10.861; (C3) distance above 8.798 and initial productivity below 10.127; and (C4) distance above 8.798 and initial productivity above 10.127. The distance threshold value 8.798 corresponds to Turkey, the 18th least distant country in our sample. The initial productivity threshold values 10.861 and 10.127 correspond to Spain and Mexico in 1997, the 16th and 21st most productive country in our sample in 1997, respectively.

4.2.2 Local convergence rates

Next, in Table 6, we present the estimated β-coefficients for each club that correspond to the threshold regression models presented in Table 5. The first column ranks the threshold models according to their AIC values and the next two columns describe their corresponding threshold variables. The models are ordered by AIC. The next eight columns show estimates of the β-coefficients and the corresponding speed of price convergence within each club.[19]

[19]In Table A4 of the Appendix, we present the results of the test for the equality of β-coefficients for each pair of regimes in each model.

The speed of convergence shows the percentage semi-annual movement of the country to its local steady state relative to the remaining distance.[20] The last column reports the AIC value. We note that we only present unique threshold regression models chosen by AIC. That is, for each pair of threshold variables q_1 and q_2 in Table 5, the sequential testing procedure gives rise to two four-regime threshold models depending on the order with which the threshold variables were chosen to split the sample. We select the model that yields the lowest AIC value and present it in Table 6. This limits the number of models to 21.

Consistent with the predictions of theories on multiple steady states, we find strong evidence of club convergence consistent with our earlier unconditional results that were based on the nonlinear factor model. That is, the β-coefficient is always estimated to be negative and strongly significant, implying the presence of club β-convergence in all regimes. This finding holds regardless of the choice of threshold variable.

We find a number of theory-relevant results.[21] First, the findings in models 2 and 3 in Table 6 are of particular theoretical interest as these models account for the effect of distance and labor productivity (or income) on price convergence, which respectively capture the traded and non-traded components of final prices on price convergence. These models are respectively ranked as the 2nd and 3rd best according to the AIC. Based on the model with distance and initial labor productivity as threshold variables (model 2), countries in the low distance regime converge faster than countries in the high distance regime as long as they have low initial labor productivity. This suggests trade is conducive to price convergence for countries that also have the non-traded Balassa-Samuelson catch up process operating in full force given low initial productivity. In addition, we find that within the low distance regime, countries with low initial productivity converge significantly faster than those in the high productivity regime. In the high-distance regime, implied convergence is not significantly higher in the low productivity regime as compared to the high productivity one. Thus, being behind the technology frontier appears to be conducive to price convergence, presumably via the Balassa-Samuelson channel, for countries with relatively small physical distance from potential trade partners that have easier access to international trade but not for countries in the high-distance regime. This suggests, again, an interaction between the non-traded and traded channels via which price convergence occurs.

[20] We calculate the speed of convergence using the coefficient for the initial price level in equations (7) and (8): $-(1 - e^{-\lambda_k t}) = \beta_k$, for regime $k = 1, 2$ and $t = 1$, where λ_k denotes the speed of price convergence.

[21] Given that the AIC values are for the most part close to each other, we use the AIC merely as a guidance for the relative strength of each model, emphasizing theory-relevant results.

The finding that price convergence depends on the interaction between the traded and non-traded channels is also preserved when we replace the level 2 threshold variable initial productivity with initial income (model 3 in Table 6). We find that countries in the low distance regime converge faster than those in the high distance regime as long as they have low initial income. We also find that convergence is faster in the low-income regime as compared to the high-income regime irrespective of whether a country lies in the low or high distance regimes. However, the difference in the speed of convergence coefficients is much greater for low versus high income countries in the low distance regime (0.151 versus 0.065) as compared to within the high distance regime (0.090 versus 0.070 respectively for low and high income regime countries). In any case, the implication is that poorer countries behind the frontier tend to exhibit faster inflation leading to price convergence. This effect is consistent with the Balassa-Samuelson hypothesis, according to which prices will increase (and thus converge) faster in poorer countries as they catch-up by growing faster over the period. This form of price convergence occurs via convergence in the non-traded component of final prices. We find similar evidence consistent with this notion in other threshold models we consider with initial income or labor productivity as first or second level threshold variables. That is, the typical finding from such models (models 2, 3, 7, 8, 9, and 11 to 16) is that countries in the low initial income or initial labor productivity regimes are associated with higher implied convergence than countries in the respective high regimes.

Second, based on the model with distance and initial prices as first and second thresholds respectively (model 10 in Table 6), countries in the low distance regime tend to converge faster than countries in the high distance regime irrespective of initial price regime. The basic result that the low distance regime is associated with faster implied convergence than the high distance regime, is quite common amongst the models we consider with distance as a first or second-level threshold variable (models 1, 2, 3, 5, 6 and 10 in Table 6).

Importantly, based on model 10, countries in the low initial prices regime converge faster than those in the high initial prices regime, irrespective of whether they are in the low or high distance regime. In fact, looking at other models with initial prices as second threshold variable (such as models 11, 13, 18, 19 and 21 in Table 6) we see that the coefficients of initial prices are always higher (and significantly so, except for model 21 in the high regime) for low initial price level regime countries as compared to high-regime ones. This implies that countries in the low initial price regime exhibit faster catch up than countries in the high initial price regime. That is, there appears to be an asymmetry in the extent that arbitrage opportunities related to international trade are exploited, with low initial price regime countries exhibiting faster convergence from below than high initial price regime countries exhibit from above. This could be related to the fact that we would typically expect less resistance to exporting (the case of initially cheap countries) than to importing (the case of initially expensive countries) where some local producers and workers stand to lose out. Thus, resistance to international trade and the resulting ability to arbitrage away price differences would be asymmetric, with countries in the low initial price regime facing less resistance and thus better able to exploit arbitrage opportunities via international trade.

Furthermore, the results in models 11 and 13 are of particular theory interest as these models capture the effect on price convergence of two variables in each case (labor productivity or income versus initial prices) that map onto the respective non-traded versus traded components of final prices. In the model with labor productivity and initial prices as threshold variables (model 11), countries in the low labor productivity regime converge faster than those in the high productivity regime, irrespective of whether they are in the low or high initial price regime. Furthermore, as we already noted above, countries with lower initial prices converge faster than countries with high initial prices, irrespective of whether a country lies in the low or high productivity regime. Similarly, in the model with initial income and initial prices as threshold variables (model 13), countries with low initial income converge faster than countries with high initial income irrespective of the initial price regime they lie in, and countries with lower initial prices converge faster than countries with high prices irrespective of whether they lie in the low or high initial income regime. These results are then consistent with a retail pricing model where final goods prices have a non-traded and traded component related to income (or labor productivity) and initial prices respectively.

Third, the institutions-related variable control of corruption appears to be conducive to price convergence. This is evident in model 4 in Table 6 where we use control of corruption with democracy as first and second threshold variables respectively, and in model 5 where we use control of corruption and distance as first and second threshold variables.

Using control of corruption and labor productivity as first and second threshold variables respectively (model 7 in Table 6), convergence in the high control of corruption regime is higher than in the low regime as long as the country has low productivity. In addition, for the high but not for the low control of corruption regime, convergence is faster for low initial productivity as compared to high productivity countries. This suggests that being behind the technology frontier appears to be conducive to price convergence, presumably via the Balassa-Samuelson channel, for countries that have good institutions successful in controlling corruption but not for countries in the low control of corruption regime.

Similarly, using control of corruption and initial income as the respective first and second threshold variables (model 14), convergence in the high control of corruption regime is higher than in the low regime as long as the country has low initial income. Interestingly, for the high but not for the low control of corruption regime, convergence is significantly faster for low initial income as compared to high income countries, suggesting again that the catch up process operating via the Balassa-Samuelson channel is present for countries that are successful in controlling corruption but not for countries with low control of corruption.

In the model with control of corruption and initial prices as threshold variables (model 19 in Table 6), countries with high control of corruption converge faster as long as they have low initial prices. Thus, control of corruption is likely to affect the ability to arbitrage away existing price differences. We would expect that countries with higher control of corruption can more readily rip the benefits of international trade and as a result would tend to exhibit relatively more rapid price convergence. In addition, higher values of this variable could be associated with higher competition in the local market that in turn reinforces price convergence. Finally, the basic finding that control of corruption facilitates convergence comes out in model 20 as well, where corruption control enters as both a first and second level threshold variable.

Fourth, we find that the best model according to the AIC is the one that splits with democratic accountability and distance. We find that convergence in low democracy regimes is greater than in high democracy regimes irrespective of distance regime. Moreover, within the low democracy regime, countries with smaller distance from potential trade partners converge faster. Typically, in the models with democratic accountability as first threshold variable (models 1, 17 and 18) or as second threshold variable (models 4, 8, 9 and 17) reported in Table 6, convergence in the low democracy regime is higher than in the high-democracy regime. Models 8 and 9 with initial productivity or income as the respective first threshold variable and democracy as second threshold variable, are of particular interest. For these models, the result that low democracy leads to convergence holds only for the low initial productivity or for the low income regime and is not the case for high productivity or rich countries. The explanation could lie in political pressures that limit Central Bank independence and lead to more expansionary monetary policies resulting in higher inflation in initially backward (proxying for poor institutions that limit the degree of Central Bank independence) countries. Here, faster convergence would not coincide with higher market integration but would just be an unintended consequence of policies leading to higher inflation in initially poor countries with initially lower prices.

4.3 Further results

In addition to our baseline results presented above, we consider two further exercises using alternative samples and model specifications. First, we present threshold regression estimation results that use labor cost as a threshold variable in Table 7. This variable, however, restricts the sample to 31 countries due to data unavailability.[22] As for our baseline sample, we reject the null hypothesis of global β-convergence and find strong evidence for club convergence. The best model according to the AIC, is the model that splits with labor cost (level 1) and democracy (level 2). In this case, we can see that countries in the low labor cost regime exhibit faster implied convergence than those in the high labor cost regime. Moreover, we can see that countries in the low democracy regime exhibit faster implied convergence than those in the high democracy regime, but only as long as they are in the low labor cost regime. This finding resembles the result discussed earlier regarding low democracy regime countries with low initial income or low initial labor productivity.

The second best model shown in Table 7 which splits using distance (level 1) and labor cost (level 2) is, however, the most theoretically appealing one. This model shows that within the low distance regime, countries with lower labor cost converge significantly faster than countries with high labor cost. This resembles the result for labor productivity in model 2 of Table 6, and is again suggestive of an interaction between the non-traded and traded channels via which price convergence occurs. Moreover, countries with low distance tend to converge faster than those with high distance from potential trade partners as long as they have lower labor cost. This result resembles the findings for labor productivity and initial income in models 2 and 3 from Table 6. It makes good sense as distance matters for trade and countries with lower labor costs might be more able to engage successfully in international trade. For example, countries with lower labor costs might face less political

[22] For brevity, we show the threshold tests in Table A7 of the Online Appendix.

resistance in engaging in international trade than countries with high labor costs where some local players would lose out from engaging in international trade.

The remaining theoretically interesting models in Table 7 are models 5 and 7, which include labor cost as second threshold with control of corruption or initial prices as the respective first threshold variables. Results for model 5 in Table 7 suggest that control of corruption helps convergence for countries with low labor cost, and that countries with low labor costs converge significantly faster than those with high labor cost as long as they have high control of corruption. Both of these results resemble what we saw in the case of initial productivity and initial income in models 7 and 14 respectively shown in Table 6.

Results for model 7 in Table 7 where labor cost enters as second threshold variable and initial prices as first threshold variable, resemble those from models 11 and 13 in Table 6 where initial prices enter as second threshold variable with initial productivity and initial income as the respective first threshold variables. That is, countries with low labor costs converge faster than countries with high labor costs irrespective of the initial price regime they lie in, and countries with lower initial prices converge faster than countries with high prices irrespective of whether they lie in the low or high labor cost regime. These findings are again consistent with a retail pricing model where final goods prices have a non-traded and traded component related to labor cost and initial prices, respectively.

In the second exercise further to our baseline results, we use our baseline sample to estimate the threshold regression model in equations 7 and 8 by including initial income, control of corruption and democracy in addition to initial prices and fixed effects.[23] We present the estimation for the augmented threshold regressions in Table 8.[24] In general, we find that for factors related to the non-traded component of final prices, high values of initial income, labor productivity and democratic accountability hinder convergence, while high control of corruption reinforces convergence. Similarly, factors related to the traded component of final prices such as distance and initial prices have a suppressing effect on price convergence, i.e., countries with higher distance or higher initial prices tend to have lower convergence rates.[25]

[23]Initial productivity was excluded from the vector z_{it} due to multicollinearity issues. Distance is also not included since it is a country-specific variable and the model includes country fixed effects.

[24]Threshold tests and tests for the equality of the β-coefficients for each pair of the regimes in each model are given in Tables A5 and A6 of the Online Appendix, respectively.

[25]We also estimate the augmented threshold regression models using the restricted sample of countries that include labor cost. The results are similar and can be found in Tables A7 and A8 of the Online Appendix.

4.4 Classification of countries in convergence clubs

In this section we attempt to classify the countries in various convergence clubs using information from threshold regressions based on our baseline sample. In the four panels of Figure 5, we present the countries that belong to the various regimes using cross-plots between the two threshold variables q_1 and q_2 for four of the best models from Table 6 that include pairs of variables capturing respectively each of the two theoretically distinct components of final prices. These four models include distance to capture the traded component in each case, and labor productivity, initial income or institutions to capture the non-traded component of final prices. Specifically, we consider Model 1 with q_1=Democracy and q_2=Distance in Panel (a); Model 2 with q_1=Distance and q_2=Initial Productivity in Panel (b); Model 3 with q_1=Distance and q_2=Initial Income in Panel (c); and Model 5 with q_1=Control of Corruption and q_2=Distance in Panel (d).

We calculate the share of years for which the country lies in one of the regimes and obtain frequencies of forming a regime for each country in each model. If the country lies in one of the regimes for more than 50% of the period, then it is classified in that regime. There are four possibilities marked by different colors: blue denotes dismal conditions in both variables; orange denotes bad conditions in q_1 but good conditions in q_2; green denotes good conditions in q_1 and bad q_2 conditions; and red denotes good conditions for both q_1 and q_2.[26] The size of the circles shows speed of convergence within each regime.

Overall, the results verify at the country level the findings described in Table 6. The "best" regime, that is, the regime with the most favorable economic conditions in both threshold variables, typically includes most of the European countries while the "bad" regime typically comprises Latin American and South East Asian countries. Interestingly, other high income countries such as the US, Canada and Japan appear to belong to intermediate regimes, which are only partially characterized by favorable conditions. Moreover, these regimes exhibit substantial differences in their convergence rates to their local long run equilibria. In particular, Panel (a) shows that countries with low democracy and low distance (in orange) appear to have the highest convergence pace. Panels (b) and (c) exhibit similar

[26]Except for distance and initial prices, for most threshold variables low values reflect bad economic conditions and high values good economic conditions. Thus, good conditions for q_i typically correspond to the high q_i regime obtained in the threshold models, except in the case of distance and initial prices where good conditions correspond to the low q_i regime in the threshold models.

patterns. They show that countries (in green) with low distance and low initial income or productivity converge faster than other countries. Finally, Panel (d) shows that countries (in red) with high control of corruption and low distance converge faster than the rest.

In general, our results in this section imply a similar classification of countries to the one based on the nonlinear factor model in Table 3.[27] For example, countries that lie in the threshold regime described by the best conditions (both threshold variables reflecting good conditions) for more than 50% of models, i.e., the Netherlands, Norway, Luxembourg, Switzerland, Sweden, Finland, Denmark, Austria, Germany, UK, Belgium, France, Spain and Australia, are countries that lie in the high-price club for more than 50% of the goods in our sample. Similarly, the majority of countries that lie in the threshold regime with worst conditions for more than 50% of the estimated models, i.e., Panama, Philippines, Guatemala, Thailand, Colombia, Peru, South Africa, Uruguay, Venezuela, Brazil, Paraguay and Kenya, are countries that lie in the medium or low price clubs for more than 50% of the goods in our sample.

5 Conclusion

We have investigated the existence of convergence clubs in the cross-country mechanism of retail prices using a sample of 96 goods in 40 countries for 1990 to 2010 at the semi-annual frequency, by doing two things. First, we employ a nonlinear factor model that distinguishes between economies that have converged and those that are converging. While we do not find evidence of global price convergence, we do find strong evidence of convergence clubs. Second, we examine the factors that determine price convergence clubs using a threshold regression methodology which allows us to model the determinants of convergence clubs using observed threshold variables related to traded and non-traded factors, and to estimate regime-specific β-coefficients common within regimes. These regime-specific estimated coefficients map onto local rates of convergence consistent with a local law of one price. In line with our findings based on the nonlinear factor model, we find strong evidence of club convergence.

[27] This is shown in Table A9 of the appendix where we present country-specific frequencies of forming a regime based on the 36 estimated threshold regression models from Table 6. As in Figure 5, we calculate the share of years for which the country lies in one of the regimes and obtain frequencies of forming each regime for each country in each model. Then, using these frequencies we compute the share of models for which the country lies in each of the regimes.

We reject the null of global β convergence, typically in favor of four convergence clubs which are due to traded and non-traded factors and the interaction between these. These factors can be viewed as barriers to global price convergence that organize countries into price convergence clubs. Here, different price convergence regimes arise both due to factors associated with convergence in the non-traded component of final prices related to non-traded input cost differences across countries (e.g., income, labor productivity or labor cost) and due to convergence in the traded component of final prices (e.g., physical distance or initial prices), consistent with a retail pricing model where traded and non-traded inputs comprise the final good. Our results are suggestive of the economic mechanisms that are at work here. With either initial income or initial productivity as one of the threshold variables, implied convergence rates for the low regime are typically higher than for the high regime, consistent with the Balassa-Samuelson hypothesis and convergence via the non-traded component of final prices. With physical distance or initial prices as thresholds, implied convergence is typically higher in the low regime than in the high regime, suggesting that countries with smaller distance from potential trade partners and those more able to exploit arbitrage opportunities experience faster convergence.[28]

Importantly, our findings point to interactions between the non-traded and traded channels via which price convergence occurs. Countries in the low distance regime converge faster than countries in the high distance regime if they have low initial labor productivity, low labor input costs or low initial income, and countries with low initial productivity or low labor input costs converge significantly faster than those in the respective high productivity or high labor cost regimes, if characterized by low average distance from trade partners. In the first instance, trade appears to be conducive to price convergence for countries that have the non-traded Balassa-Samuelson catch up process operating given low initial productivity, labor cost or initial income levels. In the second instance, being behind the technology frontier appears to be more conducive to price convergence for countries with relatively small physical distance from potential trade partners that have easier access to international trade than for countries in the high-distance regime.

In addition, we find an asymmetry in the extent that arbitrage opportunities related to international trade are exploited, with low initial price regime countries exhibiting faster

[28] Future work would do well to focus on structural threshold regression models that account for endogeneity, e.g., Kourtellos, Stengos, and Tan (2015), and can potentially be used to identify such mechanisms provided that appropriate instruments can be found.

convergence from below than high initial price regime countries exhibit from above. This can be explained by lower resistance to exporting (the case of initially cheap countries) than to importing (the case of initially expensive countries) where some local producers and workers stand to lose out, so that resistance to international trade and the resulting ability to arbitrage away price differences is rendered asymmetric, with countries in the low initial price regime facing less resistance and thus better able to exploit arbitrage opportunities via international trade.

Our results are important for two different strands of the literature. First, they relate to the price convergence literature where no previous study has shown the presence of multiple regimes we find here. Second, our results relate to the literature on club convergence which has focused on assessing economic growth regimes. Our detection of multiple regimes and the relevance of a number of factors in determining these shown here, suggest that there is much to be learned regarding club convergence by focusing on prices in addition to real GDP per capita.

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Figure 1: Heatmap for Clubs by Country

This figure shows a heatmap of the frequency of a country to form a club for the countries in our sample. Color defines club with blue, orange, green and red colors standing respectively for the high-price, medium-price, low-price and cheap clubs. Depth of color represents frequency of belonging in a certain club.

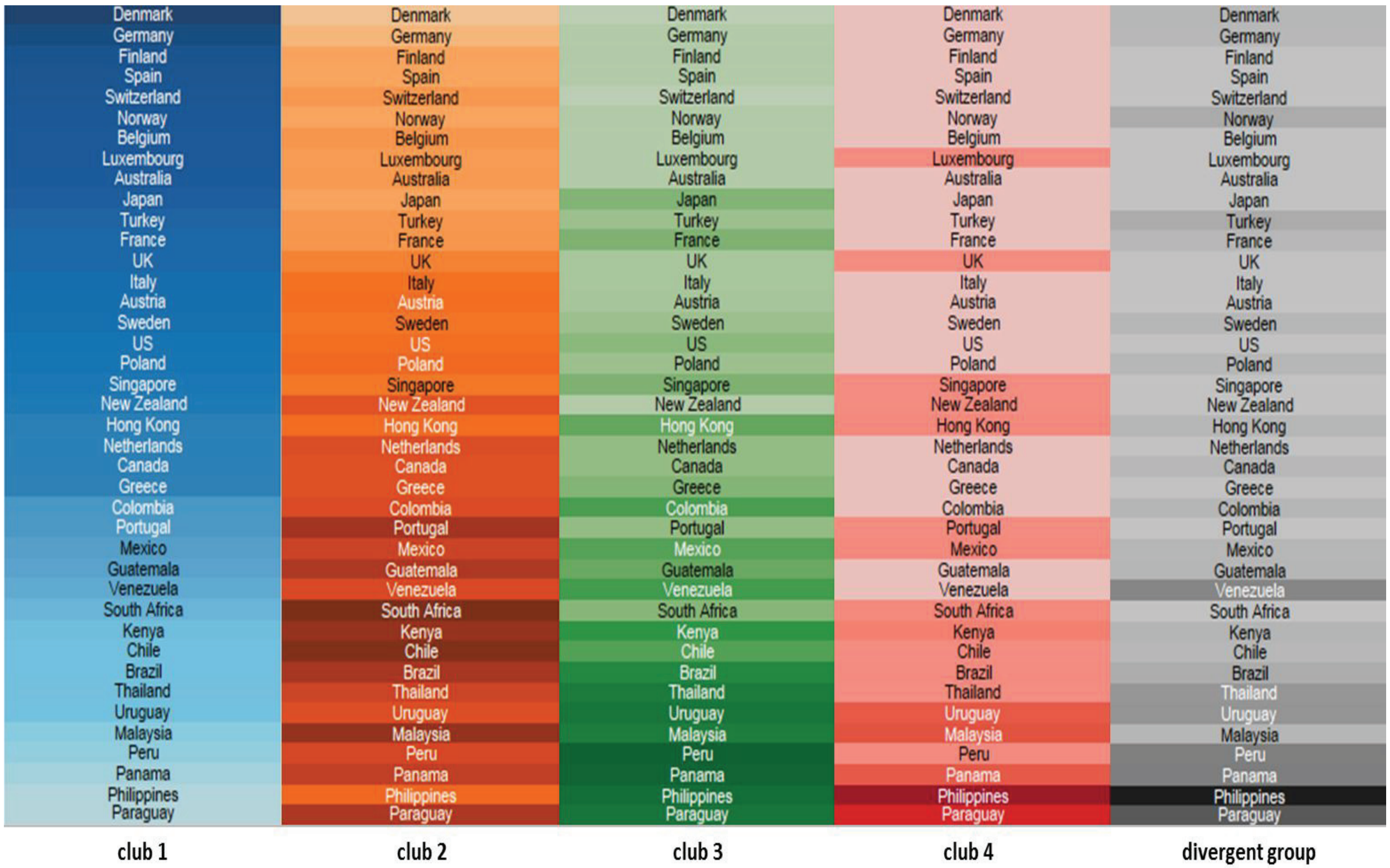


Figure 2: Price Convergence Clubs by Industry

This figure shows a geographical map of countries that belong to the various convergence clubs by industry. Color defines club: blue, orange, green and red colors stand respectively for the high-price, medium-price, low-price and cheap clubs.

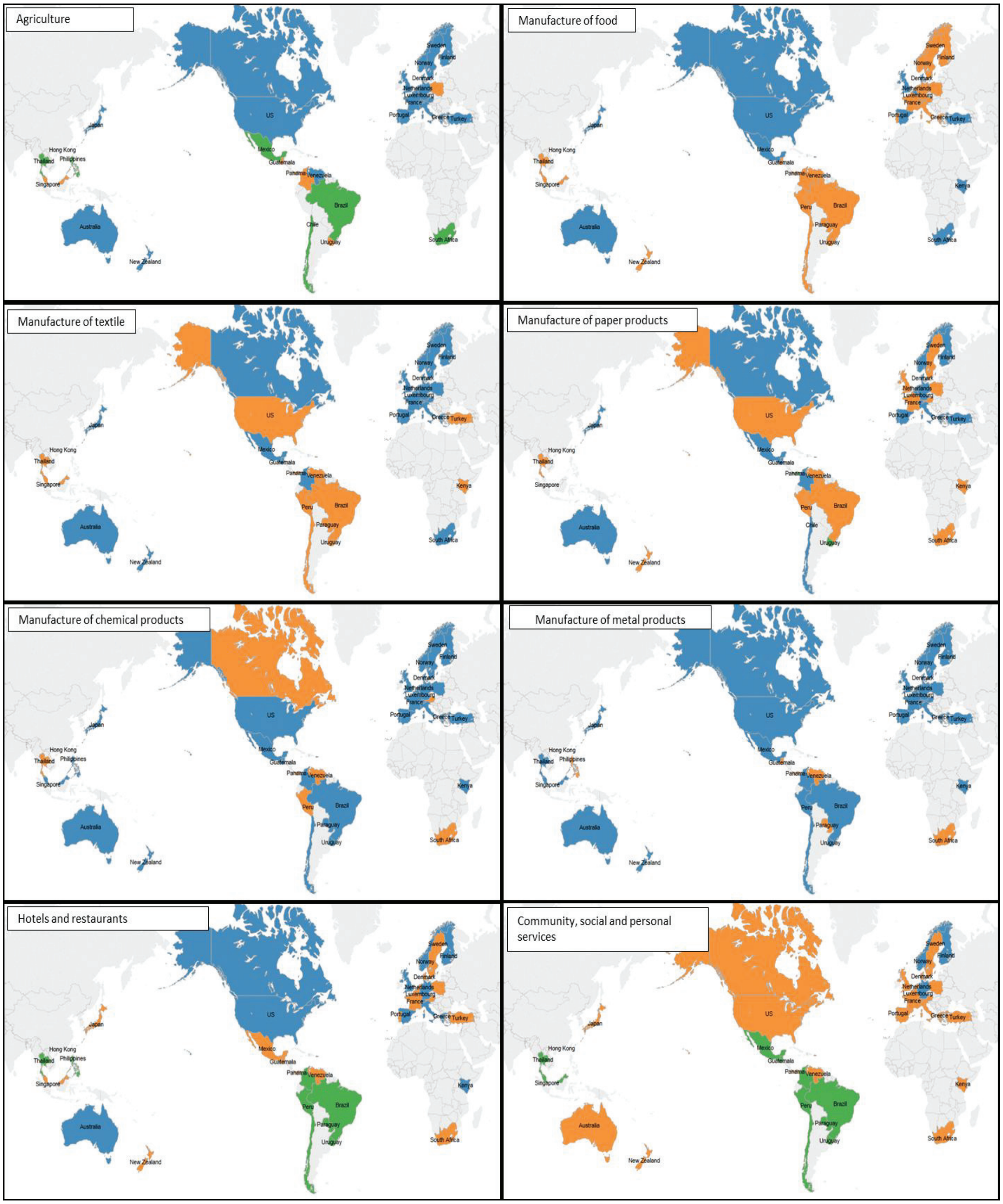


Figure 3: Transition Paths for Clubs by Industry

This figure shows transition curves for each of the three clubs defined at the industry level. The relative transition curve for each club is calculated as the average transition coefficient across countries that form the club for each industry, where the transition coefficient is defined by equation (4). Colors denote different clubs: blue is for the first club, orange for the second club and green for the third.

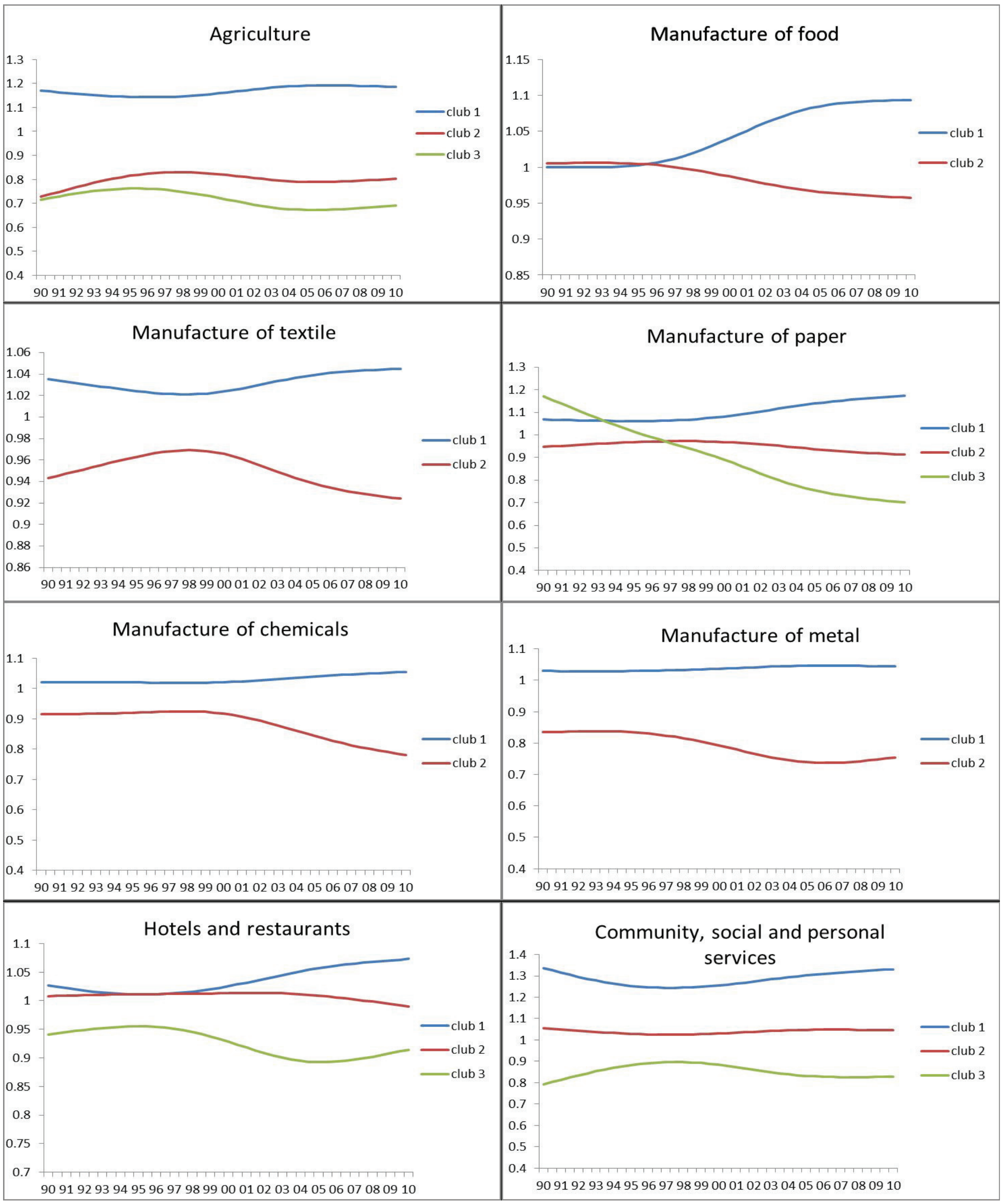


Figure 4: Price-Income Relation by Industry

This figure shows the relation between average prices and average real gdp per capita (averaged over the period of study) for each of the eight industries. We mark the clubs different countries belong in by different colors, blue is for the first club, orange for the second club, and green for the third club.

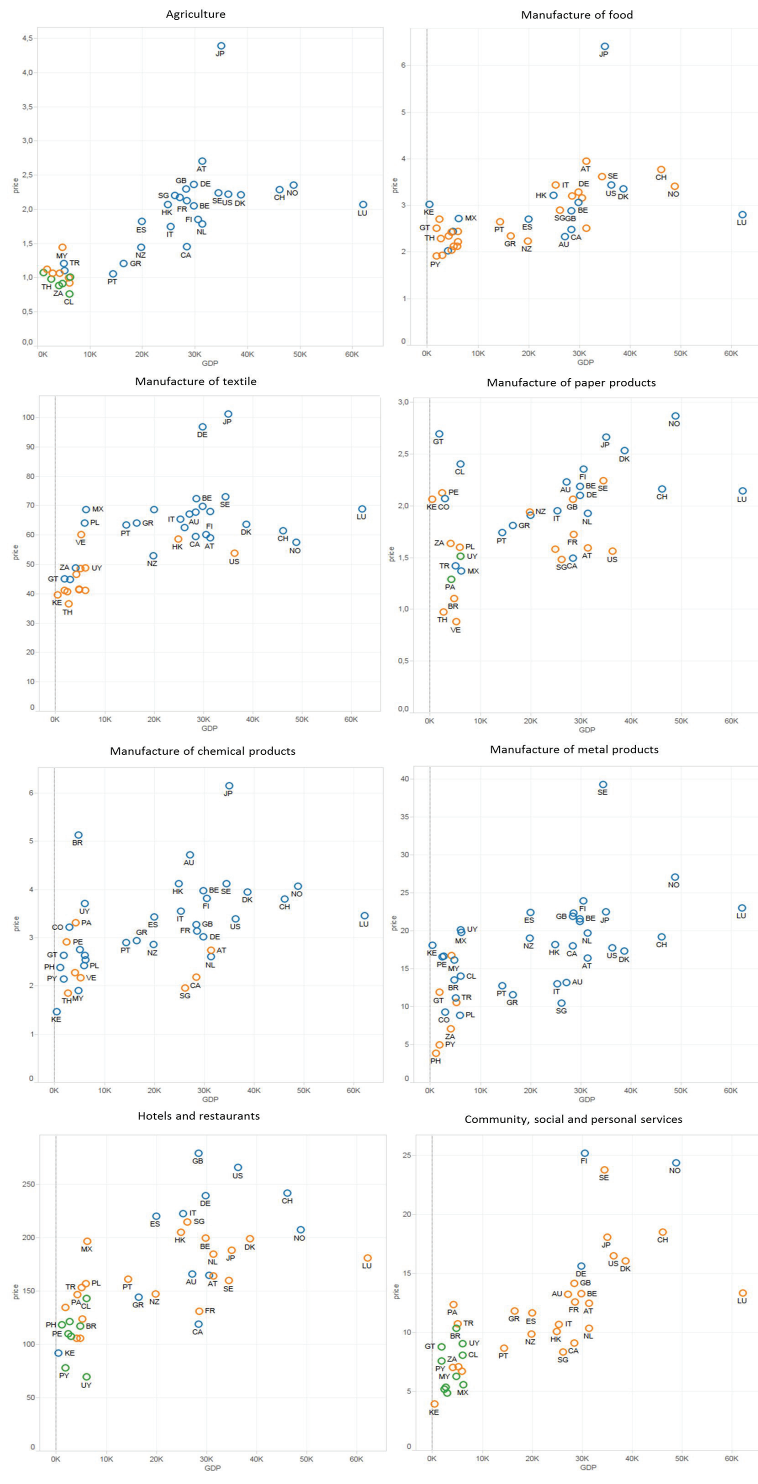
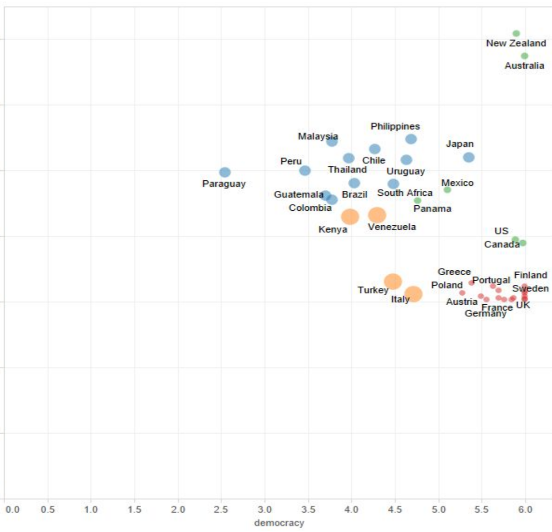
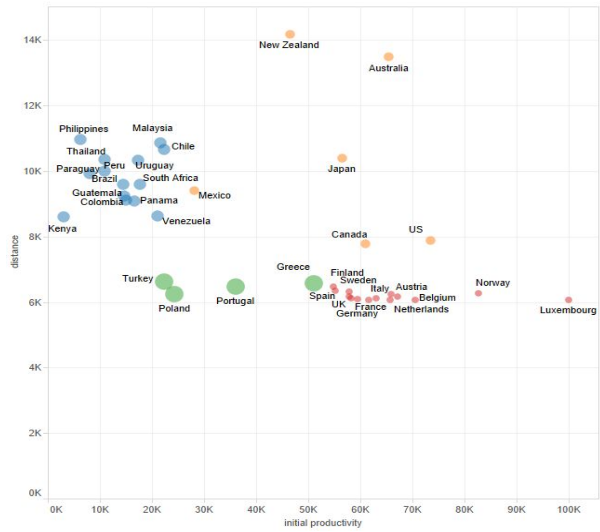


Figure 5: Classification of Countries into Convergence Clubs

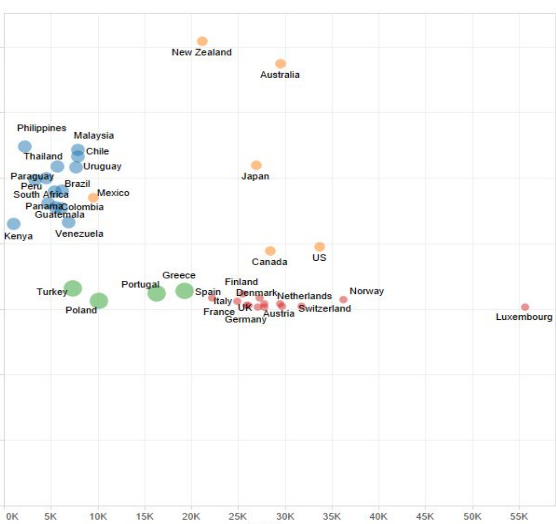
This figure shows the classification of countries into regimes using different pairs of threshold variables for four of the best models estimated in Table 6. On the vertical and horizontal axis we draw the values of the two threshold variables in each case. We mark the regime different countries belong in by different colors: blue is for the worst regime, orange for the second-worse regime, green for the second-best regime and red for the best regime (i.e., low distance, high income, high productivity, high control of corruption and high democratic accountability). The size of the circles shows speed of convergence within a regime.



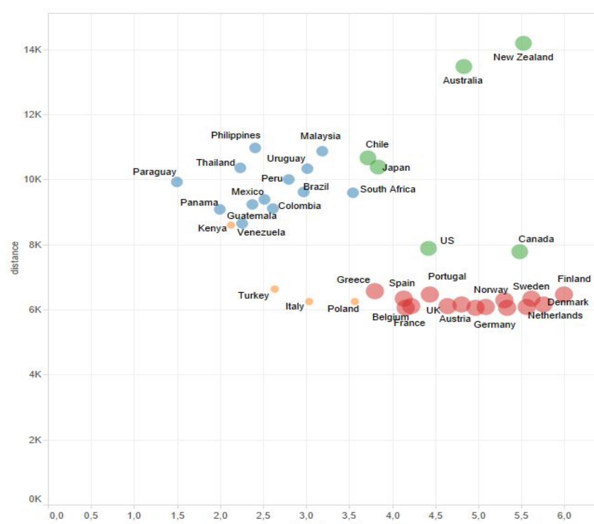
(a) Model 1: q_1=Democracy, q_2=Distance



(b) Model 2: q_1=Distance, q_2=Initial productivity



(c) Model 3: q_1=Distance, q_2=Initial income



(d) Model 5: q_1=Control of corruption, q_2=Distance

Table 1: Convergence Coefficients by Good

		Convergence Coefficient				
Item	**Global**	**Club 1**	**Club 2**	**Club 3**	**Club 4**	**Divergent group**
Personal computer	2.104	-	-	-	-	-
Peanut or corn oil	0.587	-	-	-	-	-
Potatoes	0.103	-	-	-	-	-
Olive oil	0.081	-	-	-	-	-
One good seat at cinema	-0.084*	0.180	-	-	-	-0.226**
Milk, pasteurised	-0.091**	0.394	-0.063	-	-	-
Intl. weekly news magazine	-0.091**	0.434	-	-	-	-0.678***
Four best seats at cinema	-0.093*	0.170	-	-	-	-0.306**
Regular unleaded petrol	-0.179*	0.111	-	-	-	-
White bread	-0.218*	-0.030	0.410	-	-	-
Carrots	-0.239*	-0.059	-	-	-	-4.537**
Mushrooms	-0.261*	-0.077	0.796	-	-	-
Lettuce	-0.300*	0.258	0.177	-	-	-
Flour, white	-0.314*	-0.020	0.040	-	-	-
Aspirins	-0.315*	0.095	0.327	-	-	-
Tomatoes, canned	-0.321*	0.024	0.569	-	-	-
Pineapples, canned	-0.328*	0.103	0.246	-	-	-
White rice	-0.345*	-0.050	0.662	6.820	-	-
Intl. fgn. daily newspaper	-0.350*	0.017	-	-	-	-0.269**
Beef: filet mignon	-0.365*	-0.024	0.237	-	-	-
Apples	-0.370*	-0.036	-	-	-	-3.988***
Fresh fish	-0.393*	0.358	0.064	-	-	-
Beef: steak, entrecote	-0.394*	-0.055	-0.103	-	-	-
Drinking chocolate	-0.397*	0.528	0.453	-	-	-
Beef: stewing, shoulder	-0.409*	0.225	-0.044	-	-	-
Hourly rate for domestic cleaning help	-0.432*	-0.049	0.024	-	-	-
Beef: ground or minced	-0.445*	0.075	0.365	-	-	-0.426***
Hand lotion	-0.451*	-0.024	-0.786	-1.860	-	-
Cornflakes	-0.474*	0.321	-0.036	-	-	-
Cost of developing 36 colour pictures	-0.474*	0.248	0.181	-	-	-
Beef: roast	-0.477*	0.620	-0.013	-	-	-
Ground coffee	-0.497*	0.192	0.202	-0.103	-	-
Maid's monthly wages	-0.498*	0.141	0.158	-0.114	-	-
Babysitter's rate per hour	-0.513*	0.799	0.176	-0.289	-	-
Spaghetti	-0.532*	0.242	0.141	-	-	-
3-course dinner at top restaur. for 4 ppl.	-0.537*	0.220	0.167	-	-	-
Onions	-0.547*	0.175	0.023	-	-	-
Chicken: fresh	-0.553*	0.291	-0.079	-	-	-4.517**
Tomatoes	-0.562*	0.371	-0.024	-0.770	-	-
Two-course meal for two people	-0.575*	0.052	0.056	0.156	-	-
Eggs	-0.585*	0.143	-0.069	1.426	-	-
Toilet tissue	-0.592*	-0.067	0.355	-	-	-
Peas, canned	-0.621*	0.039	0.487	-0.559	-0.116	-
Dishwashing liquid	-0.654*	0.521	0.715	0.261	-	-
Bananas	-0.662*	-0.004	0.090	0.177	-	-
Cost of a tune up (but no major repairs)	-0.681*	0.164	0.536	-	-	-
Man's haircut	-0.683*	0.135	0.006	-	-	-1.551**
Pork: chops	-0.685*	0.039	0.038	1.026	-	-
Child's shoes, dresswear	-0.703*	0.071	0.063	-	-	-

Table 1 continued

Item	Global	Club 1	Club 2	Club 3	Club 4	Divergent group
	Convergence Coefficient					
Light bulbs	-0.714*	0.623	0.141	-	-	-
Daily local newspaper	-0.720*	-0.070	0.046	-	-	-0.839**
Instant coffee	-0.721*	0.620	0.440	0.047	1.311	-
Peaches, canned	-0.724*	0.078	0.116	-	-	-
Margarine	-0.752*	0.079	1.757	-	-	-
Woman's cut & blow dry	-0.755*	0.519	0.297	1.210	-	-
Sugar, white	-0.773*	0.057	0.049	0.152	-	-
Dry cleaning, woman's dress	-0.796*	0.631	0.082	0.557	-	-
Oranges	-0.803*	0.330	0.202	0.211	-	-
Cheese, imported	-0.805*	0.528	0.794	-	-	-
Soap	-0.829*	0.521	0.530	-	-	-
One drink at bar of first class hotel	-0.841*	0.217	0.488	0.162	-	-
Dry cleaning, trousers	-0.861*	0.224	0.232	0.400	0.458	-
Dry cleaning, man's suit	-0.907*	0.019	0.134	-	-	-1.659*
Girl's dress	-0.923*	0.243	0.106	-	-	-1.355*
Moderate hotel, SRO, 1 night, BB	-0.923*	1.046	0.064	0.375	-	-
Tea bags	-0.932*	0.433	0.255	4.409	-	-7.509**
Frying pan	-0.965*	0.319	0.069	1.069	-	-
Yoghurt, natural	-0.968*	-0.007	0.405	0.185	-	-
Women's dress, daytime	-0.973*	0.221	0.083	0.389	-	-
Women's shoes, town	-0.992*	-0.038	0.070	0.208	-	-
Lemons	-0.997*	-0.188	-0.055	0.228	-	-
Shampoo	-1.008*	-0.039	0.118	-	-	-
Boy's dress trousers	-1.018*	0.037	-0.029	0.831	-	-
Butter	-1.052*	0.670	0.300	0.930	-	-
Batteries	-1.054*	0.852	0.236	1.241	-	-
Men's business suit, two piece	-1.067*	-0.031	0.035	-	-	-
Facial tissues	-1.114*	0.063	-0.006	-	-	-
Laundry detergent	-1.144*	1.129	0.158	-0.556	0.365	-
Child's jeans	-1.166*	0.154	-0.069	1.649	-	-
Business trip, typical daily cost	-1.187*	0.653	-0.137	-	-	-2.630*
Simple meal for one person	-1.192*	-0.609	0.436	-	-	-1.198**
Women's tights, panty hose	-1.200*	0.250	-0.060	-	-	-5.341**
Toothpaste with fluoride	-1.230*	-1.089	0.459	0.168	0.416	-
Men's shoes, business wear	-1.253*	0.975	0.218	-0.038	-	-3.789**
Child's shoes, sportswear	-1.257*	-0.076	-0.015	-	-	-0.326**
Men's business shirt, white	-1.263*	1.298	-0.073	0.493	0.164	-
Laundry	-1.282*	0.042	0.716	0.477	-0.025	-
Paperback novel	-1.286*	1.785	0.162	0.033	-	-
Socks, wool mixture	-1.350*	0.116	0.490	2.178	-	-4.195*
Television, colour	-1.378*	0.084	0.432	1.230	-	-
Kodak colour film	-1.457*	0.040	0.004	-0.069	-0.522	-
Compact disc album	-1.531*	-0.032	0.272	0.064	-	-
Electric toaster	-1.533*	1.388	0.112	0.533	-	-
Hilton-type hotel, SRP, 1 night, BB	-1.542*	-0.085	0.324	0.229	-	-
Razor blades	-1.841*	0.152	0.688	0.311	0.024	-
Lipstick (deluxe type)	-1.886*	0.269	0.563	-	-	-3.195*

Notes: This table presents estimates of the convergence coefficient λ_{1j} in equation (6) and convergence tests using the log t test of Phillips and Sul (2009). Column 2 presents the global convergence coefficients. The next four columns present estimates of the four club convergence coefficients based on the procedure described in section 3.4. The last column presents coefficient estimates of the divergent group. *, **, ***, refer to the significance level of 1%, 5%, and 10%, respectively, at which the null of convergence, $H_0 : \lambda_{1j} \geq 0$ is rejected.

Table 2: Average Price within Clubs by Good

Item	Overall	Club 1	Club 2	Club 3	Club 4	Divergent Group
Personal computer	891.48	891.48				
Peanut or corn oil	2.62	2.62				
Potatoes	2.13	2.13				
Olive oil	9.13	9.13				
One good seat at cinema	7.09	7.32				4.20
Milk, pasteurised	1.02	1.07	0.86			
Intl. weekly news magazine	3.72	3.80				2.37
Four best seats at cinema	28.36	29.30				16.81
Regular unleaded petrol	0.90	0.92				0.07
White bread	2.67	2.79	1.17			
Carrots	1.29	1.33				0.58
Mushrooms	5.37	5.75	3.56			
Lettuce	1.28	1.48	1.00			
Flour, white	1.04	1.13	0.91			0.97
Aspirins	9.00	9.66	3.87			
Tomatoes, canned	0.54	0.56	0.45			
Pineapples, canned	1.51	1.62	0.87			0.70
White rice	2.14	2.41	0.97	0.76		
Intl. fgn. daily newspaper	2.56	2.65				1.65
Beef: filet mignon	24.10	27.39	7.63			
Apples	1.93	1.97				1.09
Fresh fish	15.71	17.44	8.22			
Beef: steak, entrecote	17.04	21.07	6.16			
Drinking chocolate	2.96	3.44	2.67			
Beef: stewing, shoulder	8.82	11.07	6.44			
Hourly rate for domestic cleaning help	9.94	12.27	3.18			1.25
Beef: ground or minced	7.60	9.16	5.43			2.94
Hand lotion	2.85	2.99	2.07	1.48		
Cornflakes	2.41	2.68	2.08			
Cost of developing 36 colour pictures	14.79	17.17	12.00			
Beef: roast	10.90	15.46	7.86			
Ground coffee	5.83	8.39	5.10	3.01		
Maid's monthly wages	863.98	1410.56	517.85	286.39		
Babysitter's rate per hour	8.24	10.69	4.64	2.89		
Spaghetti	2.46	2.67	2.22			1.24
3-course dinner at top restaur. for 4 ppl.	424.35	497.23	223.15			121.38
Onions	1.13	1.35	0.88			
Chicken: fresh	4.09	5.39	3.37			2.20
Tomatoes	1.97	2.65	1.45	0.75		
Two-course meal for two people	126.43	147.85	81.37	51.99		
Eggs	1.76	2.18	1.26	0.97		
Toilet tissue	1.01	1.13	0.71			
Peas, canned	0.71	0.88	0.61	0.57	0.52	0.50
Dishwashing liquid	2.20	2.82	1.83	0.91		
Bananas	1.31	1.58	1.03	0.62		0.35
Cost of a tune up (but no major repairs)	223.26	255.85	140.31			
Man's haircut	26.16	30.38	11.96			10.46
Pork: chops	7.48	9.20	5.42	2.85		
Child's shoes, dresswear	49.38	74.75	46.39			
Light bulbs	1.68	2.02	1.25			3.35

Table 2 continued

Item	Overall	Club 1	Club 2	Club 3	Club 4	Divergent Group
Daily local newspaper	0.85	1.21	0.66			0.36
Instant coffee	4.49	6.56	4.51	3.41	2.03	
Peaches, canned	1.46	1.61	1.29			
Margarine	1.87	2.02	1.26			
Woman's cut & blow dry	43.60	55.68	34.82	20.88		10.58
Sugar, white	1.08	1.88	1.16	0.77		
Dry cleaning, woman's dress	8.27	22.13	8.44	5.32		2.52
Oranges	1.65	2.16	1.44	1.04		
Cheese, imported	9.68	12.31	7.71			
Soap	0.64	0.80	0.41			
One drink at bar of first class hotel	10.76	16.74	11.31	8.23		
Dry cleaning, trousers	5.09	8.16	4.81	3.85	2.63	
Dry cleaning, man's suit	10.24	12.01	7.97			11.87
Girl's dress	65.11	83.88	55.86			59.66
Moderate hotel, SRO, 1 night, BB	155.88	204.44	152.65	102.56		67.95
Tea bags	1.71	1.94	1.47	0.87		2.72
Frying pan	23.98	29.61	21.85	16.80		9.69
Yoghurt, natural	0.71	0.84	0.59	0.48		
Women's dress, daytime	231.85	326.57	195.80	140.26		
Women's shoes, town	122.06	141.82	113.77	69.01		
Lemons	1.94	2.55	1.13	0.82		0.55
Shampoo	6.60	7.08	5.98			4.30
Boy's dress trousers	45.31	57.47	33.50	19.85		
Butter	3.23	4.62	3.19	2.39		2.11
Batteries	3.66	4.51	3.34	1.99		
Men's business suit, two piece	491.36	550.33	390.26			
Facial tissues	1.44	1.51	0.85			
Laundry detergent	12.11	14.76	12.06	9.79	6.78	4.40
Child's jeans	43.03	51.02	35.82	25.87		
Business trip, typical daily cost	389.70	472.16	322.58			369.85
Simple meal for one person	36.80	39.62	22.24			18.01
Women's tights, panty hose	9.57	12.94	8.08			5.54
Toothpaste with fluoride	2.27	3.12	1.82	1.53	1.24	
Men's shoes, business wear	152.14	259.69	162.90	114.08		173.98
Child's shoes, sportswear	52.33	55.97	47.22			28.83
Men's business shirt, white	69.22	88.84	66.61	41.88	33.64	
Laundry	3.17	5.67	3.30	2.20		
Paperback novel	13.13	18.97	14.32	10.85		
Socks, wool mixture	10.65	12.27	8.49	5.56		6.20
Television, colour	927.86	1046.15	785.32	616.92		1682.99
Kodak colour film	6.30	8.12	6.31	5.09	3.88	
Compact disc album	20.64	24.14	20.08	17.39		
Electric toaster	39.79	46.98	41.00	34.25		19.91
Hilton-type hotel, SRP, 1 night, BB	257.52	299.21	224.57	197.57		
Razor blades	4.71	7.99	4.78	3.66	3.27	
Lipstick (deluxe type)	25.25	26.61	22.78			19.66

The first column of this table presents average prices across all countries in the sample for each good. The next four columns report average prices across countries that form each club. The last column shows the average prices of goods across divergent countries that do not form any club.

Table 3: Club Formation

Country	**High-price club**	**Medium-price club**	**Low-price club**	**Cheap club**	**Divergent Group**
Denmark	0.86	0.13	0.00	0.00	0.01
Germany	0.82	0.16	0.01	0.00	0.01
Finland	0.78	0.21	0.01	0.00	0.00
Spain	0.77	0.21	0.01	0.00	0.00
Switzerland	0.76	0.24	0.00	0.00	0.00
Norway	0.76	0.21	0.01	0.00	0.02
Belgium	0.75	0.24	0.01	0.00	0.00
Luxembourg	0.75	0.23	0.01	0.01	0.00
Australia	0.74	0.23	0.01	0.00	0.00
Japan	0.73	0.21	0.06	0.00	0.00
Turkey	0.70	0.24	0.03	0.00	0.02
France	0.68	0.24	0.07	0.00	0.01
UK	0.68	0.29	0.02	0.01	0.00
Italy	0.66	0.32	0.02	0.00	0.00
Austria	0.65	0.33	0.02	0.00	0.00
Sweden	0.64	0.31	0.03	0.00	0.01
US	0.62	0.33	0.05	0.00	0.00
Poland	0.61	0.34	0.04	0.00	0.01
Singapore	0.60	0.31	0.07	0.01	0.00
New Zealand	0.59	0.39	0.01	0.01	0.00
Hong Kong	0.55	0.33	0.09	0.01	0.01
Netherlands	0.55	0.40	0.04	0.00	0.00
Canada	0.55	0.40	0.04	0.00	0.01
Greece	0.54	0.40	0.06	0.00	0.00
Colombia	0.46	0.41	0.12	0.00	0.01
Portugal	0.46	0.49	0.04	0.01	0.00
Mexico	0.44	0.44	0.11	0.01	0.01
Guatemala	0.42	0.47	0.09	0.00	0.01
Venezuela	0.40	0.41	0.12	0.00	0.06
South Africa	0.36	0.56	0.06	0.01	0.00
Kenya	0.32	0.51	0.14	0.01	0.01
Chile	0.32	0.55	0.11	0.01	0.01
Brazil	0.31	0.48	0.17	0.01	0.02
Thailand	0.31	0.43	0.20	0.01	0.04
Uruguay	0.31	0.40	0.22	0.02	0.05
Malaysia	0.25	0.52	0.20	0.02	0.01
Peru	0.23	0.42	0.27	0.01	0.07
Panama	0.20	0.45	0.26	0.02	0.07
Philippines	0.16	0.34	0.24	0.06	0.19
Paraguay	0.16	0.48	0.22	0.04	0.11

Notes: This table presents the frequency of a country to form a club. These frequencies are calculated as the share of goods for which the country lies in one of the clubs. The last column shows the share of goods for which the country does not form any club. Countries are sorted according to the frequency of forming the first club.

Table 4: Convergence Coefficients at the Industry Level

	Convergence Coefficient				
Industry	**Global**	**Club 1**	**Club 2**	**Club 3**	**Divergent group**
Agriculture	-0.752*	0.163	0.707	0.000	-0.653**
Food	-0.296*	0.540	-0.049	-	-
Textile	-1.940*	-0.134	0.503	-	-
Paper products	-1.119*	0.771	-0.119	4.946	-1.406*
Chemicals	-0.407*	0.101	0.117	-	-
Metal products	-0.385*	0.246	0.117	-	-
Hotels and restaurants	-0.927*	0.184	-0.075	0.165	-
Other services	-0.736*	0.125	0.100	0.142	-

Notes: This table presents estimates of the convergence coefficient λ_{1j} in equation (6) and convergence tests using the log t test of Phillips and Sul (2009) at the industry level of analysis. Column 2 presents the global convergence coefficients. The next three columns present estimates of the three club convergence coefficients based on the procedure described in section 3.4. The last column presents coefficient estimates of the divergent group. *, ** refer to the significance level of 1% and 5%, respectively, at which the null of convergence, $H_0 : \lambda_{1j} \geq 0$ is rejected.

Table 5: Threshold Estimation and Testing

Threshold variables		Threshold point and interval estimates						AIC
Level 1 (q_1)	Level 2 (q_2)	Two-regime TR model		Four-regime TR model				
				Low q_1		High q_1		
		Threshold value	95%CI	Threshold value	95%CI	Threshold value	95%CI	
Distance	Initial income	8.798*†	[8.717, 9.246]	9.944*†	[9.658, 10.498]	8.955*†	[8.157, 10.120]	-3.502
	Initial productivity	8.798*†	[8.717, 9.246]	10.861*†	[10.558, 11.177]	10.127*†	[9.179, 10.935]	-3.503
	Distance	8.798*†	[8.717, 9.246]	8.727*†	[8.710, 8.774]	9.243*†	[9.058, 9.293]	-3.500
	Control of corruption	8.798*†	[8.717, 9.246]	4.292*†	[3.000, 5.917]	4.000*†	[2.000, 4.917]	-3.497
	Democracy	8.798*†	[8.717, 9.246]	5.375*†	[5.000, 5.917]	5.208*†	[3.000, 5.917]	-3.502
	Initial prices	8.798*†	[8.717, 9.246]	1.223**†	[0.312, 4.324]	1.655**†	[-0.100, 4.037]	-3.498
Initial prices	Initial income	1.656**†	[0.089, 4.183]	9.521*†	[8.376, 10.333]	9.244*†	[8.564, 10.418]	-3.493
	Initial productivity	1.656**†	[0.089, 4.183]	10.471*†	[9.475, 11.115]	10.720*†	[9.621, 11.144]	-3.493
	Distance	1.656**†	[0.089, 4.183]	8.798*†	[8.719, 9.246]	8.798*†	[8.714, 9.246]	-3.498
	Control of corruption	1.656**†	[0.089, 4.183]	3.083*†	[2.000, 5.042]	3.083*†	[2.375, 5.417]	-3.492
	Democracy	1.656**†	[0.089, 4.183]	5.000*†	[3.667, 5.917]	5.000*†	[4.000, 5.917]	-3.490
	Initial prices	1.656**†	[0.089, 4.183]	-0.027**†	[-0.340, 1.287]	3.672***†	[2.050, 5.316]	-3.488
Initial income	Initial income	9.521*†	[8.457, 10.380]	8.973*†	[8.077, 9.108]	10.065*†	[9.877, 10.527]	-3.495
	Initial productivity	9.521*†	[8.457, 10.380]	9.669*†	[9.018, 10.103]	10.892*†	[10.815, 11.210]	-3.497
	Distance	9.521*†	[8.457, 10.380]	9.169*†	[9.058, 9.246]	8.789*†	[8.712, 8.973]	-3.498
	Control of corruption	9.521*†	[8.457, 10.380]	2.000*†	[2.000, 3.833]	4.792*†	[3.792, 5.917]	-3.495
	Democracy	9.521*†	[8.457, 10.380]	4.333*†	[3.000, 4.917]	5.000*†	[5.000, 5.917]	-3.498
	Initial prices	9.521*†	[8.457, 10.380]	-0.047**†	[-0.194, 3.949]	2.220**†	[0.344, 4.368]	-3.496
Initial productivity	Initial income	10.471*†	[9.545, 11.131]	8.973*†	[8.077, 9.122]	10.065*†	[9.879, 10.527]	-3.494
	Initial productivity	10.471*†	[9.545, 11.131]	10.095*†	[9.018, 10.112]	10.892*†	[10.823, 11.210]	-3.496
	Distance	10.471*†	[9.545, 11.131]	9.169*†	[9.058, 9.246]	8.789*†	[8.712, 8.959]	-3.499
	Control of corruption	10.471*†	[9.545, 11.131]	2.000*†	[2.000, 3.833]	4.833*†	[4.000, 5.917]	-3.496
	Democracy	10.471*†	[9.545, 11.131]	4.333*†	[3.000, 5.000]	5.000*†	[5.000, 5.917]	-3.499
	Initial prices	10.471*†	[9.545, 11.131]	-0.067**†	[-0.190, 3.949]	2.222**†	[0.342, 4.364]	-3.497
Control of corruption	Initial income	3.083*†	[2.000, 5.417]	8.597*†	[8.055, 9.425]	10.005*†	[9.544, 10.517]	-3.496
	Initial productivity	3.083*†	[2.000, 5.417]	9.901*†	[9.009, 10.285]	10.893*†	[10.536, 11.200]	-3.499
	Distance	3.083*†	[2.000, 5.417]	9.058*†	[8.798, 9.243]	8.798*†	[8.712, 9.243]	-3.500
	Control of corruption	3.083*†	[2.000, 5.417]	2.083*†	[2.000, 2.958]	4.917*†	[4.000, 5.917]	-3.492
	Democracy	3.083*†	[2.000, 5.417]	4.333*†	[3.000, 5.458]	5.000*†	[5.000, 5.917]	-3.502
	Initial prices	3.083*†	[2.000, 5.417]	1.767**†	[-0.134, 4.032]	1.223**†	[0.260, 4.288]	-3.493
Democracy	Initial income	5.000*†	[4.000, 5.917]	9.190*†	[8.142, 9.881]	9.686*†	[9.686, 10.527]	-3.496
	Initial productivity	5.000*†	[4.000, 5.917]	10.929*†	[9.177, 10.929]	10.793*†	[10.558, 11.206]	-3.494
	Distance	5.000*†	[4.000, 5.917]	9.064*†	[8.754, 9.249]	8.789*†	[8.712, 9.058]	-3.512
	Control of corruption	5.000*†	[4.000, 5.917]	3.083*†	[2.000, 3.833]	5.417*†	[3.500, 5.917]	-3.495
	Democracy	5.000*†	[4.000, 5.917]	3.250*†	[3.000, 4.917]	5.667	[5.667, 5.917]	-3.495
	Initial prices	5.000*†	[4.000, 5.917]	-0.036**†	[-0.134, 4.008]	2.220**†	[0.301, 4.346]	-3.494

Notes: This table presents threshold estimates at the good level of analysis. In the first six columns, we report the corresponding threshold estimate and its 95% confidence interval for the first and second level of sample splitting respectively. The last column reports the Akaike information criterion (AIC). Each row presents one model with two specific threshold variables. All models estimate equation (9) with the following vector of regressors $x_{ijt} = (d'_i, d'_j, d'_t, p_{ijt-1})'$, where d_i, d_j and d_t are country, good and time dummies, and p_{ijt-1} is initial price level. *, **, ***, refer to the significance level of 1%, 5%, and 10%, respectively, at which the null of linearity is rejected. † - reject the null of a unit root at the 1% significance level based on the threshold autoregressive unit root test introduced by Caner and Hansen (2001) and extended for the panel-data model by Beyaert and Camacho (2008). Results for both tests are calculated using standard heteroskedasticity and autocorrelation corrected estimators.

Table 6: Club Convergence: Evidence from Threshold Regressions

Model	Threshold Variable		β-coefficients				Speed of convergence				AIC
	Level 1 (q_1)	Level 2 (q_2)	low q_1		high q_1		low q_1		high q_1		
			low q_2	high q_2	low q_2	high q_2	low q_2	high q_2	low q_2	high q_2	
1	Democracy	Distance	-0.139*†	-0.081††	-0.066	-0.067	0.150	0.085	0.068	0.069	-3.512
2	Distance	Initial productivity	-0.146*†	-0.065	-0.083	-0.070	0.158	0.067	0.087	0.072	-3.503
3	Distance	Initial income	-0.140*†	-0.063	-0.087*	-0.067	0.151	0.065	0.090	0.070	-3.502
4	Control of corruption	Democracy	-0.098*†	-0.057†	-0.146*	-0.070	0.103	0.059	0.158	0.072	-3.502
5	Control of corruption	Distance	-0.079††	-0.080† † †	-0.092	-0.089	0.082	0.084	0.097	0.093	-3.500
6	Distance	Distance	-0.068*	-0.116†	-0.084***	-0.070	0.071	0.123	0.088	0.072	-3.500
7	Control of corruption	Initial productivity	-0.078*†	-0.083†	-0.138*	-0.060	0.081	0.086	0.149	0.062	-3.499
8	Initial productivity	Democracy	-0.110*†	-0.080†	-0.071	-0.069	0.117	0.083	0.073	0.071	-3.499
9	Initial income	Democracy	-0.111*†	-0.077†	-0.066	-0.070	0.118	0.080	0.068	0.073	-3.498
10	Distance	Initial prices	-0.138*†	-0.069††	-0.097*	-0.062	0.149	0.071	0.102	0.063	-3.498
11	Initial productivity	Initial prices	-0.153*†	-0.082†	-0.088*	-0.049	0.166	0.085	0.092	0.050	-3.497
12	Initial income	Initial productivity	-0.084*†	-0.113†	-0.102*	-0.058	0.088	0.120	0.108	0.060	-3.497
13	Initial income	Initial prices	-0.153*†	-0.081†	-0.088*	-0.050	0.166	0.084	0.092	0.051	-3.496
14	Control of corruption	Initial income	-0.084†	-0.075†	-0.134*	-0.056	0.087	0.078	0.144	0.058	-3.496
15	Initial productivity	Initial productivity	-0.098	-0.087†	-0.102*	-0.058	0.104	0.091	0.108	0.060	-3.496
16	Initial income	Initial income	-0.103*	-0.072	-0.093*	-0.054	0.109	0.075	0.097	0.055	-3.495
17	Democracy	Democracy	-0.129*†	-0.085†	-0.067		0.138	0.089	0.069		-3.495
18	Democracy	Initial prices	-0.154*†	-0.084†	-0.086*	-0.049	0.167	0.087	0.089	0.050	-3.494
19	Control of corruption	Initial prices	-0.093*†	-0.064	-0.136*	-0.067	0.097	0.066	0.146	0.069	-3.493
20	Control of corruption	Control of corruption	-0.064*††	-0.090† † †	-0.090	-0.092	0.066	0.094	0.095	0.097	-3.492
21	Initial prices	Initial prices	-0.144*†	-0.087†	-0.067	-0.063	0.155	0.091	0.070	0.065	-3.488

Notes: This table presents coefficient estimates for the initial price level in the threshold regression models using threshold variables q_1 and q_2 at the first and second levels of sample splitting, respectively. All the coefficients are estimated to be significant at the 1% level. *, **, *** - reject the null that the coefficient for the low q_2 equals the respective high q_2 coefficient within the same q_1 regime at the 1%, 5%, and 10% level of significance, respectively. †, ††, † † †- reject the null that coefficient for the low q_1 equals the respective coefficient for high q_1 at the 1%, 5%, and 10% level of significance, respectively. Each row presents one model with two specific threshold variables. All models estimate equation (9) with the following vector of regressors $x_{ijt} = (d_i', d_j', d_t', p_{ijt-1})'$, where d_i, d_j and d_t are country, good and time dummies, and p_{ijt-1} is initial price level. The first four columns present beta coefficients for the four regimes, followed by the respective speed of convergence for the four regimes in the next four columns, and the AIC value for each model in the last column. The models are ordered by AIC.

Table 7: Club Convergence: Evidence from Threshold Regressions (Restricted Sample of Countries)

Model	**Threshold Variable**		**β-coefficients**				**Speed of convergence**				**AIC**
	Level 1 (q_1)	**Level 2 (q_2)**	**low q_1**		**high q_1**		**low q_1**		**high q_1**		
			low q_2	**high q_2**	**low q_2**	**high q_2**	**low q_2**	**high q_2**	**low q_2**	**high q_2**	
1	Labor cost	Democracy	-0.130*†	-0.087†	-0.057		0.139	0.091	0.059		-3.516
2	Distance	Labor cost	-0.133*†	-0.062	-0.088	-0.080	0.143	0.064	0.092	0.083	-3.509
3	Initial income	Labor cost	-0.099*	-0.142†	-0.101*	-0.056	0.104	0.153	0.106	0.057	-3.508
4	Initial productivity	Labor cost	-0.097*	-0.142†	-0.102*	-0.056	0.102	0.153	0.108	0.057	-3.507
5	Control of corruption	Labor cost	-0.092†	-0.084†	-0.126*	-0.060	0.097	0.088	0.135	0.062	-3.501
6	Labor cost	Labor cost	-0.097***†	-0.115†	-0.065	-0.056	0.102	0.122	0.067	0.057	-3.500
7	Initial prices	Labor cost	-0.127**†	-0.099†	-0.081*	-0.044	0.136	0.104	0.085	0.045	-3.496

Notes: This table presents coefficient estimates for the initial price level in the threshold regression models using threshold variables q_1 and q_2 at the first and second levels of sample splitting, respectively. The models are estimated on the restricted sample of 31 countries for which we have data on labor cost. All the coefficients are estimated to be significant at the 1% level. *, **, *** - reject the null that the coefficient for the low q_2 equals the respective high q_2 coefficient within the same q_1 regime at the 1%, 5%, and 10% level of significance, respectively. † - reject the null that coefficient for the low q_1 equals the respective coefficient for high q_1 at the 1% level of significance. All models estimate equation (9) with the following vector of regressors $x_{ijt} = (d_i', d_j', d_t', p_{ijt-1})'$, where d_i, d_j and d_t are country, good and time dummies, and p_{ijt-1} is initial price level. Each row presents one model with two specific threshold variables. The first four columns present beta coefficients for the four regimes, followed by the respective speed of convergence for the four regimes in the next four columns, and the AIC value for each model in the last column. The models are ordered by AIC.

Table 8: Club Convergence: Evidence from Augmented Threshold Regressions

Model	Threshold Variable		β-coefficients				Speed of convergence				AIC
	Level 1 (q_1)	Level 2 (q_2)	low q_1		high q_1		low q_1		high q_1		
			low q_2	high q_2	low q_2	high q_2	low q_2	high q_2	low q_2	high q_2	
1	Democracy	Distance	-0.138*†	-0.081† † †	-0.066	-0.067	0.149	0.085	0.068	0.070	-3.513
2	Distance	Initial income	-0.143*†	-0.063	-0.085*	-0.072	0.154	0.065	0.088	0.075	-3.508
3	Distance	Initial productivity	-0.143*†	-0.065	-0.083	-0.070	0.154	0.068	0.087	0.073	-3.504
4	Control of corruption	Democracy	-0.097*†	-0.057†	-0.129*	-0.072	0.102	0.058	0.138	0.075	-3.503
5	Control of corruption	Distance	-0.077†	-0.080††	-0.092	-0.091	0.080	0.083	0.096	0.095	-3.502
6	Distance	Distance	-0.069*	-0.114†	-0.085***	-0.070	0.071	0.121	0.089	0.072	-3.502
7	Initial productivity	Democracy	-0.109*†	-0.080	-0.071	-0.069	0.115	0.083	0.073	0.071	-3.501
8	Control of corruption	Initial productivity	-0.077*†	-0.081†	-0.138*	-0.060	0.080	0.084	0.149	0.062	-3.501
9	Initial income	Democracy	-0.110*†	-0.077	-0.066	-0.070	0.117	0.080	0.068	0.073	-3.500
10	Distance	Initial prices	-0.127*†	-0.068††	-0.097*	-0.062	0.136	0.070	0.102	0.064	-3.499
11	Initial productivity	Initial prices	-0.151*†	-0.082†	-0.089*	-0.050	0.164	0.085	0.093	0.051	-3.498
12	Control of corruption	Initial income	-0.083†	-0.075††	-0.133*	-0.057	0.087	0.078	0.143	0.058	-3.498
13	Initial income	Initial prices	-0.151*†	-0.081†	-0.088*	-0.050	0.164	0.084	0.092	0.051	-3.498
14	Initial productivity	Initial productivity	-0.098	-0.087†	-0.102*	-0.0586	0.103	0.091	0.108	0.060	-3.497
15	Initial income	Initial income	-0.102*	-0.074††	-0.093*	-0.054	0.108	0.077	0.098	0.056	-3.496
16	Initial income	Initial productivity	-0.098† † †	-0.086†	-0.102*	-0.059	0.103	0.089	0.108	0.060	-3.496
17	Democracy	Democracy	-0.109*†	-0.082	-0.067		0.115	0.086	0.069		-3.496
18	Democracy	Initial prices	-0.152*†	-0.083†	-0.086*	-0.048	0.165	0.087	0.090	0.050	-3.495
19	Control of corruption	Control of corruption	-0.064*†	-0.089††	-0.091	-0.092	0.066	0.094	0.095	0.097	-3.494
20	Control of corruption	Initial prices	-0.092*†	-0.063	-0.136*	-0.067	0.096	0.065	0.146	0.070	-3.494
21	Initial prices	Initial prices	-0.143*†	-0.085†	-0.066	-0.060	0.154	0.089	0.068	0.062	-3.489

Notes: This table presents coefficient estimates for the initial price level in the threshold regression models using threshold variables q_1 and q_2 at the first and second levels of sample splitting, respectively. All the coefficient are estimated to be significant at the 1% level. *, **, *** - reject the null that the coefficient for the low q_2 equals the respective high q_2 coefficient within the same q_1 regime at the 1%, 5%, and 10% level of significance, respectively. †, ††, † † †- reject the null that coefficient for the low q_1 equals the respective coefficient for high q_1 at the 1%, 5%, and 10% level of significance, respectively. Each row presents one model with two specific threshold variables. All models estimate equation (9) with the following vector of regressors $x_{ijt} = (d_i', d_j', d_t', p_{ijt-1}, z_{it}')'$, where d_i, d_j and d_t are country, good and time dummies, p_{ijt-1} is initial price level, and z_{it} is a vector of observable factors that belongs to q_{sit} such as initial income, control of corruption and democracy. Initial productivity was excluded from the vector z_{it} due to the problem of multicollinearity with initial income. Distance is out of the model as well, since it has no time series variation thus could not be included in the model with fixed country effects. The first four columns present β coefficients for the four regimes, followed by the respective speed of convergence for the four regimes in the next four columns, and the AIC value for each model in the last column. The models are ordered by AIC.