Empirics on global stock market integration: A valuation perspective

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Abstract

The objective of this paper is to study the extent of integration among developed and emerging stock markets in the onset of globalization. It examines market integration that manifests in the convergence of stock valuation ratios of different markets in the long run within a conceptual framework where valuation ratios reflect common global growth opportunities of stocks across markets. The spectrum of transition dynamics of earnings-price, dividend-price and book-price ratios among markets is explored with different notions of convergence, at both the total market and disaggregated industrial sector levels, in three overlapping time periods. Overall test results reveal the time-varying nature of the global stock market integration process. Developed and emerging markets have achieved different degrees of integration, and that integration at the total market level comes with different degrees of integration at the industry level, as evidenced by the asymmetric conclusions drawn from the valuation ratios employed.

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1 Introduction

As the world is undergoing the rapid process of globalization, international trade in goods and financial assets has expanded rapidly. The financial markets are characterized by strong evolutions, with liberalization of financial transactions, removal of restrictions on cross-border capital flows, development of new financial products, as well as harmonization of practices, policies, regulations and corporate governance rules. A key question then arises is whether global stock markets have become more integrated (Beine et al., 2010; Kim et al., 2005). This issue has become a core subject of econometric concern due to some significant implications. Market integration promotes international risk diversification, enhances efficient allocation of capital, lowers the cost of capital, stimulates investment flows, and thus spurs real economic growth (Arouri et al., 2010; Baele et al., 2004; Bekaert et al., 2005). More integrated markets, by virtue of broadening the investor base, also improves the accuracy of public information and reduces volatility (Umutlu et al., 2010). However, a greater extent of market integration leads to more similar risk-return characteristics across markets (Eun and Lee, 2010a), and erodes gains from international portfolio diversification for financial risk reduction. Moreover, intensified linkages in extreme market realizations harbor cross-border contagion and threaten global financial stability (Morana and Beltratti, 2008). International propagation of shocks via stock markets also has a bearing on the design of monetary policy by policy makers (Berben and Jansen, 2005).

There is an extensive literature on the study of stock market integration. Some of these studies focus on markets in accordance with their levels of stock market development, viz., developed (Berben and Jansen, 2005; Rua and Nunes, 2009), and emerging (De Jong and De Roon, 2005; Umutlu et al., 2010) markets. Some others address integration on a regional basis, for instance, Asia (Henry et al., 2007; Yu et al., 2010), Euro-zone (Moerman, 2008; Mylonidis and Kollias, 2010), Latin America (Chen et al., 2002; Hunter, 2006), NAFTA (Aggarwala and Kyawb, 2005; Darrat and Zhong, 2005), and OECD (Apergis, et al. 2011) markets. Narayan et al. (2011) have the most extensive coverage of these homogeneous panels of markets with similar characteristics based on the levels of development and geographical locations. Besides, there are also works on integration across these types of panels, for instance, between developed and emerging markets (Ali et al., 2011; Chitteti, 2010), between Asia and OECD (Mallik, 2006) markets, and between NAFTA and Latin America markets (Johnson and Soenen, 2003). To the best of our knowledge, only a few exceptions, such as Bekaert et al. (2007, 2011) and Pukthuanthong and Roll (2009), are devoted to the study of market integration across the board of global developed and emerging markets. In fact, contemporary empirical interest on the linkages between developed and emerging stock markets has its practical grounding (Arouri et al., 2010). With the onset of market liberalization activities since the 1980s, emerging markets have been attracting considerable capital inflows due to high expected returns and opportunities

for investment diversification. However, this has also contributed to a substantial increase in their financial vulnerability due to external shocks, as in the recent global financial crisis.

This paper purports to contribute to the scanty literature on global stock market integration by examining the extent of integration among global markets, utilizing a rich panel of 51 markets that covers stocks making up 75 to 80% of total market capitalization spanning the long time period of 1973-2011. The achievement of our goal necessitates a working definition of market integration and an operational measure of it for empirical analysis. Although there is no formal definition, it is commonly held that markets are integrated when the law of one price and the no arbitrage condition hold (Baele et al., 2004; Chen and Knez, 1995). Accordingly, assets with the same return and risk characteristics should be priced identically across markets. The relationship between asset characteristics and the pricing of an asset can be formalized in a standard stock valuation model.

For our purpose, we set up a conceptual framework under which normalized valuation of a stock are reflective of its profitability and growth prospects, following Bekaert et al. (2007). In so doing, we deviate from the common use of price and return measures in the literature, as in Pukthuanthong and Roll (2009), to test for market integration. Instead, our analysis is based on valuation ratios, including the popular earnings-price (EP), dividend-price (DP) and book-price (BP) ratios. Realized returns, according to Bekaert and Harvey (2000) and Fama and Frech (2002), are susceptible to high volatility and thus may bias the analytic results. By contrast, valuation ratios, which contain fundamentals (dividends, earnings, book values), are forward looking measures of expected returns, less volatile, and give more precise estimates. It is not until recently that valuation ratios have gained favor as measures in studying stock market integration. EP is employed by Bekaert et al. (2007, 2011) and Eun and Lee (2010b), DP is used in De Jong and De Roon (2005), EP and DY are considered in Carrieri et al. (2004), whereas EP and BP are adopted by Land and Lang (2002) and King and Segal (2008). We take one step further and consider all three ratios in our analysis for at least three reasons. First, due to market-specific characteristics, one ratio may excel the other as the valuation apparatus. For example, while EP is important for valuation in the US market, book value appears to be a better measure for Japan (Bildersee et al., 1990). Second, empirical works suggest that a better indicator of intrinsic fundamentals of stocks is a combination of the individual ratios. More specifically, Cheng and McNamara (2000) propose the combined EP-BP valuation method, whereas Jiang and Lee (2007) develop the DP-BP model. Third, it is well-known that valuation ratios tend to differ across industrial sectors. Using valuation ratios therefore facilitate our analysis of market integration at the industry level as discussed below.

Under our valuation approach, valuation ratios are indicators of fundamentals such as expected return and growth opportunities of stocks. With full market integration, these fundamentals would be equalized across markets, that is, different markets will converge in the long run to the same steady state balanced growth path for stock valuation. This naturally suggests

the use of the convergence hypothesis that is commonly employed by macroeconomists to study cross-economy growth patterns in the present context. Thus, unlike the studies of Apergis, et al. (2011), Baele et al. (2004) and Narayan et al. (2011) which have also employed varying notions of the convergence methodology to study market integration, we provide a more formal theoretical foundation for its empirical applicability. As pointed out by Bruno et al. (2012), there is a lack of a theory of financial system convergence in the literature, so that existing empirical studies are susceptible to the risk of doing measurement without theory. Our conceptual framework for the study of stock market integration bridges empirics and theory for stock market convergence.

We also contribute by analyzing integration at the industrial sector level on top of the aggregate market level. According to Carrieri et al. (2004), this is central for a comprehensive analysis of global market integration because integration (segmentation) at the total market level may come with different degrees of segmentation (integration) at the industry level. However, global integration at the dissaggragated level has not received much attention in the literature, aside from the works of Bekaert et al. (2011), Berben and Janson (2005), Carrieri et al. (2004) and Rua and Nunes (2009), for instance. The issue of industry integration is also related to the strand of literature that explores the importance of industrial structure for international portfolio diversification (Brooks and Del Negro, 2002; Griffin and Karolyi, 1998; Heston and Rouwenhorst, 1994; Roll, 1992).

The remainder of the paper is organized as follows. Section 2 constructs a formal conceptual framework that motivates the investigation of global stock market from the valuation perspective. Section 3 develops the technical link between the valuation approach to market integration and the convergence hypothesis in growth empirics. Section 4 describes the large panel data set employed in analysis, while Section 5 details the empirical results. Section 6 summarizes and concludes.

2 Stock market integration

The definition of stock market integration employed in this paper is based on two well-established theorems, the law of one price and the absence of arbitrage (Rubinstein, 1976; Ross, 1978; Harrison and Kreps, 1979). The law of one price states that two assets with identical payoffs (in every state of nature) should not be priced differently. If the law fails to hold, then there arises profit opportunity from buying the cheaper asset and selling the more expensive one. In other words, a stochastic discount factor exists that prices all payoffs. But profit opportunity is still possible in the presence of zero or negatively priced assets which always yield nonnegative payoffs and positive payoffs with positive probability. Thus, the absence of arbitrage requires that the discount factor be strictly positive, to rule out nonpositive prices in practice. In the general international context, integrated stock markets should assign the same positive price to assets

in different markets which yield the same payoffs by the law of one price and in the absence of arbitrage opportunities (Chen and Knez, 1995). Consequently, markets are integrated if there exists a strictly positive discount factor, which summarizes the pricing structure of a market, that is common across different markets.

Whether stock markets are becoming more integrated in the above sense in the ongoing globalization process can be asessed by analyzing whether stock valuations across markets are converging to a more similar level over time, particularly at the industry level. In fact, economic theory suggests that firms in the same industry should have similar intrinsic valuation fundamentals. This is because they typically employ industry-specific production technology and operating policies and face similar market conditions, so that they are open to similar growth opportuntities. Competition within the industry should eventually drive equalization of levels of risk and rates of return across firms. On the empirical front, Fabozzi and Francis (1979) find that different levels of risk associated with different investments can be attributed partly by the difference in levels of average risk of industries. Also, Nerlove (1968) shows that firms in the same industry typically experience similar industry-specific average rates of return. More recently, Bekaert et al. (2007) formalize this line of reasoning in the context of stock market integration by incorporating stochastic growth opportunities and discount rates in a standard stock valuation model.

Consider a stock which belongs to a certain industry of market i. The discount factor, $\exp(\rho_{i,t})$, relates the stock's current price, $P_{i,t}$, with its price and dividend payoffs in the next period, $P_{i,t+1}$ and $DV_{i,t+1}$ respectively, as follows:

$$P_{i,t} = E_t \left[\exp(-\rho_{i,t})(P_{i,t+1} + DV_{i,t+1}) \right], \tag{1}$$

where E_t is the expectation given information at time t. Time-varying log-discount rates and continuously compounded expected returns are assumed. Iterating this forward to infinity and assuming that the transversality condition, $E_t \left(\prod_{k=0}^{\tau-1} \exp(-\rho_{i,k}) DV_{i,\tau} \right) \to 0$ as $\tau \to \infty$, holds, the current price of the stock equals the present value of all future dividends, that is:

$$P_{i,t} = E_t \left[\sum_{s=1}^{\infty} \left(\prod_{k=0}^{s-1} \exp(-\rho_{i,t+k}) \right) DV_{i,t+s} \right]. \tag{2}$$

Equation (2) is the most fundamental stock valuation model, dividend discount model, which gives the intrinsic value of a stock in level form. This can be normalized by dividend to obtain the price-dividend valuation ratio, popularized by Campbell and Shiller (1988):

$$PD_{i,t} = \frac{P_{i,t}}{DV_{i,t}} = E_t \left[\sum_{s=1}^{\infty} \exp \left(\sum_{k=0}^{s-1} -\rho_{i,t+k} + \triangle dv_{i,t+1+k} \right) \right], \tag{3}$$

where $dv_{i,t}$ denotes $\log(DV_{i,t})$. The price-dividend ratio evolves according to the state variables

of discount rate and dividend growth rate. Equation (3) represents a measure of the normalized intrinsic value of the stock along the lines of Ang and Liu (1998), Lee et al. (1999), and Bakshi and Chen (2005). The use of valuation ratios in analysis provides the convenience of comparison over time for the same stock and across stocks that may be demoninated in different currencies (Bakshi and Chen, 2005; King and Segal, 2008).

Alternatively, equation (2) in level form of the intrinsic value can be normalized by earnings. For each time period, denote earnings by $EA_{i,t}$, the dividend payout ratio by $PO_{i,t}$ ($= DV_{i,t}/EA_{i,t}$), and their respective log forms by $ea_{i,t}$ and $po_{i,t}$. The following gives the widely used intrinsic valuation ratio, the price-earnings ratio, which depends on the discount rate, payout ratio, and earnings growth rate:

$$\begin{aligned} PE_{i,t} &= \frac{P_{i,t}}{EA_{i,t}} = E_t\Bigg[\sum_{s=1}^{\infty} \exp\left(\sum_{k=0}^{s-1} -\rho_{i,t+k} + \triangle po_{i,t+1+k} + \triangle ea_{i,t+1+k} \right) \\ &\quad \cdot PO_{i,t} \Bigg] , \end{aligned} \tag{4}$$

Equation (4) suggests that the price-earnings ratio is an indicator of future earnings growth.

To relate the intrinsic value of a stock to its book value, BV_t, define the return on equity as $R_{i,t} = EA_{i,t}/BV_{i,t-1}$. Then equation (4) can be written as:

$$\begin{aligned} PB_{i,t} &= \frac{P_{i,t}}{BV_{i,t}} = E_t\Bigg[\sum_{s=1}^{\infty} \exp\Bigg(\sum_{k=0}^{s-1} -\rho_{i,t+k} + \triangle po_{i,t+1+k} + \triangle r_{i,t+1+k} \\ &\quad + \triangle bv_{i,t+k} \Bigg) PO_{i,t} R_{i,t} \frac{BV_{i,t-1}}{BV_{i,t}} \Bigg] , \end{aligned} \tag{5}$$

with $r_{i,t}$ and $bv_{i,t}$ representing $\log(R_{i,t})$ and $\log(BV_{i,t})$ respectively. As thus, the price-book ratio is a function of the discount rate, payout ratio, return on equity, and the book value growth rate. It is also modeled as an indicator of future growth in book value.

Bekaert et al. (2007) assume that all earnings are paid out as dividends, that is, $PO_{i,t} = 1$, so that equation (4) collapses to equation (3), and price-earnings ratio is equivalent to price-dividend ratio. They maintain that earnings growths of an industry across integrated markets, $\triangle ea_{i,t}$, are driven similarly by the stochastic worldwide growth opportunity factor pertaining to that industry, $GO_{w,t}$, which is the sole component of the earnings growth processes that is persistent and priced (Rajan and Zingales, 1998; Fisman and Love, 2004). Furthermore, the discount rate factor for each of the integrated markets in the same industry, $\rho_{i,t}$, depends only on the stochastic world discount rate, $\rho_{w,t}$, and that these markets are exposed to common industry systematic risk. Against this background, the price-earnings ratio in equation (4) is derived as an infinite sum of exponentiated affine functions of the current realization of the

world growth opportunity and world discount rate:[1]

$$PE_{i,t} = \sum_{s=1}^{\infty} \exp\left(a_{i,s} + b_s \rho_{w,t} + c_s GO_{w,t}\right). \tag{6}$$

Linearlizing equation (6) around the mean values for the growth opportunity and discount rate results in:

$$pe_{i,t} = \overline{a}_i + \overline{b}\rho_{w,t} + \overline{c}GO_{w,t}, \tag{7}$$

where $pe_{i,t}$ denotes $\log(PE_{i,t})$. Thus, full market integration implies that the price-earnings ratios of the same industry for different markets should be similar, abeit a time-invariant market-specific component.

The connection between stock valuation and growth opportunties of a stock is also formulated in the present value of growth opportunities (PVGO) concept as discussed in standard investment textbooks such as Bodie et al. (2011). Specifically, the value of a stock can be thought of as the sum of the no-growth value of the stock and the present value of its future investment opportunities, PVGO, made possible through earnings plowback. But it can be noted that PVGO is positive and therefore enhances stock valuation only when planned investments yield an expected rate of return (measured by the return on equity) greater than the required rate of return (reflected in the discount factor). It is also argued that it is price-book ratio, not price-earnings ratio, that is an appropriate indicator of earnings growth of a stock since the former reflects future profitability (Penman, 1996). Thus, the valuation of a stock is closely tied to the payout ratio and return on equity, which are not accounted for directly in the simplified model of Bekaert et al. (2007). Moreover, price-book ratio can serve as an alternative measure of growth opportunities. These considerations motivate our investigation of stock market integration through the use of the trio of price-dividend, price-earnings and price-book ratios, which are popular valuation ratios employed to evaluate equity investments. It is expected that, as markets become more integrated and face similar growth opportunities and discount factor, arbitrage will drive valuation ratios across markets to converge to similar levels, particularly so within the same industry.

3 Convergence methodology

In the study of economic growth by macroeconomists, there is a vast literature on whether different economies converge towards each other in economic performance. We apply the convergence hypothesis established in growth empirics to the study of stock market integration

[1]Each of $GO_{w,t}$ and $\rho_{i,t}$ is assumed to follow an autoregressive process with normally distributed random shock. The detailed derivation is contained in Bekaert et al. (2007).

as described in the last section. The existence of convergence of stock valuation ratios across markets is taken as supportive evidence for market integration.

A basic notion of convergence is based on the concept of beta convergence. Under the paradigm of the neoclassical growth theory (Solow, 1956), physical capital stock is subject to diminishing marginal returns. Accordingly, developing economies with lower stocks of physical capital than developed economies commandeer a higher rate of return on their physical capital, ceterus paribus. Capital is then expected to flow to the developing economies. Moreover, developing economies learn with the diffusion of knowledge and technology from the developed economies. Consequently, developing economies will tend to grow faster than their developed counterparts initially, with catching up and thereby convergence in income level. The growth rates of developing economies then slow down, and the growth process eventually leads all economies to converge to a unique steady state balanced growth path characterized by the rate of growth of the technological progress in the long run (Islam, 1995). By the same token, in stock markets, the expected rates of return on investments tend to differ across markets, especially between developed and emerging markets. Furthernore, with the onset of the globalization process, there is rapid transfer of technology and harmonization of practices across markets as described in the introduction section. It is conceivable that under full market integration, a steady state of stock valuation exists (particularly at the industry level), which is influenced by growth rates of stock valuation fundamentals such as long-term growth and expected return. Coincidentally, the steady state concept of stock valuation ratios is also a central apparatus in the study of Lettau and Van Nieuwerburgh (2007) on stock return predictability.

To test whether this type of convergence holds for a set of N markets (economies) indexed by i over a time period T indexed by t, a cross-sectional regression of valuation ratio growth rate over this time period on the initial valuation ratio level can be employed (Barro and Salai-i-Martin, 1990, 1992):

$$\frac{1}{T-1}\left(y_{i,T}-y_{i,1}\right)=\alpha+\beta y_{i,1}+u_i,\ i=1,...,N, \tag{8}$$

where $y_{i,t}$ denotes the log of per share valuation ratio level of market i at time t, $t = 1$, ..., T, with u_i being the random error. The constant term α depends on the rate of growth of stock valuation fundamentals and the steady state valuation ratio level. A negative coefficient associated with the initial valuation level, β, is taken to indicate convergence in both valuation ratio level and growth rate. The null hypothesis of $\beta = 0$ against the alternative of $\beta < 0$ is tested based on the t-statistic on the estimated slope coefficient. However, according to Bernard and Durlauf (1996), a negative β in the above linear regression is consistent with multiple steady state models in which cross market (economy) growth behavior is typically nonlinear. Furthermore, Phillips and Sul (2007a) exemplify that this sort of regression falls short of accommodating the general case of heterogenous technological progress across markets

(economies).

Recently, Philips and Sul (2007b, 2009) develop a nonlinear dynamic factor model for income under both time series and cross-sectional heterogeneity of technological progress, and examine convergence while also modeling the heterogeneous transitional dynamics of economic growth across economies. They assume that there is a common trend component in income per capita in the panel of economies, f_t, such as knowledge and technology. This time varying common growth factor can be shared by individual economies to different extent in accordance with their individual characteristics, $b_{i,t}$, such that $y_{i,t} = b_{i,t} f_t$. In the stock valuation model discussed in the last section, valuation ratios possess multiple common growth factors such as long term growth and expected return under market integration. This time varying multiple common factor structure can be specified similarly as $y_{i,t} = \sum_{m=1}^{M} b_{m,i,t} f_{m,t} = \left(\sum_{m=1}^{M} b_{m,i,t} \frac{f_{m,t}}{f_{1,t}} \right) f_{1,t} = b_{i,t} f_t$. As such, $b_{i,t}$ is a measure of the deviation of individual market (economy) from the common trend factor that shape the transition path of the market to the common steady state growth path determined by f_t if $\lim_{t\to\infty} \frac{y_{i,t}}{y_{j,t}} = 1$ for all $i \neq j$, or equivalently $\lim_{t\to\infty} b_{i,t} = b$ for all i. The growth dynamics experience is heterogeneous among markets. The relative transition parameter at time t, $h_{i,t}$, can then be constructed as:

$$h_{i,t} = \frac{y_{i,t}}{\frac{1}{N}\sum_{i=1}^{N} y_{i,t}} = \frac{b_{i,t}}{\frac{1}{N}\sum_{i=1}^{N} b_{i,t}}, \tag{9}$$

which measures the transition element $b_{i,t}$ for market i relative to the panel average at time t. The evolution of the relative transition parameter over time traces out the trajectory of each market relative to the average, and measures the relative divergence of the market from the common steady state growth path. When there is growth convergence among the markets in the long run despite transitory heterogeneous relative transitions, $\lim_{t\to\infty} h_{i,t} = 1$ for all i. If $b_{i,t}$ converges faster than the divergence rate of f_t, level convergence is further implied.

To test for the null hypothesis of convergence for all i against the alternative of non-convergence for some i, the following time series regression is estimated:

$$\log\left(\frac{H_1}{H_t}\right) - 2\log(\log t) = a + b\log t + \epsilon_t,\ t = T_0, ..., T, \tag{10}$$

where $H_t = (1/N)\sum_{i=1}^{N} (h_{i,t} - 1)^2$ and $T_0 = [\kappa T]$ for some $\kappa > 0$, so that the first $\kappa\%$ of the time series data is discarded before carrying out regression. Under the null of growth convergence, $b \geqslant 0$, whereas $b < 0$ under the alternative. In the case of level convergence, the null and alternative hypotheses are changed to $b \geqslant 2$ and $b < 2$ respectively. The null hyothesis, whether growth or level convergence, is based on the t-statistic on the slope coefficient. This is called the log t test due to the log t regressor. Thus, growth convergence does not necessarily imply level convergence with the log t test. This corroborates the modeling under equation (7) that intrinsic valuation ratios across markets are driven by similar global growth factors but may differ by a time-invariant market-specific component.

Under the log t convergence framework, the transition and convergence experience can vary substantially from stock market to stock market. This is especially the case when many shocks, such as wars and financial crises, affect markets differentially. These shocks tend to temporarily raise the cross-sectional variance of stock valuation across markets. The notion of sigma convergence manifests in a narrowing of the cross-sectional dispersion over time (see, for instance, Baumol, 1986; Dowrick and Nguyen, 1989; Lichtenberg, 1994). This can be tested based on the likelihood ratio test of Carree and Klomp (1997), which is constructed according to:

$$\chi = (N - 2.5) \log \left[1 + \frac{1}{4} \frac{\left(\widehat{\sigma}_1^2 - \widehat{\sigma}_T^2 \right)}{\widehat{\sigma}_1^2 \widehat{\sigma}_T^2 - \widehat{\sigma}_{1T}^2} \right], \tag{11}$$

where $\widehat{\sigma}_t^2 = (1/N) \sum_{i=1}^{N} (y_{i,t} - \overline{y}_t)^2$. This is the estimated cross-sectional variance, with $\overline{y}_t = (1/N) \sum_{i=1}^{N} y_{i,t}$ being the sample mean, and $\widehat{\sigma}_{1T}^2 = (1/N) \sum_{i=1}^{N} (y_{i,1} - \overline{y}_1)(y_{i,T} - \overline{y}_T)$ being the covariance of stock valuation between the first and last period. This test statistic has a chi-square distribution with 1 degree of freedom under the null hypothesis of no convergence.

4 Data description

We collect EP, DP, and BP ratios from DataStream's Global Equity Indices for a sample of 51 markets.[2] For each market, DataStream covers a representative sample of stocks making up a minimum of 75 to 80% of total market capitalization. We refer to four leading market indices, namely Dow Jones Total Stock Market Index, FTSE Global Equity Index, MSCI, and S&P Global Broad Market Index, to classify markets as either developed or emerging in our sample. Within each market, stocks are allocated to 10 industrial sectors, which include basic materials, consumer goods, consumer services, financials, healthcare, industrials, oil and gas, technology, telecommunications, and utilities, based on the Industry Classification Benchmark jointly created by Dow Jones and FTSE. This level of disaggregation shows the major differences among industries and avoids excessive details blurring the overall picture of our analysis, especially when finer industrial breakdown reduces the number of stocks for many emerging markets substantially. Such broad industrial classification is also adopted in the literature to investigate the industry factor (Berben and Jansen, 2005; Moerman, 2008; Rua and Nunes, 2009). The sample spans the period January 1973 through July 2011. Monthly observations are being used which minimizes the influence of daily or weekly price fluctuations when compared with book values

[2] After examining several data sources, we find the data from the Global Equity Indices of DataStream best serve our purpose. The database covers data for more than 50 markets. Data on certain markets are dropped in analysis for reasons of short time span, missing observations, and non-positive values. We consider EP, DP, and BP in empirical study for the convenience that they are expressed in percentage terms. Since our analysis is based on their log transformation, results remain intact regardless of whether P is in the numerator or denominator of valuation ratios (Musumeci and Peterson, 2011).

in terms of ratios. The monthly data are end-of-month figures. Only time series with data available from 2000 or before are included in our dataset as we are concerned with cross-market phenomenon from a long run perspective. In addition, time series with non-positive values are dropped, which follows from the notion of stock market integration that we define in Section 2. This is also required mathematically as the log of valuation ratios are used in the convergence methodology outlined in Section 3. The same treatment can be found in the works of Basu (1977), Fama and French (1995); Goodman and Peavy (1983); Land and Lang (2002), and Leong et al. (2009). [3]

With respect to EP and DP, data for the entire sample period are available for certain developed markets and the South African emerging market. As for BP data, the earliest availability can be dated back to 1980. It is not until the late 1980s that data for other developed markets and a few more emerging markets become available. Starting from the late 1990s, data began to appear for a large proportion of emerging markets. Subject to such data limitation, we consider three time periods with different starting dates but the same ending date of July 2011 in analysis. The first time period (Period I) begins from January 1973 (for EP and DP) and January 1980 (for BP). The second and third time periods (Periods II and III respectively) commence from January 1990 and January 2000 respectively. As such, stock market integration can be studied among the same set of markets over time, instead of among a changing set of markets as they appear, which may bias the results. This is similar in essence to Pukthuanthong and Roll (2009), who categorize markets into cohorts according to the starting date of data availability. This time distinction is also consistent with the fact that the process of capital market liberalization can be traced backed to the mid-1970s for the developed markets following the collapse of the Bretton Woods system (Eun and Lee 2010a), whereas the removal of capital controls for emerging markets mostly took place in the late 1980s and early 1990s (Bekaert and Harvey, 2000).

To abstract from the voluminous description, we provide in Table 1 a snapshot of the data by presenting the average of the means and standard deviations of the valuation ratios across market groups (all markets and the subgroups of developed and emerging markets) for the total market and by industrial sectors over the three time periods under consideration.[4] A listing of markets in our data set for EP, DP, and BP can be found in Tables A1, A2 and A3 respectively in the Appendix. The tables also include information on market classicification and data availability in each time period.

Several patterns can be deduced from Table 1. First, the means of valuation ratios for certain industrial sectors are persistently higher than those of the total market across most or all market groups over time. These sectors include basic materials, consumer goods, and financials with respect to all three ratios, oil and gas regarding EP and DP, and utilities for

[3] In DataStream, negative earnings are treated as zero to compute the EP ratio.

[4] To test for the different notions of convergence among stock markets, we consider groups with data available for at least 3 markets.

DP and BP. Second, the sectoral volatility of ratios measured in terms of standard deviation is generally higher than the market volatility. Third, there is a tendency for the means and volatility of valuation ratios to be higher for emerging markets than for developed markets. This trend is exhibited in both Periods II and III with regards to EP and DP, and Period III as regards BP. Fourth, for all markets combined with respect to EP and DP, the lowest means and volatility generally appear in Period II. Since the three time periods are overlapping, this implies that EP and DP tend to be the lowest during 1990-2000 relative to 1973-1989 and 2000-2011. These observations provide support for our stock market integration investigation from the dimensions of industrial sector, market group, and time period.

5 Test results

5.1 Beta convergence

Figure 1 provides scatter plots and fitted regression lines of the average growth rates of the EP ratio and the logarithm of the initial EP ratio for different market groups in different time periods. Similarly, Figures 2 and 3 are for the DP and BP ratios respectively.[5] As shown in these figures, a clear negative relationship between the average growth rate of a ratio and its initial value is found. In other words, markets which start off to have high valuation ratios grows slower in their valuation ratios over time than markets with low initial valuation ratios. The estimated slope coefficients in equation (5) and their corresponding p-values for testing the null of no beta convergence are displayed in Table 2. The t-test statistics used in hypothesis testing are the heteroscedasticity-consistent ones. The test results provide overwhelming support for the notion of beta convergence with regards to the three valuation ratios for the total market across any market group over any time period.

Table 2 also contains the estimation and test results by industrial sectors. Similar to the total market scenario, there is strong evidence in support of beta convergence for four industries, namely basic materials, consumer goods, financials and industrials. There are one or two instances of non-convergence for the industrial sectors of consumer services, technology, telecommunications and utilities. For consumer services and utilities, non-rejection of the no beta convergence occurs with respect to BP, in Period II among emerging markets for the former sector, and in Period I among developed markets for the latter. For technology, non-rejection occurs in Period I with developed markets based on EP. There is no evidence against the null of no beta convergence for telecommunications with regards to DP in Period I among developed markets and in Period III among emerging markets. As for health care, there is evidence for divergence among emerging markets, using EP and DP in Period II, and EP in Period III. Turning to oil and gas, divergence is associated with BP among developed markets in Period I, and with both EP and DP across emerging markets in Period II.

[5] To conserve space, diagrams for different industrial sectors are available upon request

In conclusion, according to the notion of beta convergence, stock market integration is found for the total market, which is largely driven by the industrial sectors of basic materials, consumer goods, financials and industrials. Health care and oil and gas are the least integrated industrial sectors. For the rest of the industrial sectors in Periods II and III, there is some evidence of market segmentation among emerging markets on the one hand, but strong evidence in support of market integration among developed markets on the other. The effects of the former appear to be dominated by those of the latter, so that when all markets are considered as a whole, the phenomenon of market integration is found, following that among developed markets. Besides, evidence for market segregation is based on conclusions from the different stock valuation ratios across industries: all ratios for oil and gas, EP and DP for healthcare, EP for technology, DP for telecommunications, and BP for consumer services and utilities.

5.2 Log t convergence

Some graphical illustrations of the relative transition paths of the total market with respect to the EP, DP, and BP valuation ratios in Figures 4, 5, and 6 respectively. Consider Figure 4 for EP first. In Period I, the relative transition parameters of some markets appear to diverge in the 1970s and the early 1980s, especially for Japan. Thereafter, a narrowing in the distances of the transition paths from each other is generally observed, especially towards the end of the period. Such patterns are observed regardless of the inclusion or exclusion of South Africa. In Period II for the all-market group, the transition curves close in on each other over the entire period towards unity in general, except for Sri Lanka in 2000 and 2001 and Portugal towards the end of the period. Similar close in on pattern can also be observed for the developed-market group. The emerging markets show more varied patterns over time. Their transition paths are seen to first converge until the mid-1990s, then diverge and eventually begin to converge again in the 2000s. In Period III, the transition parameters display a completely different picture from that in the earlier periods. For all market groups, the curves first move towards unity in the first half of the time period and then turn-around to diverge from each other in the second half of the period.

We next turn to Figure 5 for DP. In Period I, there is a clear tendency of divergence for the transition curves, especially during the late 1980s and throughout the 1990s. The curves converge to more similar levels in the 2000s. For the all-market and developed-market groups in Period II, the transition curves remains persistently dispersed before 2000. A reduction in dispersion occurs thereafter, which is more evident for the latter market group with the removal of South Africa. As for the emerging-market group, there is a turnaround from the initial divergence of transition paths at around 1998. In Period III for all market groups, some large gaps exist for the transition paths in the early part of the period. These gaps narrow down so that the transition parameters come to more similar levels later on in the period.

Finally, we turn to BP in Figure 6. In Period I, the markets show prominent convergence

towards unity as early as the mid-1980s despite sharp divergence in values in the early few years. Period II for all market groups is also characterized by similar patterns observed for Period I. The only exception happens for Ireland, towards the end of the period, in which Ireland was suffering from chronic financial and debt crisis. Considering the all-market group in Period III, the markets exhibit large gaps in the values of their transition parameters both in the beginning and at the end of the time period. On the one hand, the sizeable beginning-of-period gaps for the all-market group can be attributed to those for the emerging markets, which show strong tendency of a narrowing of their gaps after the first year of widening gap. On the other, the divergence behavior of developed markets at the end of the period, despite initial small discrepancies in values of the transition parameters, contribute to the evident end-of-period gaps for the all-market group.

Overall, the graphical observation exercise suggests that for the total market, the transition parameters of markets are mostly dispersed in values away from unity towards the end of Period III. This observation is consistent with the formal statistical test results for growth and level convergence shown in Table 3, which also displays the estimated coefficients for the log t variable. Clearly, both the null of growth and level convergence are rejected at conventional significance levels in Period III based on EP for all market types and BP for the all-market and developed market groups.

Turning to the sectoral analysis, the industrial sector of consumer goods is the most supportive of the null of growth convergence, which is rejected only for the developed markets in Period I using BP. For the consumer services and technology industrial sectors, the growth convergence null is rejected only in Period III. Specifically, regarding the former, rejection is found for all market groups based on EP, for the all-market and emerging-market groups using DP, and for the developed-market group with BP. As regards the latter, there is no evidence for growth convergence for the developed markets based on EP, and for all market groups using BP.

For industrials, growth convergence is not supported in Periods I and III based on BP for the all-market and developed-market groups. With respect to the three industrial sectors of financials, oil and gas, and telecommunications, null rejections are found in Periods II and III only. For financials, only EP (for all market groups in Period III) and BP (for the all-market and developed-market groups in both periods) provide evidence against growth convergence. As for oil and gas, growth convergence is rejected based on DP for all market groups, using EP for the all-market and emerging-market groups, and with BP for the all-market and developed-market groups. As for telecommunications, rejections are found for the all-market and developed-market groups in both periods (BP), for the emerging-market group in Period III (EP and DP) and for the all-market group in Period III (EP).

There is evidence against growth convergence in all periods for the remaining three sectors, including basic materials, healthcare, and utilities. For basic materials using EP, the null is

not rejected only for the all-market group in Period I and the emerging-market group in Period II. With DP, there are rejections in Periods I and III for the developed-market group, and in Period II for the all-market group. Based on BP, there is rejection only in Period I for the developed-market group. For healthcare, growth convergence is not found in Period I for the developed markets (BP), in Period II for all markets (EP and BP) and developed markets (EP), as well as in Period III for all markets (EP and BP), developed markets (BP) and emerging markets (EP and DP). Finally, for utilities, growth convergence is not supported in Period I for developed markets (BP), in Period II for all markets and developed markets (EP and BP), and in Period III for all markets (EP), developed markets (EP and BP), and emerging markets (EP and DP).

Thus, according to the notion of growth convergence, stock market integration across all market types is supported for the total market in all time periods with the use of DP, and in Periods I and II irrespective of valuation ratio used. At the sectoral level, consumer goods is found to be the most integrated sector, especially beginning from the 1990s. The sector of industrials is also highly integrated in terms of EP and DP. Market integration is supported for financials and technology based on DP. In contrast, basic materials, healthcare, and utilities exhibit varying degrees of market segregation in different time periods by one or more valuation ratios. Of the remaining sectors, market integration is found for consumer services in Periods I and II, and for oil and gas in Period I only.

On the whole, based on the notion of growth convergence there is somewhat more evidence for market segmentation in the short time span of Period III, but the attribution of this phenomenon to developed or emerging markets varies from industry to industry. It can also be noted that overall, market integration is more supportive by DP relative to the other two valuation ratios. As for level convergence, it is generally barely supported across all market types and industrial sectors over any time period, except among the emerging markets in Period II. Furthermore, DP and BP tend to provide slightly more evidence for market integration than EP.

5.3 Sigma convergence

The cross-sectional standard deviations for the valuation ratios of EP, DP, and BP for the total market are plotted in Figure 7. The corresponding test statistics and p-values from formal statistical testing are presented in Table 4. Consider first the EP ratios. The figure shows marked sigma convergence in Period I for developed markets (with or without the inclusion of South Africa). The standard deviations appear to decline in three steps: from the highest range of values in 1973-1989 to the middle range in 1990-2004, and eventually to the lowest range in 2005-2011. When more emerging markets are considered in the shorter Period II, the standard deviations evolve in a similar fashion in that they diminish in size through two stages: from the higher level in 1990-2002 to the lower level from 2003. In Period III, however, the picture is

somewhat different. Both developed and emerging markets experience a sharp fall in value of standard deviations before 2004. Thereafter, while standard deviations remain at low levels for developed markets, there is a big upswing for emerging markets until 2010, which completely nullify the initial fall. The test results in Table 4 corroborate the graphical observations. The null of no sigma convergence is rejected in all scenarios except for emerging markets in Period III.

As for DP in Period I, the standard deviations first increase and then decrease, with the final level in 2011 still higher than the initial level in 1973. In Period II, the developed markets exhibit convergence until 2008 and slight divergence thereafter. As for the emerging markets, the initial convergence is completely offset by the later divergence starting from 2004. There is a clear picture of a drop in standard deviations for emerging markets in Period III, from the higher level in 2000-2003 to the lower level thereafter. However, developed markets first experience divergence, then convergence and divergence again, with the terminal standard deviation in 2011 not much lower than the starting value in 2000. Thus, the test results show that convergence is supported for developed markets in Period II and emerging markets in Period III. These market groups have dominating effects in their respective periods, so that all markets as a whole in these time periods are found to be converging.

Turning to BP, after lingering at a high level for the first half of Period I, the standard deviations begin to diminish in size in the second half of the period. However, this fall is not statistically significant enough to support sigma convergence in this period as shown in Table 4. Throughout Period II, there is an evident downward trend for the standard deviations across emerging markets, but not for developed markets. Thus, the null of no sigma convergence is not rejected for the latter. In Period III, developed markets exhibit a U-turn in their standard deviations, so that sigma convergence is not supported for them, as well as for all markets as a whole.

Table 4 also displays the test results for different industrial sectors. In terms of the sigma convergence, the sector of consumer goods is the most integrated. The null of no sigma convergence is not rejected only for developed markets in Period I using BP, and in Period II with DP and BP. Market integration is supported for basic materials based on EP, with rejection for the null of no sigma convergence for all time periods and all market types. Healthcare is the most segregated industrial sector. Sigma convergence is supported only for emerging markets in Period III with BP. Results also indicate that the oil and gas and technology sectors are highly segmented. For the former sector, null rejections happen only in Period II in two instances (all markets with BP and developed markets using DP, and in Period III in four instances (all markets with EP and DP, developed markets using BP, and emerging markets based on DP). For the latter sector, there is evidence for sigma convergence only in two scenarios (all markets in Period II with EP and Period III based on DP).

The rest of the five industrial sectors show varying degrees of market integration (segmen-

tation). For consumer services and industrials, there is strong support for market integration when EP is used for the former and EP and DP for the latter, especially in Periods I and III. There is only one instance of non-rejection of the null in Period II using EP (for both sectors) and DP (for industrials). As for utilities, there is evidence for market integration in Periods II and III based on DP. For financials, emerging markets are always found to be integrated, but not so for developed markets, especially in Period I. In the telecommunications sector, for markets together, market integration is found in Periods II and III based on EP and DP.

Overall, certain degree of market segmentation prevails in all time periods. Whether developed or emerging markets are more segregated depends on the sector under investigation. Also, market segmentation is generally more supportive when using BP.

6 Summary and conclusion

This paper adds to the scanty literature by investigating the crucial issue of stock market integration across the board of global developed and emerging markets amidst the ongoing globalization process. We formulate a conceptual framework under which stock valuation ratios reflect common growth opportunities of stocks across markets, and examine market integration that manifests in the convergence of the valuation ratios of different markets to a steady state balanced growth path in the long run. The spectrum of transition dynamics in the convergence processes of earnings-price, dividend-price, and book-price ratios among markets are explored in light of the notions of beta, log t, and sigma convergence. We not only study integration at the total market level, but also attend to the often neglected integration at the industrial level, by disaggregating the total market into the 10 industrial sectors of basic materials, consumer goods, consumer services, financials, health care, industrials, oil and gas, technology, telecommunications, and utilities. Our panel data spans the period January 1973 through July 2011. Market integration at both the aggregate and disaggregated levels for the global set of 51 developed and emerging markets is analyzed within the three overlapping time periods of Period I (1973/1980-2011), Period II (1990-2011), and Period III (2000-2011) in accordance with the commencement date of data availability for different markets.

Our convergence test results from Tables 2, 3, and 4 are summarized in Table 5. As a whole, there is strong evidence for beta convergence, while results for the log t convergence in the growth sense and sigma convergence are more mixed. Empirical support for the log t convergence in the level sense is found to be the weakest. Some interesting patterns can be deduced based on several dimensions considered in the analysis. At the aggregate level, market integration for all markets is the least supported in Period III, which is reasonable given that this is the shortest time span with the largest market pool. In Periods II and III, emerging markets are slightly more integrated with each other than are developed markets. This may be related to the lingering financial turmoil of some developed markets in recent years.

At the industrial level for all markets, the consumer services sector is the most integrated in Period I among developed markets (irrespective of the presence or absence of South Africa). In Period II, four industrial sectors, namely basic materials, consumer goods, consumer services and industrials, are found to be the most integrated. The consumer goods and industrials sector remain relatively highly integrated in Period III. In contrast, the health care and utilities sectors are found to be the most segregated in Periods I and II. In Period III, the health care sector persists to be the most segmented, followed by the financials sector. It is interesting to find that in Period II for emerging markets, all notions of convergence suggest unanimously the very high degree of integration within the consumer goods and financials sectors by any valuation ratio. However, results are less favorable for integration regarding the financials sector among developed markets. It is not surprising that some industrial sectors tend to be more integrated than others since industries across markets differ in terms of the degree of local regulation and the composition of non-tradable items. For instance, the consumer goods sector is largely unregulated across markets, and it is comprised mainly of internationally traded items. In sharp contrast, health care and utilities are highly regulated non-traded industrial sectors. The asymmetric extent of integration among developed and emerging markets may be attributed to the recent financial and debt problems originating from developed markets.

Besides, there are only a few occasions in which different valuation ratios give unanimous evidence for market integration regardless of the notion of convergence employed. Conclusion on integration with regards to the consumer goods sector is the most consistent across all valuation ratios, especially in Period III. Valuation ratios also give qualitative similar integration inference in Period II at the total market level among all markets, for the technology sector among developed markets, and for the financials sector among emerging markets, as well as in Period III the industrials sector among emerging markets. This may be attributed to the fact that different valuation ratios are driven by similar but not exactly the same valuation fundamentals. When valuation fundamentals converge at varying speeds due to the heterogeneous transition dynamics of different markets, evidence on integration is asymmetric across the board of valuation ratios.

Overall, the global stock market integration process is found to be time-varying in nature, as many emerging markets are still undergoing substantial development in their stock markets, and the transition paths of markets towards ultimate convergence are constantly perturbed by shocks arising from major global political, economic and financial events. Besides, integration at the total market level comes with different degrees of integration at the industry level. Certain industries, such as health care and utilities, are largely regulated and contain items that are largely non-tradable in nature, so that convergence of stock valuation fundamentals and therefore integration across markets are more difficult to be realized. In contrast, for industries such as the consumer goods sector that is highly unregulated and tradable, different valuation fundamentals across markets tend to converge in a more synchronized fashion due to more similar transition experience of the markets. On the whole, with the onset of the globalization

process, we provide evidence that global stock markets are becoming more integrated. However, markets are still far from ultimate full integration, as the integration process is characterized by heterogeneous transition dynamics across markets and industries.

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Table 1. Descriptive statistics of EP, DP, and BP ratios

	Period I			Period II			Period III		
	All	Dev	Emg	All	Dev	Emg	All	Dev	Emg
EP (mean)									
Total	0.075	0.074	—	0.066	0.065	0.069	0.084	0.075	0.095
Basic materials	0.081		—	0.075	0.072	0.088	0.104	0.076	0.143
Consumer goods	0.088		—	0.076	0.073	0.080	0.083	0.083	0.082
Consumer services	0.066		—	0.057	0.057	0.056	0.064	0.064	0.065
Financials	0.083		—	0.079	0.081	0.075	0.100	0.096	0.105
Healthcare	0.068	0.065	—	0.055	0.053	0.063	0.061	0.051	0.081
Industrials	0.077	0.073	—	0.064	0.063	0.065	0.079	0.076	0.084
Oil and gas	0.084	0.082	—	0.068	0.065	0.075	0.095	0.078	0.113
Technology	0.052		—	0.052	0.052	—	0.050	0.046	0.057
Telecommunications	—		—	0.060	0.058	—	0.068	0.069	0.065
Utilities	0.073		—	0.069	0.067	—	0.078	0.066	0.094
EP (sd)									
Total	0.028	0.027	—	0.022	0.021	0.026	0.046	0.034	0.061
Basic materials	0.038		—	0.037	0.031	0.055	0.086	0.035	0.158
Consumer goods	0.049		—	0.045	0.041	0.052	0.048	0.050	0.045
Consumer services	0.028		—	0.023	0.022	0.029	0.034	0.032	0.039
Financials	0.051		—	0.041	0.043	0.033	0.075	0.065	0.086
Healthcare	0.029	0.028	—	0.021	0.019	0.028	0.028	0.020	0.043
Industrials	0.038	0.035	—	0.029	0.029	0.030	0.040	0.038	0.044
Oil and gas	0.046	0.046	—	0.028	0.026	0.033	0.047	0.031	0.064
Technology	0.026		—	0.037	0.037	—	0.028	0.028	0.029
Telecommunications	—		—	0.029	0.025	—	0.037	0.041	0.033
Utilities	0.030		—	0.027	0.024	—	0.038	0.025	0.054
DP (mean)									
Total	3.141	3.086	—	2.722	2.696	2.779	3.122	2.961	3.304
Basic materials	3.179		—	2.936	2.718	3.534	3.392	2.875	4.044
Consumer goods	3.844		—	2.739	2.610	2.954	3.165	3.106	3.255
Consumer services	2.925		—	2.436	2.460	2.362	3.016	3.508	1.944
Financials	3.420	3.404	—	3.229	3.377	2.744	3.544	3.581	3.500
Healthe care	2.899	2.779	—	2.318	2.317	2.325	3.074	2.194	5.213
Industrials	3.004	2.958	—	2.509	2.411	2.817	2.888	2.754	3.111
Oil and gas	3.894	3.838	—	3.181	3.267	2.923	3.959	3.408	4.680
Technology	2.286		—	1.562		—	1.409	1.201	2.174
Telecommunications	3.111		—	3.088	2.914	—	3.753	3.939	3.232
Utilities	4.471		—	3.449	3.427	—	3.840	3.546	4.281
DP (sd)									
Total	1.201	1.161	—	1.090	0.886	1.535	1.309	1.210	1.421
Basic materials	1.346		—	1.704	1.230	3.008	1.837	1.265	2.560
Consumer goods	2.315		—	1.454	1.309	1.696	1.736	1.842	1.573
Consumer services	1.361		—	1.265	1.146	1.640	2.323	2.899	1.065
Financials	1.651	1.665	—	1.870	1.985	1.492	2.170	2.163	2.179
Healthcare	1.319	1.213	—	0.869	0.841	1.011	2.777	0.770	7.651
Industrials	1.376	1.345	—	1.309	1.036	2.166	1.589	1.161	2.301
Oil and gas	1.572	1.536	—	1.209	1.262	1.047	2.334	1.435	3.508
Technology	2.008		—	1.076		—	0.827	0.791	0.959
Telecommunications	1.664		—	2.075	1.614	—	1.974	1.762	2.568
Utilities	1.630		—	1.091	0.984	—	1.432	0.949	2.158

Table 1 *(continued)*

	Period I			Period II			Period III		
	All	Dev	Emg	All	Dev	Emg	All	Dev	Emg
BP (mean)									
Total	0.733	0.759	—	0.635	0.654	0.591	0.614	0.583	0.651
Basic materials	0.638	0.670	—	1.235	1.364	0.819	1.152	0.961	1.434
Consumer goods	0.581		—	0.823	0.895	0.607	0.634	0.616	0.655
Consumer services	0.471		—	0.523	0.529	0.525	0.593	0.527	0.703
Financials	0.998		—	0.829	0.872	0.639	0.775	0.811	0.731
Healthe care	0.460		—	0.441		—	0.562	0.587	0.513
Industrials	0.723	0.738	—	0.655	0.654	0.657	0.651	0.590	0.736
Oil and gas	0.652		—	0.611	0.597	0.579	0.688	0.627	0.757
Technology	—		—	0.499	0.506	—	0.469	0.402	0.611
Telecommunications	—		—	0.573	0.566	—	0.491	0.466	0.524
Utilities	0.616		—	0.712	0.716	—	0.886	0.842	0.950
BP (sd)									
Total	0.359	0.386	—	0.256	0.262	0.243	0.201	0.166	0.242
Basic materials	0.333	0.359	—	1.235	1.536	0.324	0.702	0.397	1.149
Consumer goods	0.242		—	0.686	0.811	0.186	0.234	0.188	0.292
Consumer services	0.237		—	0.302	0.327	0.141	0.305	0.314	0.289
Financials	0.613		—	0.431	0.475	0.236	0.349	0.353	0.344
Healthe care	0.255		—	0.187		—	0.352	0.413	0.236
Industrials	0.444	0.472	—	0.292	0.312	0.218	0.213	0.170	0.274
Oil and gas	0.292		—	0.241	0.207	0.197	0.253	0.217	0.294
Technology	—		—	0.368	0.390	—	0.202	0.186	0.236
Telecommunications	—		—	0.309	0.278	—	0.215	0.180	0.261
Utilities	0.212		—	0.280	0.253	—	0.377	0.300	0.487

Table 2. Beta convergence test results

		Period I			Period II			Period III		
		All	Dev	Emg	All	Dev	Emg	All	Dev	Emg
Total										
EP	coef	-0.002^{a}	-0.002^{a}	—	-0.004^{a}	-0.003^{a}	-0.004^{a}	-0.008^{a}	-0.007^{a}	-0.008^{a}
	pv	0.000	0.000	—	0.000	0.000	0.000	0.000	0.000	0.000
DP	coef	-0.002^{a}	-0.002^{a}	—	-0.003^{a}	-0.003^{a}	-0.004^{a}	-0.005^{a}	-0.006^{a}	-0.005^{a}
	pv	0.000	0.000	—	0.000	0.000	0.000	0.000	0.000	0.000
BP	coef	-0.002^{a}	-0.003^{a}	—	-0.004^{a}	-0.005^{a}	-0.004^{a}	-0.008^{a}	-0.007^{a}	-0.007^{a}
	pv	0.001	0.000	—	0.000	0.000	0.000	0.000	0.000	0.000
Basic materials										
EP	coef	-0.002^{a}		—	-0.004^{a}	-0.004^{a}	-0.005^{a}	-0.008^{a}	-0.007^{a}	-0.009^{a}
	pv	0.000		—	0.000	0.000	0.000	0.000	0.000	0.000
DP	coef	-0.002^{a}		—	-0.003^{a}	-0.003^{a}	-0.003^{b}	-0.005^{a}	-0.005^{c}	-0.005^{a}
	pv	0.000		—	0.000	0.000	0.018	0.000	0.077	0.000
BP	coef	-0.002^{a}	-0.002^{c}	—	-0.004^{a}	-0.003^{a}	-0.011^{a}	-0.007^{a}	-0.006^{a}	-0.007^{a}
	pv	0.008	0.064	—	0.000	0.000	0.001	0.000	0.003	0.000
Consumer goods										
EP	coef	-0.002^{a}		—	-0.004^{a}	-0.003^{a}	-0.004^{a}	-0.007^{a}	-0.006^{a}	-0.006^{a}
	pv	0.000		—	0.000	0.000	0.000	0.000	0.000	0.000
DP	coef	-0.001^{a}		—	-0.004^{a}	-0.003^{a}	-0.003^{a}	-0.006^{a}	-0.006^{a}	-0.006^{a}
	pv	0.000		—	0.000	0.000	0.000	0.000	0.000	0.000
BP	coef	-0.005^{c}		—	-0.004^{a}	-0.004^{a}	-0.008^{a}	-0.005^{a}	-0.004^{a}	-0.005^{a}
	pv	0.072		—	0.000	0.000	0.000	0.000	0.001	0.000
Consumer services										
EP	coef	-0.002^{a}		—	-0.004^{a}	-0.004^{a}	-0.007^{c}	-0.008^{a}	-0.008^{a}	-0.008^{a}
	pv	0.000		—	0.000	0.000	0.068	0.000	0.000	0.000
DP	coef	-0.002$^{\alpha}$		—	-0.004^{a}	-0.004^{a}	-0.005^{a}	-0.006^{a}	-0.006^{a}	-0.006^{a}
	pv	0.004		—	0.000	0.000	0.000	0.000	0.000	0.007
BP	coef	-0.002^{a}		—	-0.004^{a}	-0.005^{a}	0.002	-0.006^{a}	-0.006^{a}	-0.006^{a}
	pv	0.002		—	0.000	0.001	0.629	0.000	0.000	0.000
Financials										
EP	coef	-0.003^{a}		—	-0.004^{a}	-0.004^{a}	-0.004^{a}	-0.007^{a}	-0.008^{a}	-0.007^{a}
	pv	0.000		—	0.000	0.000	0.000	0.000	0.000	0.000
DP	coef	-0.003^{a}	-0.003^{a}	—	-0.003^{a}	-0.003^{a}	-0.004^{a}	-0.007^{a}	-0.009^{a}	-0.006^{a}
	pv	0.001	0.001	—	0.000	0.000	0.000	0.000	0.000	0.000
BP	coef	-0.003^{a}		—	-0.004^{a}	-0.005^{a}	-0.004^{a}	-0.009^{a}	-0.013^{a}	-0.007^{a}
	pv	0.000		—	0.000	0.000	0.001	0.000	0.000	0.000
Healthcare										
EP	coef	-0.002^{a}	-0.002^{a}	—	-0.004^{a}	-0.004^{a}	-0.001	-0.004^{c}	-0.009^{a}	-0.002
	pv	0.000	0.000	—	0.000	0.000	0.269	0.076	0.000	0.169
DP	coef	-0.001^{b}	-0.001^{b}	—	-0.004^{a}	-0.004^{a}	0.004	-0.007^{a}	-0.006^{a}	-0.007^{b}
	pv	0.012	0.037	—	0.000	0.000	0.747	0.001	0.001	0.050
BP	coef	-0.003^{c}		—	-0.004^{a}		0.000^{a}	-0.006^{a}	-0.006^{a}	-0.006^{a}
	pv	0.088		—	0.006		0.000	0.000	0.008	0.003

Table 2 *(continued)*

		Period I			Period II			Period III		
		All	Dev	Emg	All	Dev	Emg	All	Dev	Emg
Industrials										
EP	coef	-0.003^{a}	-0.003^{a}	—	-0.005^{a}	-0.005^{a}	-0.005^{a}	-0.006^{a}	-0.005^{a}	-0.006^{a}
	pv	0.000	0.000	—	0.000	0.000	0.000	0.000	0.000	0.000
DP	coef	-0.002^{a}	-0.002^{a}	—	-0.003^{a}	-0.004^{a}	-0.002^{b}	-0.006^{a}	-0.005^{a}	-0.006^{a}
	pv	0.000	0.001	—	0.000	0.000	0.018	0.000	0.000	0.000
BP	coef	-0.003^{a}	-0.003^{a}	—	-0.004^{a}	-0.005^{a}	-0.003^{a}	-0.006^{a}	-0.007^{a}	-0.005^{a}
	pv	0.001	0.001	—	0.000	0.000	0.003	0.000	0.000	0.000
Oil and gas										
EP	coef	-0.002^{b}	-0.002^{b}	—	-0.004^{a}	-0.004^{a}	-0.005	-0.008^{a}	-0.008^{a}	-0.008^{a}
	pv	0.018	0.024	—	0.000	0.000	0.101	0.000	0.000	0.000
DP	coef	-0.001^{b}	-0.001^{b}	—	-0.003^{a}	-0.004^{a}	-0.002	-0.007^{a}	-0.010^{a}	-0.006^{a}
	pv	0.018	0.027	—	0.001	0.000	0.180	0.000	0.000	0.000
BP	coef	-0.004		—	-0.005^{a}	-0.005^{a}	-0.008^{c}	-0.006^{a}	-0.007^{a}	-0.005^{b}
	pv	0.240		—	0.000	0.001	0.075	0.000	0.000	0.016
Technology										
EP	coef	-0.001		—	-0.004^{a}	-0.005^{a}	—	-0.008^{a}	-0.007^{a}	-0.007^{a}
	pv	0.211		—	0.000	0.002	—	0.000	0.000	0.000
DP	coef	-0.002^{b}		—	-0.004^{a}		—	-0.007^{a}	-0.006^{a}	-0.007^{c}
	pv	0.014		—	0.001		—	0.000	0.009	0.057
BP	coef	—		—	-0.003^{a}	-0.003^{a}	—	-0.005^{a}	-0.006^{a}	-0.003^{b}
	pv	—		—	0.001	0.001	—	0.000	0.003	0.011
Telecommunications										
EP	coef	—	—	—	-0.004^{a}	-0.004^{a}	—	-0.007^{a}	-0.006^{a}	-0.008^{a}
	pv	—	—	—	0.000	0.000	—	0.000	0.000	0.000
DP	coef	-0.001		—	-0.003^{a}	-0.003^{a}	—	-0.007^{a}	-0.007^{a}	-0.003
	pv	0.206		—	0.000	0.001	—	0.000	0.000	0.395
BP	coef	—		—	-0.005^{a}	-0.005^{a}	—	-0.006^{a}	-0.006^{a}	-0.006^{a}
	pv	—		—	0.000	0.003	—	0.000	0.002	0.000
Utilities										
EP	coef	-0.004^{b}		—	-0.004^{a}	-0.005^{a}	—	-0.008^{a}	-0.009^{a}	-0.007^{a}
	pv	0.013		—	0.000	0.001	—	0.000	0.001	0.000
DP	coef	-0.002^{a}		—	-0.004^{a}	-0.003^{a}	—	-0.007^{a}	-0.006^{a}	-0.008^{a}
	pv	0.001		—	0.000	0.000	—	0.000	0.000	0.000
BP	coef	-0.003		—	-0.005^{a}	-0.005^{a}	—	-0.007^{a}	-0.008^{a}	-0.006^{a}
	pv	0.201		—	0.000	0.000	—	0.000	0.008	0.000

Notes: "coef" is the estimated beta coefficient in equation (8) whereas "pv" is the p-value of the test statistic.
^{a}, ^{b}, and ^{c} represent significance at the 1%, 5%, and 10% levels respectively.

Table 3. Log t convergence test results

		Period I			Period II			Period III		
		All	Dev	Emg	All	Dev	Emg	All	Dev	Emg
Total										
EP	coef	0.836_{a}	0.898_{a}	—	0.312_{a}	-0.167_{a}	1.205_{b}	-1.598^{a}_{a}	-1.169^{a}_{a}	-2.040^{a}_{a}
	pv1	1.000	1.000	—	0.799	0.323	0.998	0.000	0.000	0.000
	pv2	0.000	0.000	—	0.000	0.000	0.031	0.000	0.000	0.000
DP	coef	0.481_{a}	0.499_{a}	—	1.255_{b}	1.119_{a}	1.406	-0.009_{a}	-0.221_{a}	0.066_{a}
	pv1	0.878	0.891	—	0.999	1.000	0.992	0.478	0.177	0.633
	pv2	0.000	0.000	—	0.031	0.002	0.154	0.000	0.000	0.000
BP	coef	2.341	2.494	—	-0.358_{a}	-1.127_{a}	1.777	-1.846^{a}_{a}	-2.990^{a}_{a}	-0.366_{a}
	pv1	0.994	0.994	—	0.320	0.125	0.965	0.010	0.002	0.263
	pv2	0.642	0.692	—	0.001	0.001	0.410	0.000	0.000	0.000
Basic materials										
EP	coef	0.792_{a}		—	-0.300^{c}_{a}	-0.508^{b}_{a}	0.212_{a}	-0.676^{a}_{a}	-0.443^{c}_{a}	-1.007^{b}_{a}
	pv1	0.988		—	0.071	0.031	0.642	0.000	0.086	0.012
	pv2	0.000		—	0.000	0.000	0.001	0.000	0.000	0.000
DP	coef	-0.528^{c}_{a}		—	-0.279_{a}	-0.643_{a}	0.592_{c}	-1.126^{a}_{a}	-1.949^{a}_{a}	-0.499_{a}
	pv1	0.090		—	0.358	0.191	0.716	0.000	0.000	0.143
	pv2	0.000		—	0.001	0.000	0.087	0.000	0.000	0.000
BP	coef	-0.404_{a}	-0.546^{c}_{a}	—	1.925	1.720	2.486	1.414	0.539_{c}	4.096
	pv1	0.144	0.085	—	0.998	0.999	1.000	0.905	0.714	1.000
	pv2	0.000	0.000	—	0.456	0.303	0.768	0.294	0.062	0.957
Consumer goods										
EP	coef	1.257_{c}		—	0.556_{a}	0.083_{a}	1.597	0.485_{a}	0.672_{a}	0.379_{a}
	pv1	0.997		—	0.940	0.572	1.000	0.964	1.000	0.838
	pv2	0.053		—	0.000	0.000	0.126	0.000	0.000	0.000
DP	coef	0.275_{b}		—	1.349_{c}	1.335	1.595	-0.228_{a}	-0.411_{a}	0.110_{a}
	pv1	0.607		—	0.999	0.992	1.000	0.283	0.143	0.688
	pv2	0.044		—	0.071	0.115	0.176	0.000	0.000	0.000
BP	coef	-0.855^{b}_{a}		—	1.214_{b}	0.936_{a}	1.512	0.277_{a}	-0.007_{a}	0.860_{a}
	pv1	0.038		—	1.000	0.994	0.993	0.879	0.492	1.000
	pv2	0.000		—	0.014	0.002	0.213	0.000	0.000	0.000
Consumer services										
EP	coef	1.133_{a}		—	0.437_{a}	0.782_{a}	0.539_{a}	-0.684^{a}_{a}	-0.496^{c}_{a}	-0.563^{c}_{a}
	pv1	1.000		—	0.904	0.936	0.886	0.000	0.054	0.052
	pv2	0.000		—	0.000	0.009	0.001	0.000	0.000	0.000
DP	coef	-0.646_{a}		—	1.496	0.889_{a}	3.624	-0.546^{b}_{a}	0.055_{a}	-3.586^{b}_{a}
	pv1	0.170		—	0.997	0.993	0.989	0.040	0.601	0.033
	pv2	0.000		—	0.182	0.001	0.848	0.000	0.000	0.002
BP	coef	1.156		—	-0.545_{a}	-0.809_{a}	1.228	-0.484_{a}	-2.255^{a}_{a}	2.255
	pv1	0.954		—	0.188	0.137	0.921	0.230	0.003	1.000
	pv2	0.109		—	0.000	0.000	0.187	0.000	0.000	0.698
Financials										
EP	coef	0.603_{a}		—	0.073_{a}	-0.429_{a}	2.127	-0.991^{b}_{a}	-1.088^{b}_{a}	-0.845^{b}_{a}
	pv1	0.877		—	0.547	0.265	0.998	0.017	0.026	0.041
	pv2	0.004		—	0.001	0.000	0.570	0.000	0.000	0.000
DP	coef	0.413_{a}	0.369_{a}	—	0.702_{b}	0.238_{a}	2.671	-0.403_{a}	-0.938_{a}	0.225_{a}
	pv1	0.916	0.889	—	0.893	0.660	1.000	0.221	0.114	0.665
	pv2	0.000	0.000	—	0.011	0.001	0.801	0.000	0.000	0.000
BP	coef	5.533		—	-3.784^{c}_{a}	-2.554^{c}_{a}	2.166	-4.144^{a}_{a}	-7.560^{a}_{a}	-0.555_{b}
	pv1	0.990		—	0.051	0.072	0.946	0.001	0.000	0.334
	pv2	0.931		—	0.006	0.005	0.549	0.000	0.000	0.024
Healthcare										
EP	coef	-0.209_{a}	-0.001_{a}	—	-0.799^{c}_{a}	-1.625^{a}_{a}	2.514	-1.118^{a}_{a}	0.044_{a}	-2.719^{a}_{a}
	pv1	0.367	0.500	—	0.061	0.002	1.000	0.000	0.566	0.000
	pv2	0.000	0.009	—	0.000	0.000	0.767	0.000	0.000	0.000
DP	coef	-0.352_{a}	-0.293_{a}	—	0.307_{a}	0.362_{a}	0.446	-0.515_{a}	0.106_{b}	-2.151^{a}_{a}
	pv1	0.196	0.256	—	0.724	0.748	0.635	0.213	0.550	0.000
	pv2	0.000	0.000	—	0.001	0.001	0.115	0.000	0.012	0.000
BP	coef	-1.168^{a}_{a}		—	-0.595^{c}_{a}		—	-1.107^{a}_{a}	-1.564^{a}_{a}	0.105_{a}
	pv1	0.000		—	0.093		—	0.000	0.000	0.579
	pv2	0.000		—	0.000		—	0.000	0.000	0.000

Table 3 *(continued)*

		Period I			Period II			Period III		
		All	Dev	Emg	All	Dev	Emg	All	Dev	Emg
Industrials										
EP	coef	0.254_{a}	0.242_{a}	—	0.225_{a}	0.119_{a}	0.425_{a}	-0.451_{a}	-0.730_{a}	-0.186_{b}
	pv1	0.707	0.705	—	0.652	0.577	0.747	0.224	0.122	0.438
	pv2	0.000	0.000	—	0.001	0.001	0.007	0.000	0.000	0.033
DP	coef	-0.180_{b}	-0.169_{b}	—	1.781	2.027	1.746	0.505_{a}	1.216_{b}	-0.244_{a}
	pv1	0.429	0.435	—	1.000	1.000	0.990	0.959	0.999	0.121
	pv2	0.015	0.017	—	0.239	0.520	0.367	0.000	0.025	0.000
BP	coef	-1.003^{b}_{a}	-1.110^{b}_{a}	—	0.254_{a}	-0.057_{a}	1.936	-0.979^{c}_{a}	-1.908^{b}_{a}	-0.056_{a}
	pv1	0.049	0.040	—	0.634	0.470	0.940	0.059	0.012	0.470
	pv2	0.000	0.000	—	0.009	0.004	0.480	0.000	0.000	0.003
Oil and gas										
EP	coef	0.721_{a}	0.862_{a}	—	0.182_{a}	0.107_{a}	0.333_{a}	-0.817^{a}_{a}	-0.200_{a}	-1.013^{a}_{a}
	pv1	0.989	0.993	—	0.774	0.655	0.756	0.007	0.255	0.005
	pv2	0.000	0.001	—	0.000	0.000	0.000	0.000	0.000	0.000
DP	coef	0.527_{a}	0.562_{a}	—	-1.108^{a}_{a}	-0.529^{c}_{a}	-2.973^{a}_{a}	0.869_{b}	-0.150_{a}	1.112
	pv1	0.988	0.979	—	0.000	0.091	0.000	0.920	0.363	0.901
	pv2	0.000	0.000	—	0.000	0.000	0.000	0.034	0.000	0.152
BP	coef	-0.270_{a}		—	0.958	0.341_{b}	-0.635_{a}	-0.883^{c}_{a}	-1.221^{b}_{a}	-0.320_{a}
	pv1	0.378		—	0.848	0.641	0.231	0.089	0.041	0.324
	pv2	0.005		—	0.131	0.039	0.001	0.000	0.000	0.000
Technology										
EP	coef	1.337		—	0.131_{a}	0.249_{a}	—	-0.458_{a}	-0.906^{b}_{a}	-0.312_{a}
	pv1	0.992		—	0.597	0.663	—	0.136	0.012	0.298
	pv2	0.115		—	0.000	0.002	—	0.000	0.000	0.000
DP	coef	1.264		—	-1.570_{b}		—	4.701	2.927	2.800
	pv1	0.852		—	0.226		—	0.991	0.985	0.996
	pv2	0.271		—	0.044		—	0.914	0.754	0.779
BP	coef	—		—	0.208_{a}	-0.134_{a}	—	-1.810^{a}_{a}	-2.389^{a}_{a}	-1.484^{a}_{a}
	pv1	—		—	0.614	0.435	—	0.000	0.000	0.000
	pv2	—		—	0.006	0.005	—	0.000	0.000	0.000
Telecommunications										
EP	coef	—		—	1.008_{b}	0.906_{b}	—	-0.421^{c}_{a}	-0.141_{a}	-0.494^{b}_{a}
	pv1	—		—	0.982	0.969	—	0.094	0.375	0.044
	pv2	—		—	0.020	0.012	—	0.000	0.000	0.000
DP	coef	3.751		—	7.638	7.881	—	0.655_{a}	3.011	-2.267^{b}_{a}
	pv1	0.990		—	1.000	1.000	—	0.968	1.000	0.020
	pv2	0.860		—	1.000	1.000	—	0.000	0.971	0.000
BP	coef	—		—	-1.366^{c}_{a}	-3.344^{a}_{a}	—	-1.120^{a}_{a}	-1.595^{a}_{a}	-0.617_{a}
	pv1	—		—	0.051	0.000	—	0.000	0.000	0.132
	pv2	—		—	0.000	0.000	—	0.000	0.000	0.000
Utilities										
EP	coef	0.839_{b}		—	-1.034^{c}_{a}	-1.688^{b}_{a}	—	-1.988^{a}_{a}	-2.507^{a}_{a}	-1.656^{a}_{a}
	pv1	0.905		—	0.094	0.024	—	0.000	0.000	0.000
	pv2	0.035		—	0.000	0.000	—	0.000	0.000	0.000
DP	coef	0.437_{a}		—	-0.400_{a}	-0.166_{a}	—	-0.140_{a}	0.201_{a}	-0.399^{c}_{a}
	pv1	0.950		—	0.205	0.386	—	0.342	0.627	0.088
	pv2	0.000		—	0.000	0.000	—	0.000	0.002	0.000
BP	coef	-0.616^{b}_{a}		—	-1.170^{b}_{a}	-1.039^{b}_{a}	—	-0.700_{a}	-1.516^{b}_{a}	2.320
	pv1	0.031		—	0.023	0.040	—	0.234	0.026	0.948
	pv2	0.000		—	0.000	0.000	—	0.003	0.000	0.589

Notes: "coef" is the estimated coefficient of the log t variable in equation (10).
"pv1" and "pv2" are the *p*-values for test statistics of growth and level convergence respectively.
^{a}, ^{b}, and ^{c} represent significance at the 1%, 5%, and 10% levels respectively for growth convergence.
$_{a}$, $_{b}$, and $_{c}$ represent significance at the 1%, 5%, and 10% levels respectively for level convergence.

Table 4. Sigma convergence test results

		Period I			Period II			Period III		
		All	Dev	Emg	All	Dev	Emg	All	Dev	Emg
Total										
EP	stat	12.515^{a}	12.281^{a}	—	12.549^{a}	7.702^{a}	10.831^{a}	11.521^{a}	7.567^{a}	1.756
	pv	0.000	0.000	—	0.000	0.006	0.001	0.001	0.006	0.185
DP	stat	0.028	0.029	—	4.827^{b}	5.565^{b}	0.525	9.189^{a}	0.241	8.452^{a}
	pv	0.866	0.864	—	0.028	0.018	0.469	0.002	0.623	0.004
BP	stat	1.665	1.648	—	5.516^{b}	0.821	24.722^{a}	1.690	0.361	6.530^{b}
	pv	0.197	0.199	—	0.019	0.365	0.000	0.194	0.548	0.011
Basic materials										
EP	stat	5.600^{b}		—	12.681^{a}	9.040^{a}	4.656^{b}	14.275^{a}	3.798^{c}	6.899^{a}
	pv	0.018		—	0.000	0.003	0.031	0.000	0.051	0.009
DP	stat	0.039		—	3.323^{c}	6.494^{b}	0.024	0.456	2.166	1.739
	pv	0.844		—	0.068	0.011	0.877	0.499	0.141	0.187
BP	stat	0.862	0.151	—	7.780^{a}	5.279^{b}	1.400	5.011^{b}	0.353	3.352^{c}
	pv	0.353	0.698	—	0.005	0.022	0.237	0.025	0.553	0.067
Consumer goods										
EP	stat	3.944^{b}		—	18.874^{a}	6.819^{a}	10.878^{a}	11.301^{a}	3.209^{c}	7.988^{a}
	pv	0.047		—	0.000	0.009	0.001	0.001	0.073	0.005
DP	stat	6.770^{a}		—	10.563^{a}	1.066	8.944^{a}	11.142^{a}	6.594^{a}	4.375^{b}
	pv	0.009		—	0.001	0.302	0.003	0.001	0.010	0.036
BP	stat	0.340		—	14.650^{a}	0.091	6.203^{b}	5.645^{b}	0.522	10.939^{a}
	pv	0.560		—	0.000	0.762	0.013	0.018	0.470	0.001
Consumer services										
EP	stat	11.392^{a}		—	8.870^{a}	19.581^{a}	0.237	9.789^{a}	6.869^{a}	4.590^{b}
	pv	0.001		—	0.003	0.000	0.627	0.002	0.009	0.032
DP	stat	0.022		—	1.154	0.298	4.908^{b}	2.258	1.701	3.536^{c}
	pv	0.881		—	0.283	0.585	0.027	0.133	0.192	0.060
BP	stat	3.708^{c}		—	4.951^{b}	7.621^{a}	0.237	3.975^{b}	0.074	10.227^{a}
	pv	0.054		—	0.026	0.006	0.627	0.046	0.786	0.001
Financials	stat									
EP	pv	1.577		—	8.623^{a}	4.592^{b}	10.052^{a}	8.746^{a}	1.271	7.782^{a}
	stat	0.209		—	0.003	0.032	0.002	0.003	0.260	0.005
DP	pv	2.087	1.814	—	2.551	0.173	4.568^{b}	1.123	3.490^{c}	5.305^{b}
	stat	0.149	0.178	—	0.110	0.677	0.033	0.289	0.062	0.021
BP	pv	1.550		—	5.581^{b}	4.510^{b}	4.777^{b}	1.582	8.769^{a}	12.335^{a}
		0.213		—	0.018	0.034	0.029	0.208	0.003	0.000
Healthcare										
EP	stat	2.191	1.527	—	1.745	1.248	0.274	0.083	0.003	0.092
	pv	0.139	0.217	—	0.186	0.264	0.600	0.774	0.957	0.762
DP	stat	0.083	0.006	—	0.116	0.061	0.701	0.292	0.092	0.078
	pv	0.774	0.938	—	0.733	0.804	0.403	0.589	0.762	0.781
BP	stat	0.047		—	0.012		—	0.399	2.591	3.517^{c}
	pv	0.828		—	0.912		—	0.528	0.107	0.061

Table 4 *(continued)*

		Period I			Period II			Period III		
		All	Dev	Emg	All	Dev	Emg	All	Dev	Emg
Industrials										
EP	stat	6.515^{b}	5.968^{b}	—	4.303^{b}	1.490	7.391^{a}	14.938^{a}	7.562^{a}	6.953^{a}
	pv	0.011	0.015	—	0.038	0.222	0.007	0.000	0.006	0.008
DP	stat	4.642^{b}	5.347^{b}	—	8.669^{a}	7.774^{a}	1.114	17.885^{a}	10.769^{a}	6.024^{b}
	pv	0.031	0.021	—	0.003	0.005	0.291	0.000	0.001	0.014
BP	stat	0.745	0.683	—	1.015	0.051	2.204	3.358^{c}	0.253	3.862^{b}
	pv	0.388	0.409	—	0.314	0.821	0.138	0.067	0.615	0.049
Oil and gas										
EP	stat	0.096	0.077	—	1.808	2.171	0.002	6.646^{a}	0.822	2.005
	pv	0.756	0.782	—	0.179	0.141	0.963	0.010	0.365	0.157
DP	stat	1.031	0.903	—	1.333	4.184^{b}	0.000	7.519^{a}	0.412	4.738^{b}
	pv	0.310	0.342	—	0.248	0.041	0.987	0.006	0.521	0.029
BP	stat	0.175		—	7.509^{a}	0.061	0.357	2.154	4.954^{b}	0.019
	pv	0.675		—	0.006	0.805	0.550	0.142	0.026	0.892
Technology										
EP	stat	0.135		—	3.120^{c}	0.587	—	1.983	1.351	0.367
	pv	0.713		—	0.077	0.444	—	0.159	0.245	0.545
DP	stat	1.825		—	0.792		—	4.283^{b}	0.070	0.744
	pv	0.177		—	0.373		—	0.038	0.791	0.388
BP	stat	—		—	1.959	2.140	—	0.597	0.385	0.110
	pv	—		—	0.162	0.143	—	0.440	0.535	0.740
Telecommunications										
EP	stat	—		—	3.785^{c}	1.943	—	2.994^{c}	0.725	4.286^{b}
	pv	—		—	0.052	0.163	—	0.084	0.395	0.038
DP	stat	0.059		—	8.552^{a}	6.210^{b}	—	2.782^{c}	14.803^{a}	1.429
	pv	0.809		—	0.003	0.013	—	0.095	0.000	0.232
BP	stat	—		—	0.028	0.130	—	1.273	0.063	1.508
	pv	—		—	0.867	0.719	—	0.259	0.802	0.220
Utilities										
EP	stat	0.699		—	0.117	2.081	—	0.009	8.426^{a}	2.081
	pv	0.403		—	0.733	0.149	—	0.923	0.004	0.149
DP	stat	2.023		—	5.064^{b}	6.359^{b}	—	15.879^{a}	4.802^{b}	8.130^{a}
	pv	0.155		—	0.024	0.012	—	0.000	0.028	0.004
BP	stat	0.360		—	1.867	0.450	—	5.734^{b}	9.184^{a}	4.392^{b}
	pv	0.548		—	0.172	0.502	—	0.017	0.002	0.036

Notes: "stat" is the test statistic whereas "pv" is the corresponding p-value.
^{a}, ^{b}, and ^{c} represent significance at the 1%, 5%, and 10% levels respectively.

Table 5. Summary of beta, log t, and sigma convergence test results

	Beta convergence			Log t convergence						Sigma convergence		
				Growth			Level					
	EP	DP	BP	EP	DP	BP	EP	DP	BP	EP	DP	BP
Period I												
*All markets**	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N
Basic materials	Y	Y	Y	Y	N	Y	N	N	N	Y	N	N
Consumer goods	Y	Y	Y	Y	Y	N	N	N	N	Y	Y	N
Consumer services	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	Y
Financials	Y	Y	Y	Y	Y	Y	N	N	Y	N	N	N
Health care	Y	Y	Y	Y	Y	N	N	N	N	N	N	N
Industrials	Y	Y	Y	Y	Y	N	N	N	N	Y	Y	N
Oil and gas	Y	Y	N	Y	Y	Y	N	N	N	N	N	N
Technology	N	Y	—	Y	Y	—	Y	Y	—	N	N	—
Telecommunications	—	N	—	—	Y	—	—	Y	—	—	N	—
Utilities	Y	Y	N	Y	Y	N	N	N	N	N	N	N
Period II												
All markets	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y
Basic materials	Y	Y	Y	N	Y	Y	N	N	Y	Y	Y	Y
Consumer goods	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y
Consumer services	Y	Y	Y	Y	Y	Y	N	Y	N	Y	N	Y
Financials	Y	Y	Y	Y	Y	N	N	N	N	Y	N	Y
Health care	Y	Y	Y	N	Y	N	N	N	N	N	N	N
Industrials	Y	Y	Y	Y	Y	Y	N	Y	N	Y	Y	N
Oil and gas	Y	Y	Y	Y	N	Y	N	N	u	N	N	Y
Technology	Y	Y	Y	Y	Y	Y	N	N	N	Y	N	N
Telecommunications	Y	Y	Y	Y	Y	N	N	Y	N	Y	Y	N
Utilities	Y	Y	Y	N	Y	N	N	N	N	N	Y	N
Developed markets	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	N
Basic materials	Y	Y	Y	N	Y	Y	N	N	Y	Y	Y	Y
Consumer goods	Y	Y	Y	Y	Y	Y	N	Y	N	Y	N	N
Consumer services	Y	Y	Y	Y	Y	Y	N	N	N	Y	N	Y
Financials	Y	Y	Y	Y	Y	N	N	N	N	Y	N	Y
Health care	Y	Y	Y	N	Y	N	N	N	N	N	N	N
Industrials	Y	Y	Y	Y	Y	Y	N	Y	N	N	Y	N
Oil and gas	Y	Y	Y	Y	N	Y	N	N	N	N	Y	N
Technology	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N
Telecommunications	Y	Y	Y	Y	Y	N	N	Y	N	N	Y	N
Utilities	Y	Y	Y	N	Y	N	N	N	N	N	Y	N
Emerging markets	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	Y
Basic materials	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N
Consumer goods	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Consumer services	Y	Y	N	Y	Y	Y	N	Y	Y	N	Y	N
Financials	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Health care	N	N	Y	Y	Y	—	Y	Y	—	N	N	—
Industrials	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	N
Oil and gas	N	N	Y	Y	N	Y	N	N	N	N	N	N
Technology	—	—	—	—	—	—	—	—	—	—	—	—
Telecommunications	—	—	—	—	—	—	—	—	—	—	—	—
Utilities	—	—	—	—	—	—	—	—	—	—	—	—

Table 5 *(continued)*

	Beta convergence			Log t convergence						Sigma convergence		
				Growth			Level					
	EP	DP	BP	EP	DP	BP	EP	DP	BP	EP	DP	BP
Period III												
All markets	Y	Y	Y	N	Y	N	N	N	N	Y	Y	N
Basic materials	Y	Y	Y	N	N	Y	N	N	Y	Y	N	Y
Consumer goods	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y
Consumer services	Y	Y	Y	N	N	Y	N	N	N	Y	N	Y
Financials	Y	Y	Y	N	Y	N	N	N	N	Y	N	N
Health care	Y	Y	Y	N	Y	N	N	N	N	N	N	N
Industrials	Y	Y	Y	Y	Y	N	N	N	N	Y	Y	Y
Oil and gas	Y	Y	Y	N	Y	N	N	N	N	Y	Y	N
Technology	Y	Y	Y	Y	Y	N	N	Y	N	N	Y	N
Telecommunications	Y	Y	Y	N	Y	N	N	N	N	Y	Y	N
Utilities	Y	Y	Y	N	Y	Y	N	N	N	N	Y	Y
Developed markets	Y	Y	Y	N	Y	N	N	N	N	Y	N	N
Basic materials	Y	Y	Y	N	N	Y	N	N	N	Y	N	N
Consumer goods	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y
Consumer services	Y	Y	Y	N	Y	N	N	N	N	Y	N	N
Financials	Y	Y	Y	N	Y	N	N	N	N	N	Y	Y
Health care	Y	Y	Y	Y	Y	N	N	N	N	N	N	N
Industrials	Y	Y	Y	Y	Y	N	N	N	N	Y	Y	N
Oil and gas	Y	Y	Y	Y	Y	N	N	N	N	N	N	Y
Technology	Y	Y	Y	N	Y	N	N	Y	N	N	N	N
Telecommunications	Y	Y	Y	Y	Y	N	N	Y	N	N	Y	N
Utilities	Y	Y	Y	N	Y	N	N	N	N	Y	Y	Y
Emerging markets	Y	Y	Y	N	Y	Y	N	N	N	N	Y	Y
Basic materials	Y	Y	Y	N	Y	Y	N	N	Y	Y	N	Y
Consumer goods	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y
Consumer services	Y	Y	Y	N	N	Y	N	N	Y	Y	Y	Y
Financials	Y	Y	Y	N	Y	Y	N	N	N	Y	Y	Y
Health care	N	Y	Y	N	N	Y	N	N	N	N	N	Y
Industrials	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y
Oil and gas	Y	Y	Y	N	Y	Y	N	Y	N	N	Y	N
Technology	Y	Y	Y	Y	Y	N	N	Y	N	N	N	N
Telecommunications	Y	N	Y	N	N	Y	N	N	N	Y	N	N
Utilities	Y	Y	Y	N	N	Y	N	N	Y	N	Y	Y

Notes: "Y" indicates evidence for convergence whereas "N" signifies evidence against convergence.
*Results for all markets are qualitatively applicable to developed markets except with BP for basic materials.
In Period II, markets are all developed with BP in the health care sector, and with DP in the technology sector.

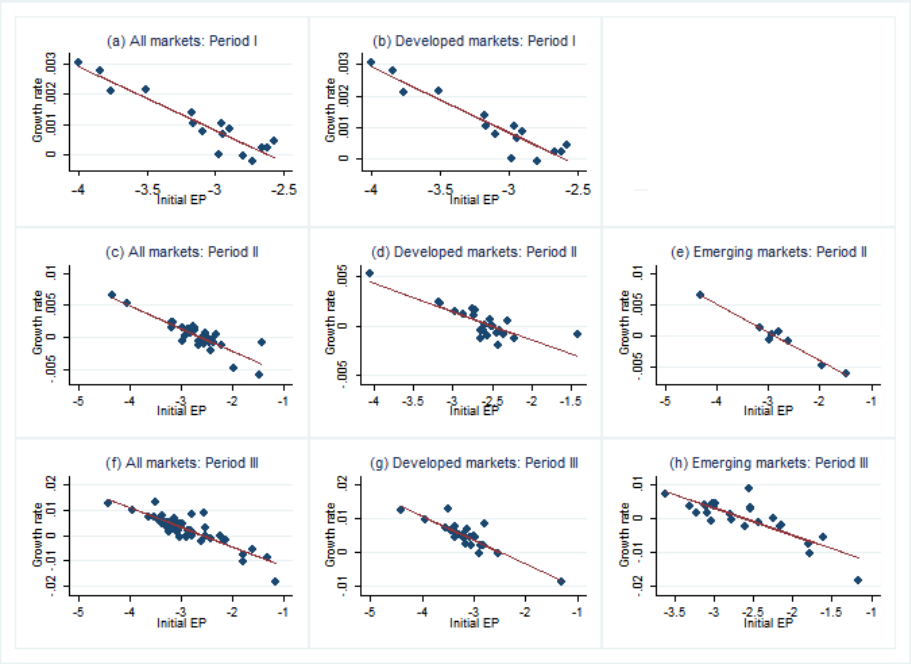

Figure 1. Average growth rate versus log initial level of EP ratio

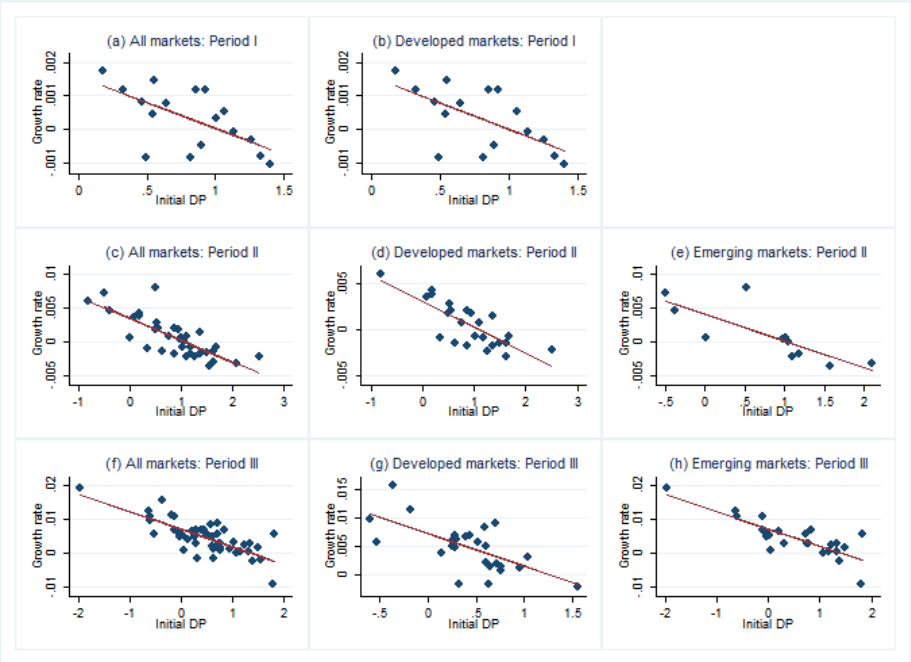

Figure 2. Average growth rate versus log initial level of DP ratio

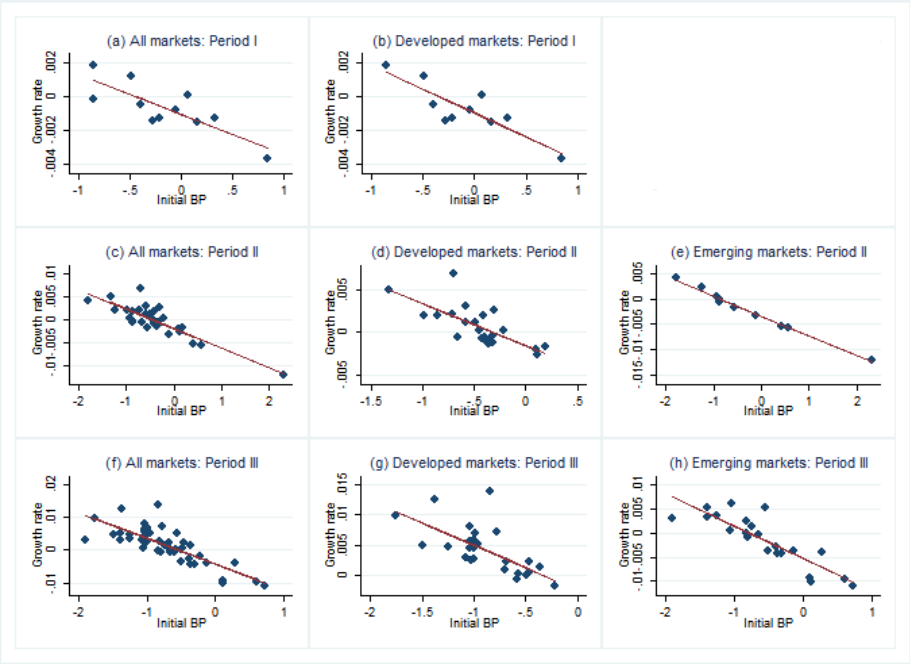

Figure 3. Average growth rate versus log initial level of BP ratio

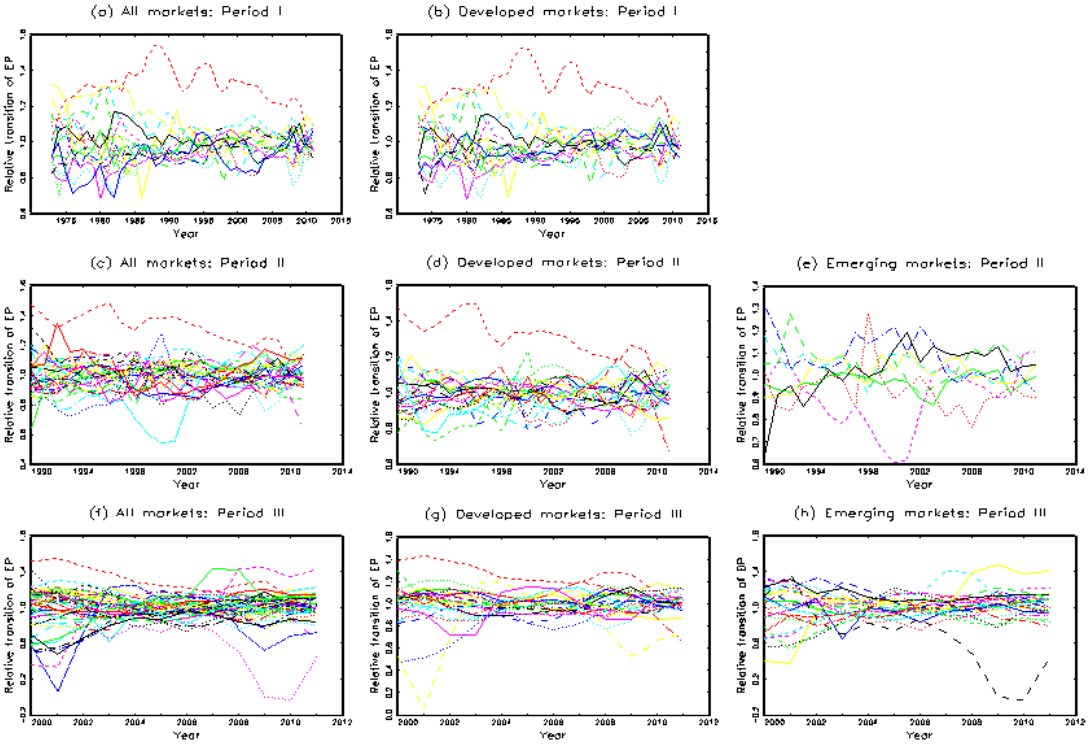

Figure 4. Relative transition paths of EP ratio

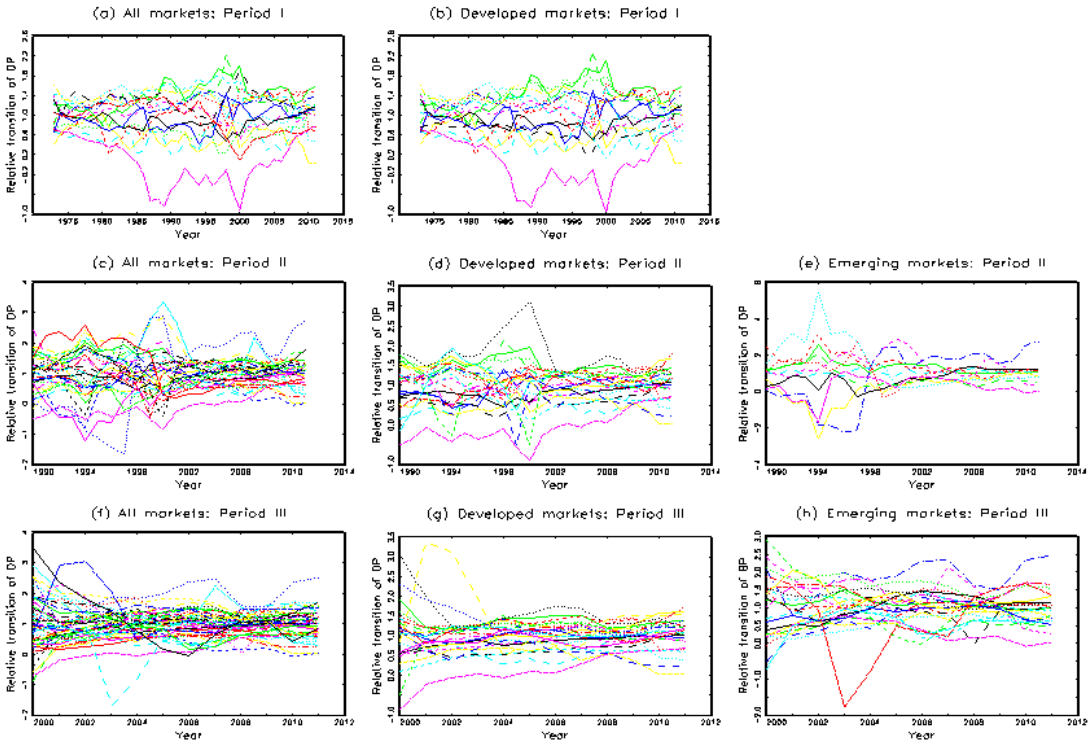

Figure 5. Relative transition paths of DP ratio

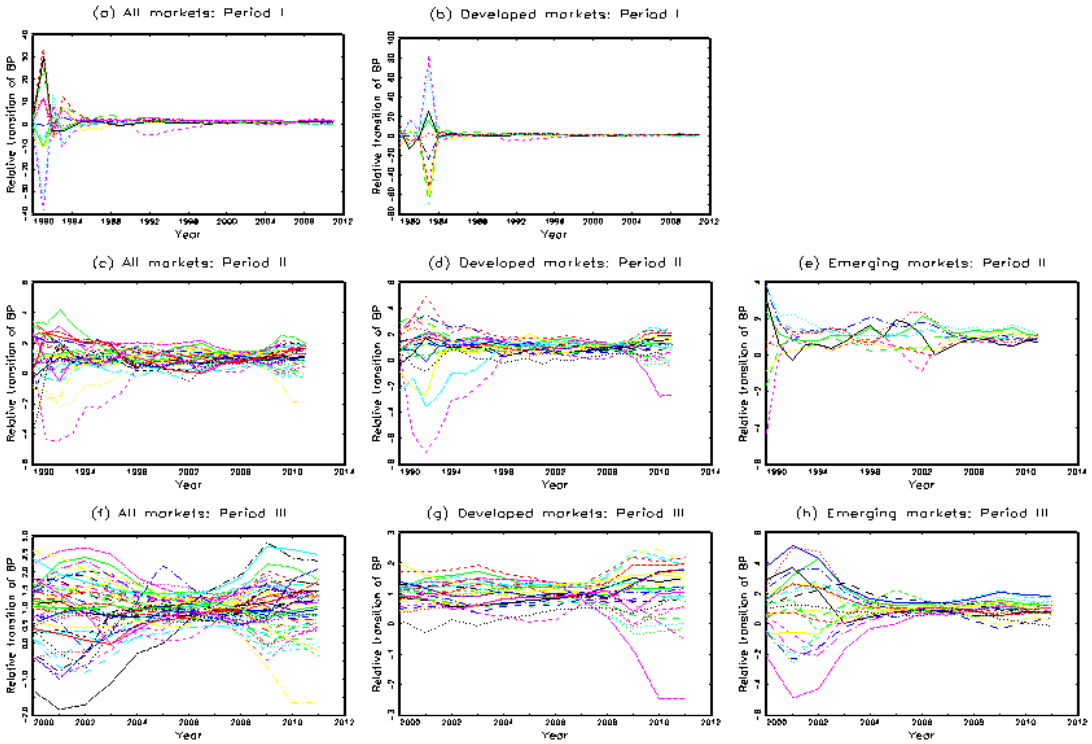

Figure 6. Relative transition paths of BP ratio

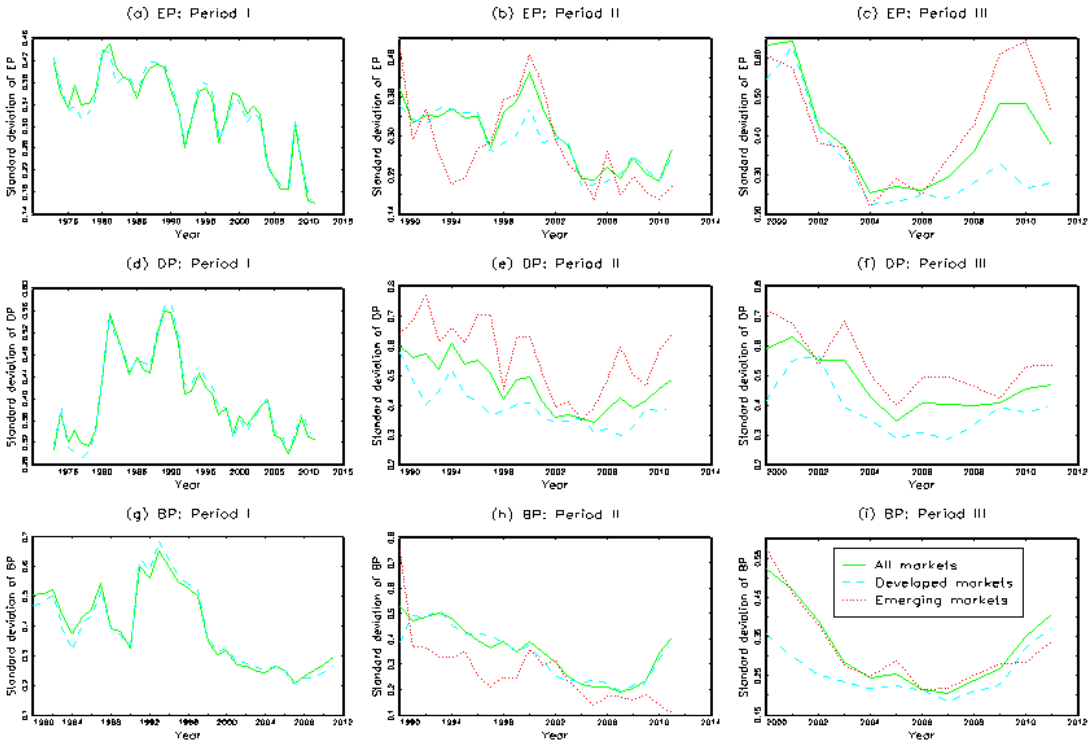

Figure 7. Cross-sectional standard deviations of EP, DP and BP ratios

Appendix

The sample contains 51 markets, of which 27 are developed and 24 are emerging, with the latter marked with ^{e}. Each market total is disaggregated into ten industrial sectors, namely (1) Basic Materials, (2) Consumer Goods, (3) Consumer Services, (4) Financials, (5) Health Care, (6) Industrials, (7) Oil and Gas, (8) Technology, (9) Telecommunications, and (10) Utilities. For each market and industrial sector, the span of data used, subject to data availability, can be distinguished into the three time periods of (A) Period I: 1973-2011, (B) Period II: 1980-2011, and (C) Period III: 1990-2011.

Table A1. Data of EP ratio by market, industrial sector, and time period

Markets	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
ARGENTINA^e	C				C						C
AUSTRALIA	A	A		A	A	A	A	A		C	A
AUSTRIA	A	A			A		C	C			B
BELGIUM	A	A	C	B	A	B	B		B		A
BRAZIL^e	C	C	C		C		C	C		C	C
CANADA	A	A	B	B	B		A	A	A	B	A
CHILE^e	B	B	B	B	B		B	B		B	B
CHINA^e	C	C	C		C		C	C	C		C
COLOMBIA^e	C	C	C	C	C				C		C
CYPRUS	C	C	C	C	C		C				
CZECH REP^e	C				C	C	C	C			C
DENMARK	A		B	C	A	A	A			C	
EGYPT^e	C		C		C		C				
FINLAND	B	C		B	B		B		B		C
FRANCE	A	A	A	A	A	A	A	A	A	C	
GERMANY	A	A	A	A	B	A	A		C		A
GREECE	B	B		C	B		B	C			
HUNGARY^e	C		C	C	C	C	C		C	C	C
HONG KONG	A	B	C	A	A		A	C	B	B	A
INDIA^e	B	B	B	C	C	B	B	B	C	C	B
INDONESIA^e	C	C			C	C		C		C	
IRELAND	A		C	A	A	B					
ISRAEL	C	C	C	C	C	C	C	C			
ITALY	B	B	B	B	B	B	B	B		B	B
JAPAN	A	A	A	A	A	A	A	A	A	A	A
KOREA	B	B	B	B	B	B	B	B	C	B	B
LUXEMBURG	C	C	C	C	C		C				
MALAYSIA^e	B	B	B	B	B		B	B		C	C
MEXICO^e	C	C		C	C		C			C	
NETHERLANDS	A	A	A	A	A	A	A	A	B		
NEW ZEALAND	B		B	B	B	B	C				C
NORWAY	B	B	C		B		B	B	C		
PAKISTAN^e	C	C	C		C	C	C	C			C
PHILIPPINES^e	B		B	C	B	B	C			B	C
PERU^e	C	C			C						
POLAND^e	C	C	C	C	C				C	C	
PORTUGAL	B	B	B	C	B		B			C	C
ROMANIA^e	C	C	C	C	C	C	C	C			
RUSSIA^e	C				C			C			
SINGAPORE	A	A	B	A	A	A	A			C	
SOUTH AFRICA^e	A	C	C	C	B	A	A	A	C	C	
SPAIN	B	B	C	B	B	B	B	B		B	B
SRI LANKA^e	B	B	B	C	B		B	C			
SWEDEN	B	B	B	B	B	C	B			C	C
SWITZERLAND	A	A	B	A	A	A	A		B	C	A
TAIWAN^e	B	B	B	B	B		B		B		
THAILAND^e	B	B	B	B	B	B		C	C	C	C
TURKEY^e	C		C	C	C		C	C			C
UK	A	A	A	A	A	A	A	A	B	B	B
US	A	A	A	A	A	A	A	A	A	A	A
VENEZUELA^e	C	C			C						

Table A2. Data of DP ratio by market, industrial sector, and time period

Markets	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
ARGENTINA[e]	C	C			C						
AUSTRALIA	A	A	A	A	A	A	A	A		C	A
AUSTRIA	A	A			A		B	C			B
BELGIUM	A	A	C	A	A	B	B	C	B		A
BRAZIL[e]	C	C	C		C		C	C		C	C
CANADA	A	A	B	A	A		A	A		B	A
CHILE[e]	B	B	B	B	B		B	B		B	B
CHINA[e]	C	C	C				C	C			C
COLOMBIA[e]	C	C	C		C						C
CYPRUS	C	C	C	C	C						
CZECH REP[e]	C				C	C					C
DENMARK	A	B	C		A	A	A				
EGYPT[e]	C	C	C		C	C	C				
FINLAND	B	B		B	B	B	B		B		C
FRANCE	A	A	A	A	A	A	A	A	A	C	
GERMANY	A	A	A	A	A	A	A		B	A	A
GREECE	B	B		C	B		B	C		C	
HUNGARY[e]	C					C					C
HONG KONG	A	B	C	A	A		A		B		A
INDIA[e]	B	B	B	C	C	B	B	B	C	C	B
INDONESIA[e]	C	C								C	
IRELAND	A		C	A	A						
ISRAEL	C	C	C	C	C	C	C	C			
ITALY	A	A	A	B	A	B	A	B		B	B
JAPAN	A	A	A	A	A	A	A	A	A	A	A
KOREA	B	B	B	B	B		B	B	C	B	
LUXEMBURG	C		C	C	C		C				C
MALAYSIA[e]	B	B	B	B	B		B	B			C
MEXICO[e]	B	B		B	C		C			C	
NETHERLANDS	A	A	A	A	A	A	A	A	B		
NEW ZEALAND	B	B	B	B	B	B	C	B		C	C
NORWAY	B	B	C				B	B	C		B
PAKISTAN[e]	C	C	C		C	C	C	C			C
PHILIPPINES[e]	B		B	C	B		C				
PERU[e]	C	C			C						C
POLAND[e]	C	C	C		C			C			
PORTUGAL	B	B	B	C	B		B				C
ROMANIA[e]	C	C			C		C	C			
RUSSIA[e]	C			C	C			C			
SINGAPORE	A		B	A	A	A	A	C		C	
SOUTH AFRICA[e]	A	C	B	B	A	A	A	A	C		
SPAIN	B	B		B	B	B	B	B			B
SRI LANKA[e]	B	B	B	C	B		B	C			
SWEDEN	B	B	B	B	B	C	B			C	B
SWITZERLAND	A	A	B	A	A	A	A			C	A
TAIWAN[e]	B	B	B	B	B		B		C		
THAILAND[e]	B	B	B	B	B	B		C			C
TURKEY[e]	B		B	C	C		C	C			C
UK	A	A	A	A	A	A	A	A	A	B	B
US	A	A	A	A	A	A	A	A	A	A	A
VENEZUELA[e]	B	B			C		B				

Table A3. Data of BP ratio by market, industrial sector, and time period

Markets	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
ARGENTINA[e]	B	C	B	C	C		C	B		C	C
AUSTRALIA	A	A	C	B	A	C	B	B		C	
AUSTRIA	A	B			B		A	B			B
BELGIUM	A	A	C	C	A	A	A	C	C		
CANADA	B	B	B	B	B	C	B	B	C	B	B
CHILE[e]	B	B	B	C	C		B	B		B	B
CHINA[e]	C	C	C		C		C				C
COLOMBIA[e]	C	C	C	C	C		C	C			C
CZECH REP[e]	C	C	C		C			C	C	C	C
DENMARK	A		B		A	A	A	C		C	C
EGYPT[e]	C	C	C		C	C	C			C	
FINLAND	B	B	B	B	B		B		B	C	C
FRANCE	B	B	B	B	B	B	B	B	B		B
GERMANY	A	A	A	A	A	A	A		B	C	A
GREECE	B	C	B	B	B	C	B	C		C	C
HUNGARY	C	C	C	C	C	C	C	C	C	C	C
HONG KONG	A	C	C	A	A		A	C	C	C	A
INDIA[e]	B	C	C	C	C	C	B	C	C	C	C
INDONESIA[e]	C	C	C		C	C		C		C	
IRELAND	B	C	B	B	B		B				
ISRAEL	C	C	C	C	C	C	C		C	C	C
ITALY	B	B	B	B	B	B	B	B		B	C
JAPAN	A	A	A		A	A	A	A	A	B	A
KOREA	B	B	C	C	B		B	B	C	C	B
LUXEMBURG	C	C	C	C	C			C			C
MALAYSIA[e]	B	B	B	B	B		B	C		C	C
MEXICO[e]	B	B	B	B	C		B				
NETHERLANDS	A	B	B	A	B		A	C	B	C	
NEW ZEALAND	C	C	C	C	C		C			C	C
NORWAY	B	C	C	C	C		B	C			B
PAKISTAN[e]	C	C	C		C	C	C	C		C	C
PHILIPPINES[e]	B		C	C	B	C	C	C		C	C
PERU[e]	C	C	C	C	C		C			C	C
POLAND[e]	C	C	C		C		C	C	C	C	
PORTUGAL	B	C	B	B	B	C	B		C	C	C
RUSSIA[e]	C			C	C			C		C	C
SINGAPORE	B	B	B	B	B	B	B	B	C	C	
SLOVENIA[e]	C					C					
SOUTH AFRICA[e]	A	A	C	B	B	C	A	B	B	C	
SPAIN	B	B	B	C	B	B	B	B	B	B	B
SRI LANKA[e]	C		C		C		C	C			
SWEDEN	B	B	B	B	B	C	B		B	C	
SWITZERLAND	B	B	B	B	B	B	B		B	C	B
TAIWAN[e]	B	B	C	C	C		B		C		
THAILAND[e]	B		B	C	B	C	C	C	C	C	C
TURKEY[e]	B	B	B	C	B		C	C	C		B
UK	A	A	A	A	A	A	A	A	C	B	B
US	A	A	A	A	A	A	A	A	A	A	A