1-2-2016

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James E. Prieger

Catherine Bampoky

Luisa R. Blanco

Aolong Liu

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JAMES E. PRIEGER[a], CATHERINE BAMPOKY[b], LUISA R. BLANCO[a] and AOLONG LIU [a]

[a] Pepperdine University, Malibu, USA
[b] American University, Washington DC, USA

January 2, 2016

Abstract

Using data from the Global Entrepreneurship Monitor (GEM), we examine data from developed and developing countries to estimate the ''growth penalty" over 2003–11 when a country's entrepreneurship deviates from its optimal level. We account for heterogeneity among countries in the optimal entrepreneurship rate, in the growth penalty from deviating from that optimum, and in other factors affecting growth. Notwithstanding that developing countries have more of their population running nascent small firms than in developed countries, a marginal increase in the entrepreneurship rate in developing countries has a positive effect on growth. On the contrary, in developed countries, there is no evident growth penalty. Supplemental results suggest that is because in developed countries as a whole, entrepreneurship is now close to its optimal level, whereas in developing countries the optimal rates of entrepreneurship are much higher. We also explore how the growth penalty varies with characteristics of the country, allowing us to test theories regarding the relationship between entrepreneurship and growth. We show that higher levels of R&D capability decrease the growth penalty of having too few entrepreneurs, suggesting that entrepreneurship and R&D are substitutes. Availability of venture capital also increases the growth penalty, but only in developing countries, where our data on venture capital best proxy its availability to start-ups.

1   INTRODUCTION

In recent decades there has been growing interest in the role of entrepreneurship in stimulating economic growth in knowledge economies. New, small companies play a vital role in the modern entrepreneurial economy, in conjunction with the ICT (Information and Communications Technology) revolution, globalization, and changes in organizational structure and the competitive milieu after the transformation of managed economies (Audretsch & Thurik 2000, 2001). While the literature strongly suggests that entrepreneurship contributes to growth in developed nations (Mueller 2007; Acs et al. 2012), less is known about the role of entrepreneurs in middle and low income nations. Sautet (2013) argues that "[e]mpirically, the effect of entrepreneurship on development remains to be established" [390] and Naudé (2011) asserts in this journal that in development economics "entrepreneurship is largely absent from explanations of growth and development" [33].

The relationship between entrepreneurship and growth in less developed countries (LDCs) is complex, and there is no conclusive theoretical and empirical evidence on the impact of entrepreneurship on economic growth in these countries.[1] Self-employment is negatively correlated with income per capita (Acs 2006): LDCs have many self-employed individuals and low income. Not all self-employment is entrepreneurial, however.   The important question we address is whether more entrepreneurial activity, appropriately defined, would increase economic growth in the developing world. Determining whether entrepreneurship spurs

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[1] We use the term LDCs to refer to the low and middle income countries (as categorized below), not to be confused with Least Developed Countries.

economic growth has important policy implications. Despite solid evidence from the literature, international development agencies treat entrepreneurship as a tool to alleviate poverty and improve the effectiveness and sustainability of aid.[2] Our analysis provides empirical evidence that is applicable to the question: Do policies that promote entrepreneurship are likely to result on greater economic growth in LDCs?

In order to study the impact of entrepreneurship on economic growth, we investigate whether a country suffers a "growth penalty" when entrepreneurship deviates from its optimal level. Entrepreneurship here refers specifically to new business creation: the fraction of the working age population engaged in starting a business or running one that is less than 3.5 years old. Following Audretsch et al. (2002), we estimate growth equations that allow each country to have its own optimal rate of entrepreneurship. Deviations from the optimal level of entrepreneurial activity—in either direction—lower national output from its potential, negatively impacting growth. The approach accounts for heterogeneity among countries, since the extent of fundamental changes in industry structure can differ across countries.

Our study aims at understanding how entrepreneurship affects growth in the developing and developed nations in the last decade, and contributes to the literature in several ways. First, we extend the analysis of Audretsch et al. (2002), who study how deviations from the optimal industry structure affect economic growth. While Audretsch et al. (2002) use data from 18 developed European countries during the 1990-94 period, our study includes data from

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[2] Refer to Naudé (2013) for a review of the literature on theory and empirical evidence linking entrepreneurship and development.

developed and developing countries for a more recent period. Our data on entrepreneurship, which comes from the Global Entrepreneurship Monitor (GEM), cover the period 2003-2011, which is a more recent period than has been examined by previous studies of the impact of entrepreneurship on growth. Using data from the 2000s from a broad range of countries is important to investigate how entrepreneurship can help developing countries grow in the new millennium.. Second, we also extend the literature by treating the impact of entrepreneurship on growth as heterogeneous across countries and by exploring some sources of the differences in impact. We expect—and find—that the marginal impact of entrepreneurship differs across countries. Third, the methodology used in this analysis accounts for unobserved country- and year-specific confounding factors in the determinants of the level and growth rate of real national output per capita, including the unobserved optimal rate of entrepreneurship and differing initial stages of development. Fourth, we develop and implement a novel methodology to estimate the optimal level of entrepreneurship in a country. Fifth, our analysis also expands on previous work by considering how R&D capabilities and the availability of venture capital influence the impact that entrepreneurship has on economic growth.

Our analysis shows that in LDCs entrepreneurship is generally below its optimal level. Our finding is robust to many different regression specifications and methods. Notwithstanding that LDCs have more of their population running nascent small firms than in developed countries, a marginal increase in the entrepreneurship rate in LDCs has a positive effect on growth. On the contrary, in high income countries, there is no evident growth penalty. Supplemental results suggest that is because in developed countries as a whole, entrepreneurship is now close to its optimal level, whereas in LDCs the optimal rates of entrepreneurship are much higher.

We also explore how the growth penalty varies with characteristics of the country, allowing us to test theories regarding the relationship between entrepreneurship and growth. We show that higher levels of R&D capability decrease the growth penalty of having too few entrepreneurs, suggesting that entrepreneurship and R&D are substitutes (Braunerhjelm et al. 2010). Availability of venture capital also increases the growth penalty, but only in low-income countries, where our data on venture capital best proxy its availability to start-ups.

The next section reviews some of the relevant literature on entrepreneurship and economic growth. The data for the empirical study are described in section 3, and the main econometric methodology is introduced in section 4. The empirical results are discussed in section 5, and the final section contains concluding discussion on the findings and import of the work.

2   ENTREPRENEURSHIP AND GROWTH

Economists have long known that modern national economic growth cannot fully be explained by growth in the usage of inputs such as labor, land, and capital alone (Solow 1957). Recently, attention has turned to the role of the entrepreneur in seizing opportunities in the dynamic economy to produce growth (Holcombe 1998). The shift from a managed to an entrepreneurial economy heightened the importance of the small entrepreneur (Loveman & Sengenberger 1991; Acs & Audretsch 1993; Audretsch & Thurik 2000).

Holcombe's (1998) provides a theoretical framework linking entrepreneurship to growth, drawing on Adam Smith's vision of economic growth, in which "entrepreneurial insights are profit opportunities that had previously gone unnoticed" [46]. Under this view, which also derives from Kirzner's (1973) theory of entrepreneurship, the process matters more than the

inputs in the production function, and economic growth is derived from these unnoticed profit opportunities. Economic growth also results in more entrepreneurial opportunities, which consequently result in greater incentives for entrepreneurs to act on them. Thus, there is a virtuous cycle in which entrepreneurship leads to growth and thence to more entrepreneurship. Thus, entrepreneurship is an important determinant of economic growth under this framework.

Other theoretical models that illuminate the relationship between entrepreneurship and growth include those of Acs et al. (2012, 2009), which build knowledge spillovers into the theory of entrepreneurship. In these models, the start-up of new firms—entrepreneurial activity—facilitates knowledge spillovers, which lead to greater economic growth. Given that knowledge is non-rivalrous and only partially excludable, all firms benefit from knowledge created by entrepreneurs and labor employed in R&D.

Reynolds et al. (1999) provide a conceptual model in which entrepreneurial opportunities lead to more start-ups and jobs but also firm deaths and job destruction in overturned segments of industry. The process depends on the capacity of the economy: access to financing, R&D transfer, government policies and programs, education, and other factors. In our empirical investigation, we therefore explore whether the impact of entrepreneurship is modified by access to venture capital and R&D capacity. The "creative destruction" that results from the interaction of entrepreneurial opportunities and capacity shapes business dynamics and economic growth.

When defining entrepreneurship for purposes of this study, note first that identifying entrepreneurship with self-employment alone may lead to misleading results, since self-employment is negatively associated with economic growth in some cases (Salgado-Banda

2007). Gindling and Newhouse (2013) show that self-employment is often a necessity instead of a choice in LDCs. In industrialized countries self-employment is more often a voluntary decision, instead of merely representing "disguised unemployment" for a large share of self-employed individuals as in middle and low income countries (Mandelman & Montes-Rojas, 2009).

We therefore focus on the entrepreneur as the starter and owner of new businesses. Thus, in the rest of this article the term *entrepreneurship* is to be understood to refer to early-stage entrepreneurial activity in new firms, in accord with our empirical measure discussed in section 3. Consider two related individuals: the small business owner and the Schumpeterian entrepreneur. A Schumpeterian view of entrepreneurship implies intense and continuous competition between new products and ideas (Wennekers & Thurik 1999). Entrepreneurial aspects such as risk taking and motivation lead to the growth of firms through innovation (Hampel-Milagrosa et al. 2015). Not all small businesses are entrepreneurial and not all entrepreneurship takes place in small firms. However, when the two concepts overlap, they are of great importance to the economy (Wennekers & Thurik 1999; Thurik et al. 2002).

2.1 The Entrepreneur and Stages of Economic Development

The role of the entrepreneur changes with the level of development of an economy. The small entrepreneurial firm is especially important in developing countries, whether one look to the past in the US or LDCs today. In less developed markets characterized by imperfections in coverage and institutions, an important role of the small entrepreneur is to fill gaps in markets. This requires discovering opportunities and being willing to be the ultimate risk-bearer (Leibenstein 1968). The entrepreneur as gap-filler and risk-bearer is especially important to

economic growth in developing nations, where "routinized market mechanisms" do not exist and new ideas must often self-financed (Leff 1979).

With progressive economic development, the prevalence and importance to the economy of larger firms increases. Theoretical literature, beginning with Lucas (1978), predicts that the average size of the firm grows with national income. Lucas hypothesizes that as economic development progresses, the increasing intensity of capital raises wages and, therefore, the opportunity costs of the entrepreneur. As a result, some entrepreneurs give up entrepreneurship and become wage workers in established firms instead. Schumpeter (1943) pointed in *Capitalism, Society, and Democracy* to large enterprises as the chief drivers of the capitalist engine of technological progress and increasing prosperity. As capitalism progresses, "technological progress is increasingly becoming the business of teams of trained specialists who turn out what is required and make it work in predictable ways" [p. 132] and the R&D departments of large firms are required to support such effort. These ideas suggest that entrepreneurship and R&D can be substitute determinants of growth, which we test. Braunerhjelm et al. (2010) formalize this notion in a model where entrepreneurship and R&D turn out to be substitutable around the balanced growth path in the economy, and also find empirical support for it.

Schumpeter's writings predated the reversal of the mid-20th century trend towards centralization, identified by Blau (1987) as beginning in the mid-1970s. The development of new information and communication technology reduced or eliminated the efficiency advantages of large corporations, allowing nimbler and more flexible small organizations to thrive in the new economy (Carlsson 1989). Thus even advanced economies today will benefit

from having small entrepreneurs.

The preceding discussion shows that empirical analyses that look for monotonic effects of entrepreneurship on growth are likely to be misspecified. Regardless of the level of development in the economy, the optimal fraction of individuals devoted to entrepreneurship is neither zero nor one. The Schumpeterian entrepreneur is required to turn knowledge into profitable business activity (Schumpeter 1911; Braunerhjelm et al. 2010). As Wennekers & Thurik (1999) discuss, when there are too few small, innovative business owners, competition in the economy may suffer, with attendant loss of efficiency. On the other hand, large incumbent firms produce the most new knowledge through R&D (Schumpeter 1943; Scherer 1992), by taking advantage of scale and scope in R&D. With too many small entrepreneurs, technological progress stemming from large-scale R&D may suffer and the average scale of production will be inefficiently low. The necessity of both entrepreneurship and larger incumbent firms implies an interior equilibrium in the entrepreneurship rate. Thus, we follow Audretsch et al. (2002), Carree et al. (2002, 2007) and van Stel et al. (2014) in adopting an empirical model that accounts for an interior optimal entrepreneurship rate and therefore nonmonotonic effects on growth of the actual entrepreneurship rate.

2.2 Evidence on the Contribution of Entrepreneurship to Growth

Many empirical studies measure the contribution of entrepreneurship rates to economic growth in OECD countries. Such research generally finds positive association between entrepreneurship and higher productivity that is robust to different model specifications and periods (Mueller 2007; Braunerhjelm et al. 2010; Acs et al. 2012).

The literature quantifying the impact of entrepreneurship on growth in developing nations

is smaller but growing rapidly due to the availability of new datasets. Several studies use earlier waves of the same data studied here, GEM. Van Stel et al. (2005) find the total entrepreneurship rate (TEA) to be positively associated with growth in rich countries and inversely correlated with growth in low income countries. Stam et al. (2009) and Valliere & Peterson (2009) find that high-growth entrepreneurs contribute to growth in developed countries only. Referring to such negative results, Sautet (2013) refers to the apparent impotence of entrepreneurship to spur growth as "the puzzle of entrepreneurship and economic development." Our conclusions differ from those of these authors. Once we control for differences among countries in the optimal industry structure and for unobserved country- and year-specific growth factors, we find evidence that more entrepreneurship stimulates growth in LDCs. Our results are closer to those of Van Stel et al. (2010), who also find that TEA has no significant impact on growth in rich countries, but does in poor countries. Wong et al. (2005) find that high-growth entrepreneurship contributes to growth regardless of income level.

Our methodology is most similar to a set of papers examining whether there is a growth penalty for countries that have not adjusted towards the optimal industry structure. In their sample of seventeen European countries between 1990 and 1994, Audretsch et al. (2002) find evidence that when countries shift away from large firms they experience higher growth rates. Carree et al. (2002) reach similar conclusions for a sample of 23 OECD countries between 1976 and 1996. Carree et al. (2007) and van Stel et al. (2010, 2014) use similar methodology to test other hypotheses concerning the growth penalty. Like the first of these papers but unlike the others, our estimates are robust to the presence of unobserved country- and year-specific confounding factors in the determinants of the level and growth rate of national output. Unlike

any of the previous literature, we also allow the impact of entrepreneurship on growth to be heterogeneous at the country level.

3 DESCRIPTION OF THE DATA

The variable of interest for this study is the rate of entrepreneurship in a country, taken from the Global Entrepreneurship Monitor (GEM).[3] The annual GEM surveys collect data from individuals around the world regarding entrepreneurial activity, and include countries across the range of national income. The data employed here are derived from GEM's Adult Population Survey. To collect data that are comparable across countries and time, the same survey is administered at the same time of year to a representative national sample targeting at least 2,000 randomly selected adults.[4] The final sample size varies by country and by year.[5] The data are weighted to be representative at the national level by matching each country's distribution of the population by gender and age groups.[6]

We use the resulting nationally aggregated GEM data for 2001-2011 from 53 countries (the most allowed by the availability of data), although data are not observed for all years for

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[3] See http://www.gemconsortium.org.

[4] The sample of 18 to 65 year olds used for our entrepreneurship variable (*TEA*) may be smaller. In 2009, for example, the final sample size ranged from 1,607 to 17,500. The first quartile was 2,000, the median was 2,005, the third quartile was 2,401, and the average was 2,814.

[5] Refer to the GEM annual reports, Appendix 2, for countries included, the number of individuals surveyed, and the interview procedure used. The countries in our sample are listed in Table 1.

[6] Refer to http://www.gemconsortium.org/about/wiki for explanation of the survey weights.

some countries. Of the nine years used for estimation,[7] there is an average of 5.1 observations per country. Our main variable of interest is the total early-stage entrepreneurial activity (*TEA*), defined as the percentage of subpopulation aged 18-64 who are nascent entrepreneurs or who own and manage a new business.[8] In contrast to some previous studies that also explore data from GEM, we focus solely on *TEA* to measure entrepreneurial activity.[9]

The outcome of interest for the estimations is the growth rate of *GDPPC*, the per capita gross domestic product*, expressed in terms of purchasing power parity (PPP, constant international 2005 currency), taken from the World Bank's World Development Indicators (WDI).[10] For some estimations, the countries are placed into low, middle, and high income groups using data from the beginning of the sample. Countries in the bottom and top quartile

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[7] Although the data begin in 2001, given the double difference specification adopted below the first year in the estimation sample is 2003.

[8] A nascent entrepreneur is one who is actively involved in starting a business, and the enterprise has paid salaries, wages, or other payments to the owners for three months or fewer. A new business is defined as an active enterprise that has paid salaries, wages, or other payments to the owners for between three and 42 months. See survey definitions at http://www.gemconsortium.org/about/wiki.

[9] Other measures explored by previous authors include the proportion of entrepreneurs who hold high growth expectations and business owners who state they became entrepreneurs out of opportunity instead of necessity. We do not use these measures because their subjective nature may make them less comparable across countries and cultures and because they may create endogeneity problems in the estimations. For example, when an economy is growing, more entrepreneurs may state that they have high expectations for growth, which may lead to spurious association between this measure of entrepreneurship and growth. *TEA*, on the other hand, is defined by objective criteria.

[10] See http://data.worldbank.org/data-catalog/world-development-indicators.

groups of initial GDPPC compose the low and high income groups, respectively, and the remaining middle half of countries compose the middle income group.[11] See Table 1 for the list of countries in each income group.

Other variables are included in the study to model the heterogeneity of the growth penalty. The first country-level variable we use is the log number of R&D researchers per million people (*RDworker*, from WDI). *RDworker* is a proxy for the R&D capacity or capability in the economy. We use *RDworkers* instead of actual performed R&D or the stock of R&D to focus on the capacity to do R&D and to avoid potential issues with endogeneity and reverse causality. The other country-level variable is the log of the total venture capital value as a fraction of GDP, *VentureCapAmt*. The data on venture capital are from the Zephyr database.[12] A related variable, *VentureCapAny*, is an indicator variable for countries with any venture capital activity at all during the sample period, and *VentureCapNone* is a complementary variable.

Summary statistics by income level for all variables are in Table 2. Growth in national output per capita averages 3.0% for low income countries, 1.8% for middle income countries, and 0.9% for the high income group. Lower income countries tend to have more of their

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[11] Our results to follow are not dependent upon the categorization of income. The final set of regressions do not use these categorizations, yet still show that LDCs have too few entrepreneurs and the highest growth penalties.

[12] Zephyr is an international deal information database from Bureau van Dijk with extensive worldwide coverage; see Reiter (2013) for details. Where the value of a deal was unavailable (17.8% of deals), the average value from other deals from that country and year were used. The remaining missing values for total deal value for the country-year (7.4% of observations) were filled in with tobit regression-based imputation (with left censoring at zero). Variables included in the regression for imputation were GDP, GDP squared, and a country dummy variable.

working age population engaged in entrepreneurship than in middle income countries, although there is a high degree of variation in the low income sample. Over all years, *TEA* averages 15.6% in low income countries and 7.7% in middle income countries. Middle income nations have more entrepreneurs than high income countries on average, although there are some notable exceptions to the latter general comparison. Whereas *TEA* averages 6.5% for the high income group, the entrepreneurship rate of two of those nations (Iceland and the United States) is greater than 10%. *TEA* for several middle-income nations is above 10% (Argentina, Australia, Brazil, Chile, New Zealand, and Uruguay) or below 5% (Belgium, France, Italy, and Malaysia). High income countries have the most workers engaged in research and the highest amount of venture capital activity.

4 EMPIRICAL STRATEGY

In this section the foundation for the empirical work is described. We base our initial empirical analysis on extensions to the growth penalty model of Audretsch et al. (2002). Audretsch et al.'s (2002) empirical model is motivated by the shifts in industry structure related to the process of decentralization and deconcentration experienced by industrialized countries since the 1980s. The transition in the industry structure toward new, small entrepreneurial firms is likely to result in job creation and growth. The empirical approach allows us to account for the fact that the timing and extent of the shift in industry structure is different across countries and is shaped by country-specific factors.

Denote the one-year change in log(*GDPPC*) for country i in year t as y_{it}. Then national output growth is modeled as a function of y_{it}*, the economic growth rate when entrepreneurship

is at its optimal rate, a growth penalty caused by any deviation from the optimal industry structure TEA_i^*, and an econometric error term:

$$y_{it} = y_{it}^* - \gamma |\log TEA_{it-1} - \log TEA_i^*| + (\alpha_i + \varepsilon_{it}) \qquad (1)$$

TEA is lagged one period both to avoid problems of endogeneity and because it takes time for the impact of changes in industrial structure to affect national output. TEA_i^* is the entrepreneurship rate that maximizes growth. TEA_i^* is allowed to differ freely among countries, but for expositional convenience is assumed to be constant in equation (1) within a country. This assumption can be relaxed to allow TEA^* to vary over time within an income group, although we will not indicate this in the notation.[13] Parameter γ is positive if growth depends on industry structure at all, by definition of TEA_i^*. The form of the growth penalty term in equation (1) implies that output growth declines linearly with deviation to either side of the optimal TEA. Given the use of logs within the absolute value bars in equation (1), the deviation is expressed in approximate percentage terms. The error term in equation (1) consists of a country-specific term α_i and a mean-zero residual ε_{it} incorporating idiosyncratic deviations from mean output growth conditional on the regressors and α_i. Parameter α_i captures all unobserved growth factors unique to the nation that do not change over time. One such factor is the initial income level of the country, which has been found to be an important determinant of growth in the macroeconomic literature on the convergence hypothesis (e.g.,

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[13] Due to the addition of the fixed effects for year × income group (discussed below), we can relax the restriction that TEA_i^* does not vary over time. If $TEA^* = \overline{TEA}_i^* + TEA_{gt}^*$, where $\overline{TEA}_i^*$ is the time-mean of optimal entrepreneurship for country i and TEA_{gt}^* captures yearly deviations in the optimum common to all countries in income group g, then our estimators for the growth penalty will still be unbiased and consistent.

Barro 1991; de la Fuente 1997) and in previous studies on entrepreneurship and growth (e.g.,
van Stel et al. 2005; Stam et al. 2009).

Taking the first difference of the equation above cancels the unobserved optimal entrepreneurship rate and α_i, removing the possibility that unobserved country-specific factors will confound the analysis. The first difference is expressed as follows:

$$\Delta y_{it} = \Delta y_{it}^* - \gamma(|\log TEA_{it-1} - \log TEA_i^*| - |\log TEA_{it-2} - \log TEA_i^*|) + \Delta \varepsilon_{it} \quad (2)$$

As long as the economy in country i does not leapfrog the optimal entrepreneurship rate from one year to the next,[14] the expressions within the absolute value bars have the same sign and equation (2) can be written as:

$$\Delta y_{it} = \Delta y_{it}^* + \kappa \Delta \log TEA_{it-1} + \Delta \varepsilon_{it} \quad (3)$$

where $\kappa = \gamma \operatorname{sgn}(TEA_i^* - TEA_{i.})$. Whereas γ is positive, the sign of κ is determined by whether entrepreneurial activity in a country is above or below its optimal level. If TEA_{it-1} and TEA_{it-2} are less than TEA_i^*, then κ is positive. Conversely, if entrepreneurship is above its optimal level, κ is negative. Thus, estimates of κ can be used to infer whether the actual entrepreneurship rate is above or below its unobserved optimal level. The size of κ indicates the marginal effect of any deviation from the optimal industry structure on economic growth.

Equation (3) is not directly estimable because the optimal growth rate y_{it}^* is not observed. If within any year y_{it}^* is the same for all countries at approximately the same level of development, then we can replace the first term on the right side of equation (3) with a set of indicator variables for the year interacted with a set of indicator variables for the initial income

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[14] The assumption is justified below; refer to footnote 28.

group of the country. This leads to an equation feasible for use in our first estimation:

$$\Delta y_{it} = \delta_{gt} + \kappa \Delta \log TEA_{it-1} + \Delta \varepsilon_{it} \tag{4}$$

where δ_{gt} is a fixed effect for income group g (= *low, mid, high*) in year *t*. Thus in Regression 1 we regress the double difference of log real GDP on the lagged change in log *TEA* and a set of dummy variables.

We relax the assumption that κ is homogenous across countries in our second specification. It may be the case that some nations have too much entrepreneurship while others have too little. The discussion in section 2.1 suggests that the optimal entrepreneurship rate varies with the level of development. Replacing κ in equation (4) with income-group specific parameters allows us to examine how the growth penalty varies by stage of development across upper, middle and low income countries:

$$\Delta y_{it} = \delta_{gt} + \kappa_g \Delta \log TEA_{it-1} + \Delta \varepsilon_{it} \tag{5}$$

Finally, our third specification allows us to investigate whether other factors reduce the effect that entrepreneurship would otherwise have. Here we model directly the heterogeneity in the growth penalty by writing κ as a function of a vector of time-constant[15] national level covariates Z_i and an independent mean-zero error term ν_i:

$$\kappa_i = \pi' Z_i + \nu_i \equiv \bar{\kappa}_i + \nu_i \tag{6}$$

Substituting equation (6) into equation (4) yields

$$\Delta y_{it} = \delta_{gt} + \pi' Z_i \Delta \log TEA_{it-1} + (\nu_i \Delta \log TEA_{it-1} + \Delta \varepsilon_{it})$$

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[15] We model κ as time invariant because if it changes over time, then differencing equation (1) no longer removes the unobserved *TEA$_i$** from the estimating equation.

$$= \delta_{gt} + \bar{\kappa}_i \Delta \log TEA_{it-1} + \eta_{it} \qquad (7)$$

For element j of vectors π and Z_i, we have

$$\pi_j = \frac{\partial \partial E(\Delta y_{it})}{\partial Z_{ij} \partial \Delta \log TEA_{it-1}}$$

and thus the interaction coefficients modify the impact of deviations from optimal TEA on growth. When $\bar{\kappa}_i$ is positive, $\pi_k > 0$ implies that marginal increases in Z_{ij} increase the magnitude of the growth penalty. From equation (7), the composite error term η is clearly heteroskedastic and serially correlated, and therefore all inference will be based on standard errors calculated to be robust to heteroskedasticity and clustering at the country level.[16]

Our inclusion of few regressors other than *TEA* follows the approach of the entrepreneurship literature (e.g., Audretsch et al. 2002). However, the reader more familiar with the growth literature in macroeconomics will find the specifications here unusually parsimonious. Literally hundreds of variables have appeared in growth regressions over the last three decades (Durlauf et al. 2005). We do not include variables besides *TEA*, apart from those used to model heterogeneity in κ_i, for several reasons. First, the twice-differenced specification already controls for all factors influencing GDP or its growth rate that do not vary within a country. Given the relatively short period under study, the specification is thus largely immune to bias from omission of slowly-evolving growth factors. Second, the year×income group fixed

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[16] While some of the previous literature on entrepreneurship and growth (Audretsch et al. 2002; Carree et al. 2002, 2007; van Stel et al. 2010, 2014) mention using heteroskedasticity consistent standard errors, none apparently corrected the standard errors for the likely non-independence of observations within a country. Without accounting for clustering within the unit of observation, standard errors in panel data econometrics are likely to be biased downward (Wooldridge 2003).

effects control for all trending factors in the world economy that affect the growth of countries within the same stage of development equally. These two features of our model remove many potential concerns about omitted variable bias.

Finally, entrepreneurship is embedded in the fabric of a modern entrepreneurial economy, and the changing role of entrepreneurship is linked inextricably with change and restructuring in other parts of the economy. Readers should not view our specifications as implying that entrepreneurship is the only factor that can spur growth. The literature on entrepreneurship points out that deregulation, privatization, globalization, and the widespread adoption of ICT have led to transformations in market exchange, competition, transactions among firms, and flexibility in production and input markets (Audretsch & Thurik 2001). Entrepreneurship has co-evolved with these other phenomena, both benefiting from and contributing to them. By not including these other factors in our regressions, the estimated impact of our entrepreneurship variable will include not only the direct effect of *TEA* but also all the indirect effects of changes in the other factors prompted by entrepreneurship. We thus caution the reader when interpreting our coefficients related to *TEA*.[17]

5   RESULTS

Table 3 presents the results of our empirical specifications, all of which are estimated by

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[17] In particular, the coefficient on *TEA* is not to be read as the "causal impact on growth of increasing entrepreneurship while holding all else equal in the economy." Given how intertwined entrepreneurship is with other institutional and economic features of the modern economy, we do not find such a concept to be meaningful.

OLS on the differenced panel data.

5.1 Homogeneous growth penalty

Regression 1 is based on equation (4). The estimate for κ is positive and statistically significant, implying that overall in the sample the entrepreneurship rate is below its optimum.[18] We do not report the year/income group coefficients, δ_{gt}, in the table, even though they are individually and jointly significant, since these fixed effects are in the regression merely to control for the unobserved optimal economic growth rate and other factors with secular movements common to all countries in a group. Although the coefficient $\hat{\kappa}$ appears to be small, the magnitude of the effect is not trivial. The size of the estimate, 0.014, implies that each additional percentage point of relative deviation of *TEA* from its optimum is associated with a decrease in the growth rate of per capita real output of approximately 0.014 percentage points. For example, consider a middle income country with output growing at the sample average for such countries of 1.81% per annum, with actual *TEA* equal to the average of 7.7% and with an optimal *TEA* of 25%. The latter figure is chosen in accord with results to be shown later (see section 5.3). If the country's actual *TEA* increases by one standard deviation to 11.8%, so that the relative deviation of *TEA* from *TEA** decreases from 69% to 53%, then output growth increases by 0.014×(69-53) = 0.22 percentage points to 2.03% per annum. That is a 12%

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[18] A referee suggested that past growth might affect future *TEA*. If so, the assumption of strict exogeneity necessary for the first difference estimator to be consistent would not hold. We test this by adding $\log TEA_{it-1}$ and $\log TEA_{it}$ to Regression 1 (see Wooldridge (2002), p.285). These coefficients were insignificant, whether singly or jointly, showing no evidence of violation of the assumption.

improvement in the growth rate, and the additional growth in output per capita compounds over the years.[19]

5.2   Growth penalty varying by income level

In Regression 2, κ is allowed to vary with the initial income level of the country, as in equation (5). Estimates of Regression 2 are shown in Table 5. The growth penalty decreases with the development level of the country and there is evidence that entrepreneurship rates are too low only in low and perhaps also middle income countries. The coefficient for high income countries is very small and insignificant, which does not allow us to conclude whether developed countries have too many or too few entrepreneurs. The nations in the highest income quartile group are those that led the way in adjusting their industrial structure to changes in the competitive and political environment—what Audretsch & Thurik (2000) call the replacement of the managed economy with the entrepreneurial economy. If these countries have close to the optimal amount of entrepreneurship, there may not be enough variation in the deviation from *TEA** to identify precisely the growth penalty for this group.[20] Alternatively, it may be that

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[19] We explored adding extra control variables in this and the following regression: Hofstede's six cultural factors, and indexes measuring law and order, government stability, and political risk. In no case was there any statistically significant change in the coefficients of interest, nor were the additional variables significant, whether the extra regressors entered equations (4) and (5) in levels or changes. See Table A1, in the Appendix, for a summary of these alternative estimations that include other variables as controls.

[20] When TEA_{it} is close to TEA_i* during the sample period, it must be the case that there is little variation in TEA_{it}, since TEA_i* is time-constant. Regressors with little variation have larger standard errors in their coefficient estimates, and are therefore less likely to be significant.

advanced economies indeed have a lower growth penalty from suboptimal entrepreneurship, given how productive the larger, established firms are in such countries. For either reason, then, it is perhaps unsurprising that there is no evidence that high-income economies suffer a significant growth penalty from not having enough entrepreneurs.[21]

The growth penalty coefficient for middle income countries is about the same as was found for all countries in Regression 1, and has a *p*-value of 0.054. Low income countries have a significant coefficient of 0.041, three times larger than the penalty for middle income countries. Thus, the consequences for low income countries from having suboptimal industrial structure are greater than for other countries. Since both of these coefficients are positive, the results indicate that middle and low-income economies would benefit on average from more entrepreneurial activity. The latter finding is in contrast with some previous results in the literature, and we explore the issue more thoroughly in the following section.

Finally, we note that the Wald test for the joint significance of the three *TEA*-related coefficients is very close to significance at the 5% level (*p*-value = 0.051). Given the lack of a highly significant connection in this regression between the development level of a country and its growth penalty in this regression, we further explore this relationship in an alternative regression. When κ is parameterized with a cubic polynomial in income instead of discrete income groups, the results (not reported) show a similar pattern for the growth penalty: highest

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[21] Braunerhjelm et al. (2010) found, in contrast (albeit with a different sample of countries, definition of entrepreneurship, and econometric method) that as late as 2002 there was too little entrepreneurial activity in OECD countries.

for low-income countries, lowest for high-income countries. The *TEA*-related coefficients were jointly significant at the 5% level in this alternative regression. The relationship between income and the growth penalty in investigated yet further in section 5.6. The evidence presented there shows that while there are exceptions for some countries within each income group, in general the growth penalty is highest for low-income countries.

5.3   Do low-income countries really need more entrepreneurs?

Some previous studies find that entrepreneurship contributes nothing to growth in low income countries (Stam et al. 2009; Valliere & Peterson 2009) or even hinders growth (Van Stel et al. 2005). How then may the present finding (and the similar findings of van Stel et al. (2010, 2014) that, on average, low-income countries have too few entrepreneurs be reconciled with these earlier studies? After all, *TEA* is generally higher in low-income countries to begin with (refer to Table 2). Setting aside some differences in the dates and definitions of the entrepreneurship variables included in the regressions and the fact that our sample size is much larger,[22] there are three major differences between these earlier studies and the present work. First, through differencing the panel data, we control for country-specific unobserved factors that affect growth. The previous studies used either cross-sectional or pooled data, and thus are subject to potential confounding of the impact of entrepreneurship with unobserved factors correlated with both entrepreneurship and growth. Second, we allow the optimal rate of

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[22] Van Stel et al. (2005) and Stam et al. (2009) use 36 cross-country observations on *TEA* from 2002. Valliere & Peterson (2009) have one or two observations per country on three entrepreneurship measures for a total of 68 observations.

entrepreneurship to differ by country. Third, our model postulates that *deviations* from the optimal entrepreneurship rate—not merely the observed rate level—affect growth. Many previous studies tacitly build the assumption into their regression models that growth is monotone in entrepreneurial activity.

Figure 1 illustrates how these differences in the econometric approach can help identify the impact of entrepreneurship on growth where cross-sectional or pooled approaches may lead to spurious results. For the sake of illustration, in the figure (but not in our modeling) it is assumed that developed countries (DCs) have higher growth and lower *TEA* than LDCs, and that DCs and LDCs are homogeneous within their group.[23] The true impact of *TEA* on growth is given by the solid regression lines; given the nature of equation (1) these are symmetric inverted V shapes with slope equal to γ in absolute value. The data points are depicted as circles for DCs and squares for LDCs. Simple regression of growth on *TEA* yields a negatively sloped, but spurious, regression line (the long-dashed line in the figure). This is what cross-sectional or pooled data regression would yield. If separate regression intercepts and slopes are estimated for DCs and LDCs but only the level of *TEA* is assumed to affect growth (as in some previous studies), then the two (again spurious) regression lines with the short dashes are found. In this case one would conclude that entrepreneurship prompts growth in DCs but not in LDCs. The point of the illustration is not to argue that the actual data are as depicted in the figure, but

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[23] Note that DCs has been used sometimes to denote Developing countries. Because in our analysis we want to make a distinction between high (developed) and middle and low (less developed, developing) income countries we use DCs and LDCs to distinguish both groups.

rather to point out how econometric methods that do not control for country-specific optimal entrepreneurship rates and nonlinearities in the impact of entrepreneurship on growth may fail to reveal the true relationships.

If we are to conclude that LDCs need more entrepreneurs despite having more than developed countries, then it must be the case that the optimal rates of entrepreneurship are higher in LDCs. This necessary condition is not testable with the regression model used above, since TEA_i* is differenced out of the regression specification in equation (3). To test whether TEA_i* is indeed higher on average in LDCs than in higher income countries, we modify the econometric model in this section. If the marginal growth cost of deviating from optimal entrepreneurship increases the farther a country is from its optimum, instead of being constant, then TEA_i* is estimable with panel data.[24] In particular, revise equation (1) to be:

$$y_{it} = y_{it}^* - \gamma_g [f(TEA_{it-1}) - f(TEA_i^*)]^2 + (\alpha_i + \varepsilon_{it}) \tag{8}$$

where the growth penalty γ_g is allowed to differ by income group and f is a monotone transformation of *TEA* to be defined later. The quadratic specification in the middle of equation (8), which replaces the term in absolute value in equation (1), implies that economic growth suffers an increasing penalty on the margin as entrepreneurship deviates more from its optimal level. The curvature of the growth penalty can be used to estimate the optimal entrepreneurship rate, TEA_i^*, in the following manner. Expanding the quadratic term in equation (8),

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[24] Van Stel et al. (2010, 2014) estimate optimal entrepreneurship rates for OECD countries using a different method. Unlike their method, the procedure here does not require TEA_i^* to be correctly specified in a separate equation as a linear function of a known set of other economic variables.

differencing over time, and replacing Δy_{it}^* with year-income group indicators as in equation (4) yields the regression equation:

$$\Delta y_{it} = \delta_{gt} - \gamma_g[X_{it-1} - 2f(TEA_i^*)Z_{it-1}] + \Delta\varepsilon_{it} \tag{9}$$

where $X_{it} = \Delta\{[f(TEA_{it})]^2\}$ and $Z_{it} = \Delta f(TEA_{it})$. Define $\beta_{1g} = -\gamma_g$ and $\beta_{2i} = 2\gamma_g f(TEA_i^*)$. Then equation (9) can be written in the form of a linear regression:

$$\Delta y_{it} = \delta_{gt} + \beta_{1g}X_{it-1} + \beta_{2i}Z_{it-1} + \Delta\varepsilon_{it} \tag{10}$$

Consistent estimates of β_{1g} and β_{2i} can therefore be obtained by OLS, as long as there are at least two observations per country to identify β_{2i}. Given the definitions of β_{1g}, β_{2i}, and equations (9) and (10), the estimates can be inverted to find the optimal rate of entrepreneurship according to the following relationship:

$$TEA_i^* = f^{-1}\left(-\frac{\beta_{2i}}{2\beta_{1g}}\right) \tag{11}$$

Given the range of TEA_i^*, f can be any monotone function mapping the [0,100] interval onto the real line.[25] We choose the inverse of the generalized normal distribution for f, as explained in the appendix.

Obtaining accurate estimates of β_{2i} from our relatively short panel is problematic in practice, since only variation in *TEA* within each country can be exploited to estimate the country-specific slope parameter. Therefore, for practical purposes we first assume that β_{2i} is common to all countries in the same income group. We thus first estimate a single estimate for

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[25] If f is the identity function (i.e., if the quadratic in equation (8) is taken directly on the deviation of TEA_{it-1} from TEA_i^*), then the resulting estimates of TEA_i^* are not bounded to be proper percentages. This is why f is introduced in equation (8).

the average *TEA** for each income group, which allows us to test whether optimal entrepreneurship rates are higher in low-income countries.

The resulting estimates of *TEA** from equation (11), using parameter estimates from a regression based on equation (11) with β_{2i} restricted to be common within an income group, are in Table 4 (labeled Estimation 3). The estimates indicate that optimal entrepreneurship rates are indeed higher in low and middle income countries than in high income countries. The estimate of *TEA** for low income countries is 26.3%, a bit lower for middle income countries, and only 8.4% for high income countries. Hypothesis testing reveals that there are statistically significant differences among the three estimates ($p = 0.000$) and between the estimates for the low and high incomes countries ($p = 0.000$).[26]

The second estimation presented in Table 4, Estimation 4, is based directly on equation (11), with individual estimates of *TEA** for each country. For the reasons mentioned above, the parameter estimates of β_{2i} generally have large standard errors and these result should only be read as suggestive. Nevertheless, for comparison to Estimation 3 we present the average and median optimal entrepreneurship rates for each income group. Again, *TEA** is estimated to be highest for the low income countries and lowest for the high income countries. The country-specific estimates of *TEA** from Estimation 4 are depicted in Figure 2. The negative relationship between the estimated *TEA** and the initial income level of the country can be

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[26] Given the relatively large s.e. for the middle income estimate , there is no significant difference between the low and mid income estimates nor between the mid and high income estimates.

clearly seen from the nonparametric regression line calculated from the points.[27] Carree et al. (2007) found a similar negative relationship for OECD countries. Parenthetically, Estimation 4 allows us to test the "no-leapfrogging" assumption that allows equation (3) to be derived from equation (2).[28]

The final column in Table 5 contains the median gaps between the average actual *TEA* for a country and its estimated optimal rate. In accord with the finding above, these results also suggest that low and middle income countries do not have enough entrepreneurs for optimal growth. The entrepreneurship levels in high income countries, on the other hand, are estimated to be close to their optimal levels.[29] Taken together, the results of this section thus bolster the finding from Regression 2 that economic growth in LDCs would benefit from more entrepreneurship, notwithstanding the fact that they have higher levels of *TEA* than high income countries.

5.4   Country-specific growth penalties: R&D capacity

We now return to the simpler econometric model of section 4 to investigate further heterogeneity in the growth penalty across countries. The final four regressions are based on equation (7) and model the heterogeneity of the growth penalty coefficient as a function of

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[27] The nonparametric regression curve is calculated using Cleveland's (1979) locally weighted scatter plot smoother (implemented with the lowess function in Stata 13).

[28] Only 10.7% of observations are on the other side of the estimated TEA_i^* from the majority of country i's observations, and in no case was the potential leapfrogging statistically significant.

[29] The results in Table 4 depend on the functional form chosen for f in equation (8). In the appendix we discuss how alternative functional forms generally yielded qualitatively similar results.

covariates. To be consistent with equation (6), the time averages of the variables discussed in this subsection and the next are used (see footnote 15). In Regression 5, reported in Table 5, κ is a function of a constant and log *RDworkers*. The coefficient for *RDworkers*, which is an element of π in equation (6), is negative and highly significant. To understand the implication of the negative sign, first recall that Regressions 1 and 2 show that κ is positive where it is significant. Thus, having more R&D capability in the economy reduces the magnitude of the growth penalty from having too few entrepreneurs.

This finding is consistent with the theoretical model and empirical findings of Braunerhjelm et al. (2010), mentioned in section 2.1. Entrepreneurial start-ups typically do little or no R&D, but instead focus on developing new products, services, and business models (Braunerhjelm et al. 2010) and if necessary rely on the accumulated stock of knowledge developed by larger (non-entrepreneurial) incumbent firms (Acs et al. 2009). An economy with greater R&D capacity available for use by incumbents has more potential for growth from this avenue, and correspondingly suffers less of a penalty from a lack of entrepreneurs.

Variable *RDworker* may best proxy R&D capability in advanced economies, where knowledge workers have the most access to education, knowledge, and capital. We therefore expect the growth penalty to be affected by *RDworker* most in high income countries. In Regression 6, π from equation (6) is allowed to differ by income level. While the impact of *RDworker* on the growth penalty is indeed greatest in the wealthiest countries ($\hat{\pi} = -0.027$ for them), the sample size is too small to estimate precisely separate impacts by income group; none of the estimated $\hat{\pi}$ are significant (although the coefficients for all the regressors

involving *TEA* are still jointly significant).[30]

5.5   Country-specific growth penalties: Access to venture capital

LDCs tend to have high levels of *TEA*, much of which may not be engaged in innovative activity. Innovative start-ups often require venture capital (VC) to succeed, and VC has become an increasingly important engine for growth across the globe (Wright et al., 2005). We expect access to VC raise the growth penalty, since innovative entrepreneurship would have the greatest chance of contributing to national growth in such areas. VC is well established in developed countries; the variable *VentureCapAmt* is likely to best proxy an entrepreneur's potential access to VC in LDCs, where VC is most variable.

In Regression 7, the VC variables replace *RDworkers* as the covariates determining the growth penalty.[31] Preliminary estimations showed that the impact of VC differed greatly among income groups, and so π from equation (6) is allowed in the specification to differ in LDCs, compared to the baseline coefficient pertaining to all countries. Several low-income countries[32] had no VC activity during the sample period. Thus, the regression function from

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[30] In an alternative regression allowing the impact of *RDworker* on the growth penalty to vary with a cubic polynomial in the income level, $\hat{\pi}$ is insignificant for low and lower-middle income countries and is negative and significant for upper-middle and upper income countries (result available upon request). This provides further evidence that, as expected, the growth penalty is affected by *RDworker* the most in higher income countries.

[31] We do not include the R&D and venture capital variables in the same regression because there are several missing observations for *RDworkers*.

[32] These are Bosnia and Herzegovina, the Dominican Republic, Guatemala, Peru, Servia, and Tunisia.

equation (6) is specified so that such countries are given their own coefficient in π, and the coefficient of log *VentureCapAmt* for low-income countries applies only to observations with positive amounts of VC. Thus:

$$\bar{\kappa}_{high,i} = \pi_{hi,0} + \pi_{hi,1}\log(VentureCapAmt_i)$$

$$\bar{\kappa}_{\Delta mid,i} = \pi_{\Delta mid,0} + \pi_{\Delta mid,1}\log(VentureCapAmt_i)$$

$$\bar{\kappa}_{\Delta low,i} = \pi_{\Delta low,0} + \pi_{\Delta low,1}VentureCapNone \times \ln(VentureCapAmt_i)$$

$$+ \pi_{\Delta low,2}VentureCapNone$$

where the notation Δg means that the coefficients reflect the difference of group g from high-income countries.

The results, reported in Table 5, show that the coefficients on log *VentureCapAmt* ($\pi_{hi,1}$ and $\pi_{\Delta mid,1}$) are not significant for high and medium income countries. However, for low-income countries (where the VC variables best proxy for access to VC), the estimates for coefficients $\pi_{\Delta low,1}$ and $\pi_{\Delta low,2}$ show that having more access to venture capital increases the growth penalty. Thus in LDCs, where κ is positive, increased access to VC is associated with an even larger growth penalty from having too little entrepreneurship. This result is consistent with the observation that where there is little access to VC in LDCs, the entrepreneurs missing from suboptimal *TEA* are less likely to be high-growth value, Schumpeterian entrepreneurs.

5.6 Country-specific growth penalties: A closer look

Using the results of the regressions in Table 5, we can use equation (6) to compute the coefficient for the mean growth penalty, $\bar{\kappa}_i$, for each country as $\hat{\pi}'Z_i$. Figure 3 contains the distribution of the country-specific estimates of $\bar{\kappa}$ based on Regression 5. As suggested by the

results of Regression 2, the countries on the left side of the graph, where the coefficients are small and insignificant, are generally more developed countries. All but 12 estimates out of 47 countries have a positive estimate of $\bar{\kappa}$, and none are significantly negative. In 24 countries, the estimated $\bar{\kappa}$ is significant at the 5% level. Figure 4 shows similar but even more significant results based on Regression 7, with significance for 40 out of 51 estimates. Here a few high income countries and one middle income country have significant negative estimates of $\bar{\kappa}$. Taken together, the figures suggest that, with some exceptions, LDCs generally have too few entrepreneurs, as evidenced by their positive, significant estimates of $\bar{\kappa}$. On the other hand, high income countries either have no growth penalty or perhaps—in a few cases—too many entrepreneurs.

The relationship between the level of development of the country and the growth penalty coefficient is further explored in Figures 5-8. The curve in each figure is a smoothed scatterplot[33] of initial GDP and the estimated $\bar{\kappa}_i$ from the four regressions in Table 5. The overall downward trend of the curves reflects the negative average relationship between income and the growth penalty. This finding that LDCs on average have too many entrepreneurs while high income countries do not is robust to the changes in how the regressions are specified among the figures. Furthermore, the figures show that not only is there heterogeneity in the growth penalty across income levels, but that there is additional heterogeneity in $\bar{\kappa}_i$ within income groups. For example, the left side of Figure 5 shows a cluster of LDCs with widely varying growth penalty, and the right side of Figure 6 shows the

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[33] Refer to footnote 27.

same for high income countries. This shows the importance of the factors besides income—R&D capability and access to venture capital—in the link between industry structure and growth.

6 DISCUSSION AND CONCLUSIONS

In this paper, we have analyzed the impact of being above or below the optimal rate of entrepreneurship on economic growth. The investigation uncovers a result that is at first a conundrum. LDCs have more new, small businesses than wealthier countries. At the same time, our empirical evidence shows that low and middle income countries generally do not have enough entrepreneurs. How are we to reconcile these facts? There are several possible reasons why LDCs may remain poor despite the high levels of entrepreneurship:

1) even more entrepreneurship might be required for growth in an LDC to take off,

2) there might be other factors that reduce the impact of entrepreneurship on growth, and

3) entrepreneurship in LDCs might not be of the right kind.

The work in section 5.3 presents statistical evidence for the first of these reasons: the optimal rate of entrepreneurship is generally higher in lower income countries. Carree et al. (2007) found a similar result within a narrower set of OECD countries. Apart from our results here, there are several other reasons to expect that the best rate of entrepreneurship for developed countries is lower than for LDCs. As discussed in section 2.1, economic theory predicts that the average size of firms increases with progressive economic development (Lucas 1978; Iyigun & Owen 1998). Given that LDCs have lower capital per worker ratios than developed countries, the Lucas hypothesis can explain why the optimal entrepreneurship rates in LDCs

are higher than in more developed countries.

Furthermore, Pagano & Schivardi (2003) explain that in developed economies, larger firms can take advantage of economies of scale and scope in R&D. This is in accord with our finding that most developed countries appear not to suffer any growth consequences from a suboptimal level of entrepreneurial activity. The case is the opposite in LDCs. Without strong technical, managerial, and organizational capability to exploit large-scale R&D opportunities, large firms in LDCs enjoy less of an advantage over smaller firms. It may also be the case that large incumbents are less efficient in LDCs if their market position was motivated by rent seeking and gained through political patronage, cronyism, or capture of regulators (Emerson 2002). Therefore, even though LDCs have higher entrepreneurship rates, it is entirely possible that having even more small firms would increase their economic growth.

The growth penalty proves to be heterogeneous in dimensions other than income, which provides some evidence in favor of the second reason mentioned above for why high levels of entrepreneurship and low national income may coexist in LDCs: other factors are involved. In countries where R&D capability is higher, deviating from the optimal rate of entrepreneurship does not reduce economic growth as much as in countries with less capacity for R&D. This suggests that entrepreneurship and R&D can be alternative factors for national growth. Lack of access to venture capital also decreases the cost of deficient entrepreneurship in developing nations. Without venture capital, highly innovative entrepreneurs—those who would add the most to national growth—would be more likely to fail anyway. Apart from the access to funding itself, venture capitalists provide a valuable "coach" role for start-ups, which Colombo and Grilli (2010) found to be empirically important for the growth of new firms.

The validity of our conclusion that LDCs would benefit from more new businesses does not rest upon the unrealistic assumption that changing the structure of the economy toward more entrepreneurship is costless. The estimated growth penalties are identified from variation in entrepreneurship and growth within each country. Thus, whatever costs a country incurred due to structural change are already netted out of the estimated impacts on growth.

We close with a brief discussion of cautions, policy implications, and desired future work. Our results should not be viewed as reducing the relationship between entrepreneurship and growth to a mechanistic process. The third reason for the coincidence of many small businesses and sluggish growth in LDCs mentioned above recognizes that not every entrepreneur will innovate or create jobs and wealth in communities. The results from section 5.5 suggest that low-income countries need more innovative start-ups, for where there is no (or less) VC activity the growth penalty is smaller.

Therefore, it is important that policy makers in LDCs learn from those in developed countries, who have responded to the changing role of the entrepreneur in the last few decades by promoting new formation of businesses with high potential for growth (Thurik et al. 2002). The large opportunity cost we find for LDCs for their slow adjustment to the optimal industry structure has alarming consequences for forgone growth. Whether through encouraging entrepreneurship through explicit policy or reforming institutions and the myriad policies that discourage entrepreneurship indirectly (Litan et al. 2009), policy makers can promote innovation and remove roadblocks to national economic growth.

Our results in section 5.3 suggest that high income countries suffer no growth penalty because they may be close to their optimal rates of entrepreneurship. However, a definitive

answer will have to await the collection of more years of data to identify more precisely the individual countries' optimal rates. Another important caution concerns the validity of our results for LDCs. The work in section 5.6 shows that despite the robust average relationship between income and the growth penalty, there can be much variation in the latter among countries of similar income. As for external validity, we do not know whether our results would apply equally to the many LDCs—particularly the poorest countries—not in the sample. As the coverage of GEM and other datasets grows, we hope to discover more detailed knowledge of the role entrepreneurship plays in developing countries.

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FIGURES

Figure 1: An illustration of how pooling the data may lead to spurious results
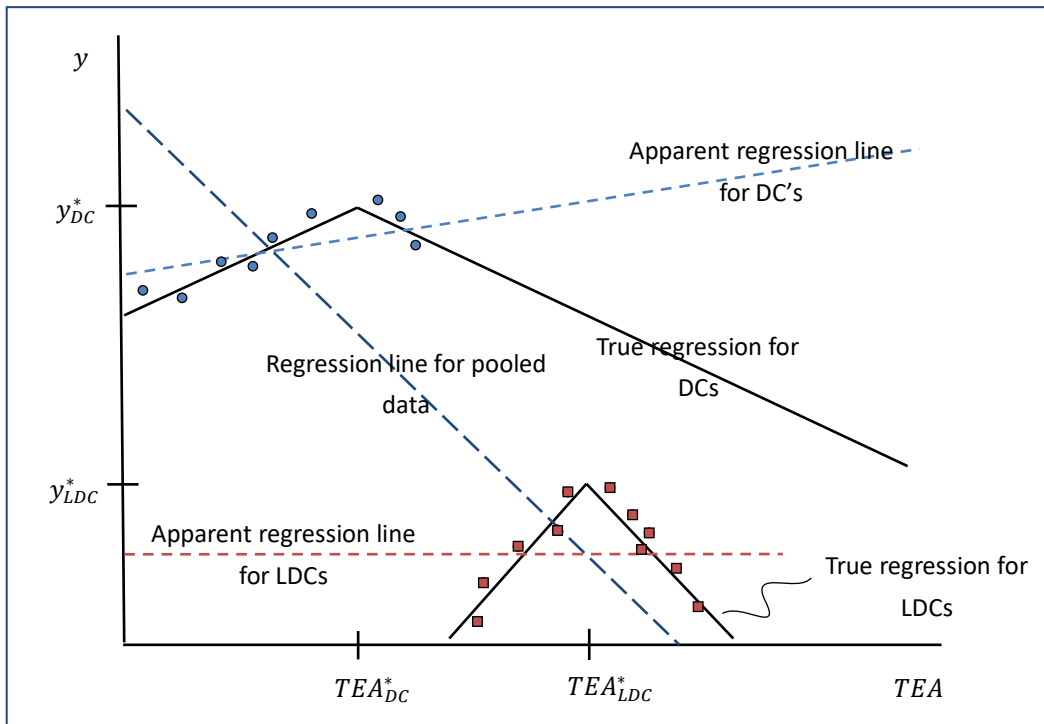

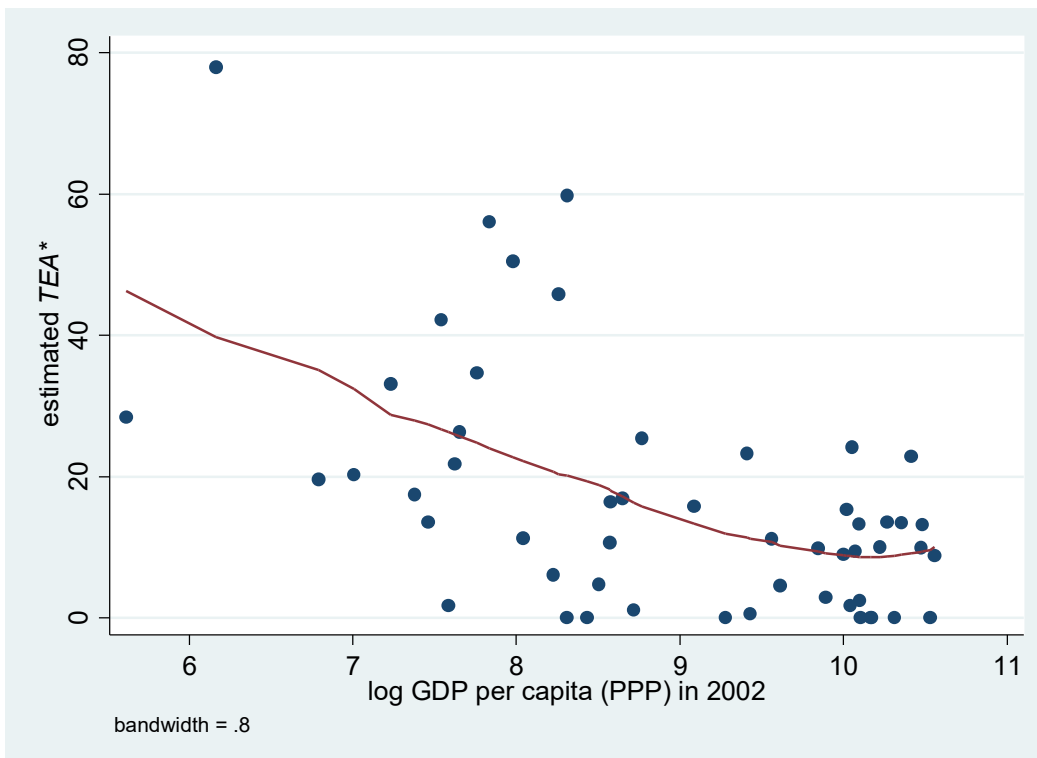**Figure 2: Estimated Optimal Entrepreneurship Rates by Country**

Figure 3: The Distribution of Country-Specific Growth Penalty Coefficients, Based on Regression 5
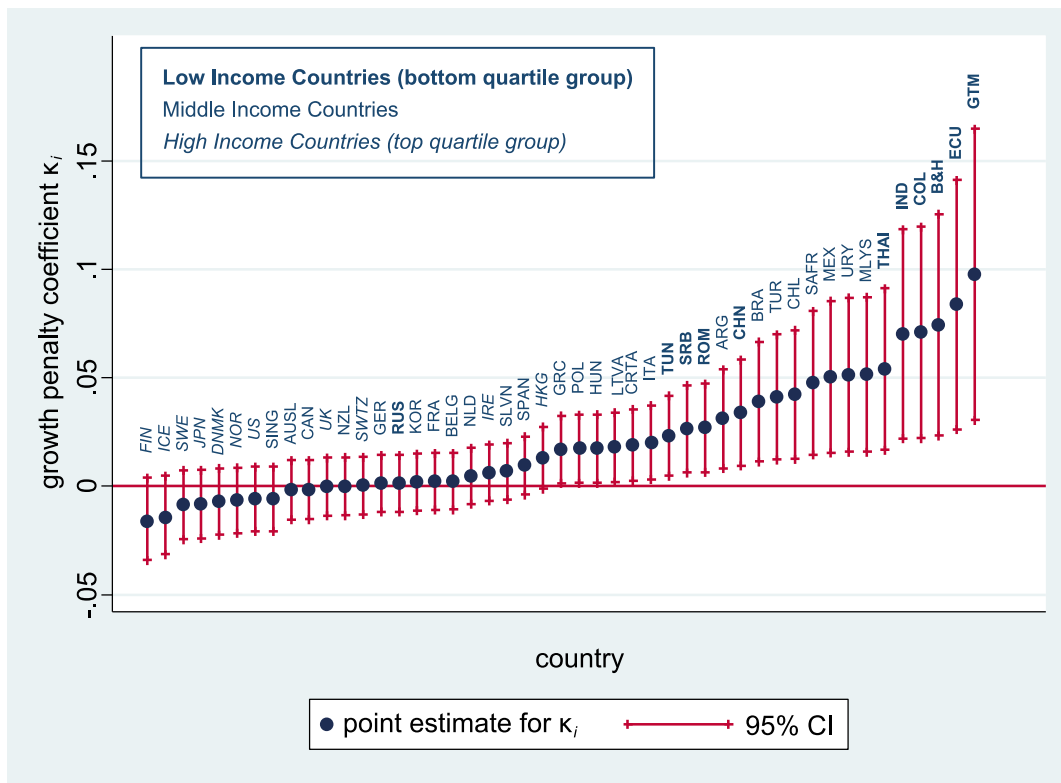

Figure 4: The Distribution of Country-Specific Growth Penalty Coefficients, Based on Regression 7
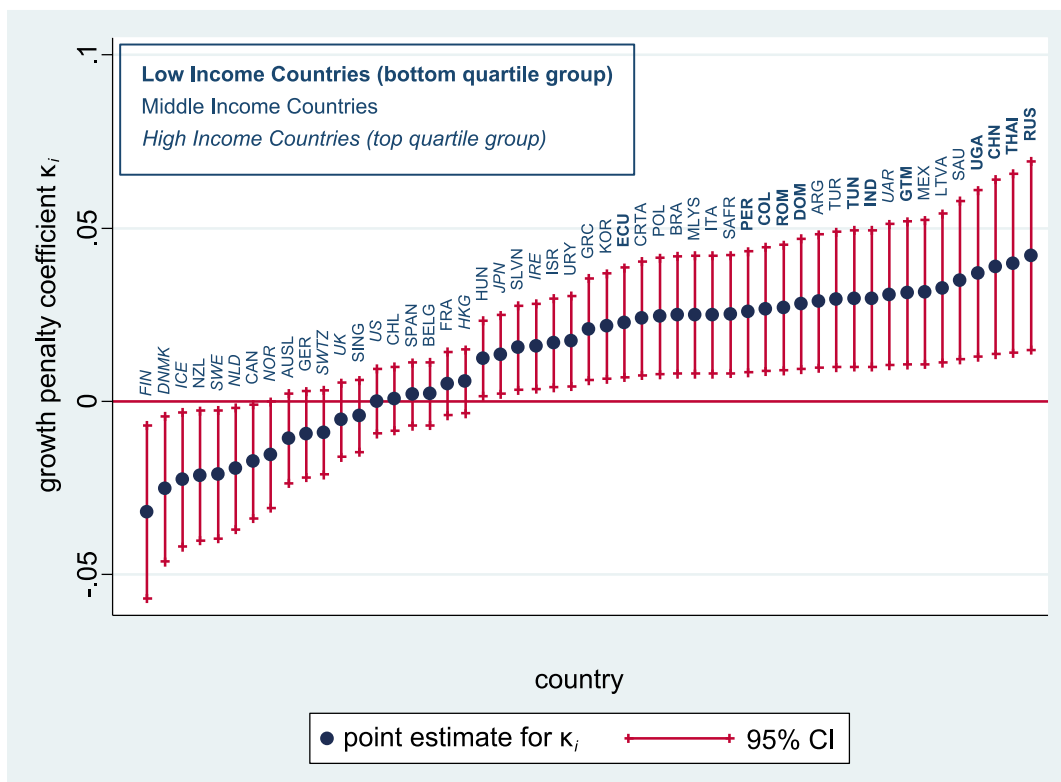
Figure 5: The Relationship between Growth Penalty Coefficient and Income, Based on Regression 5
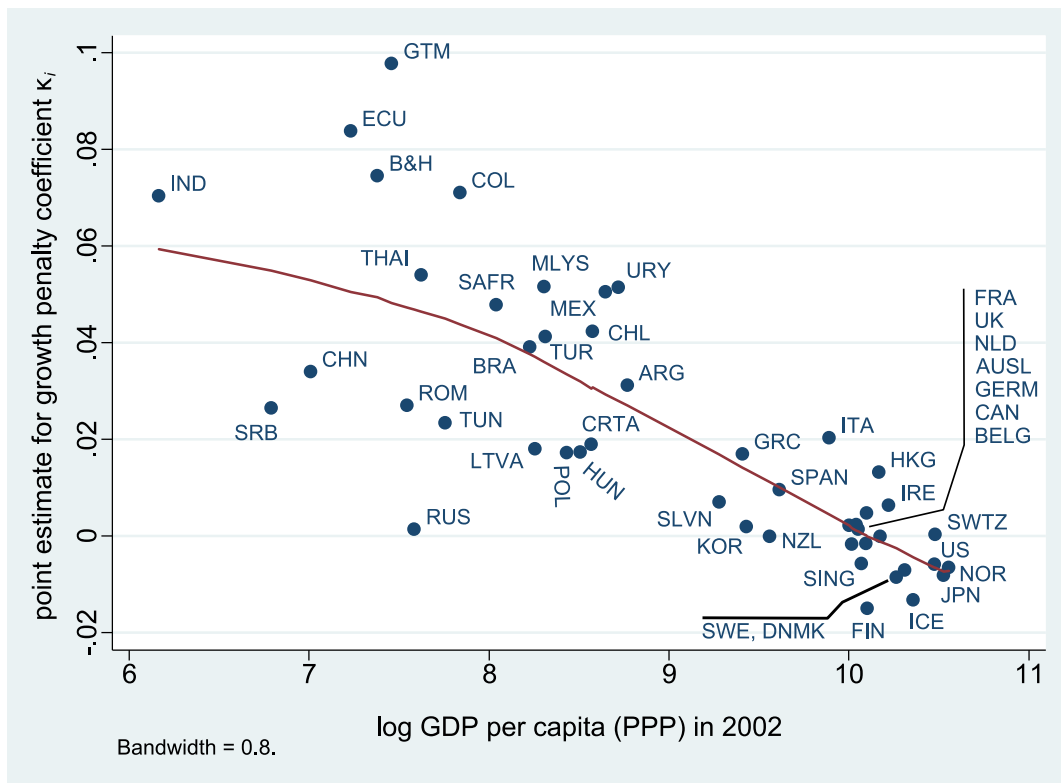

Figure 6: The Relationship between Growth Penalty Coefficient and Income, Based on Regression 7
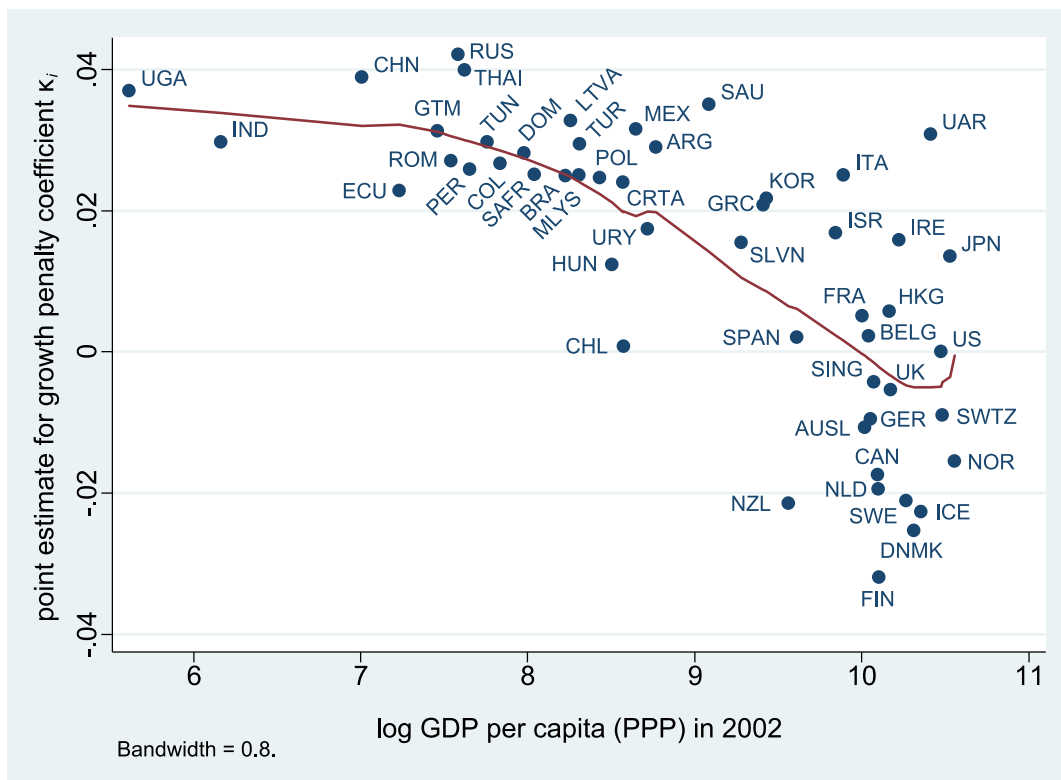
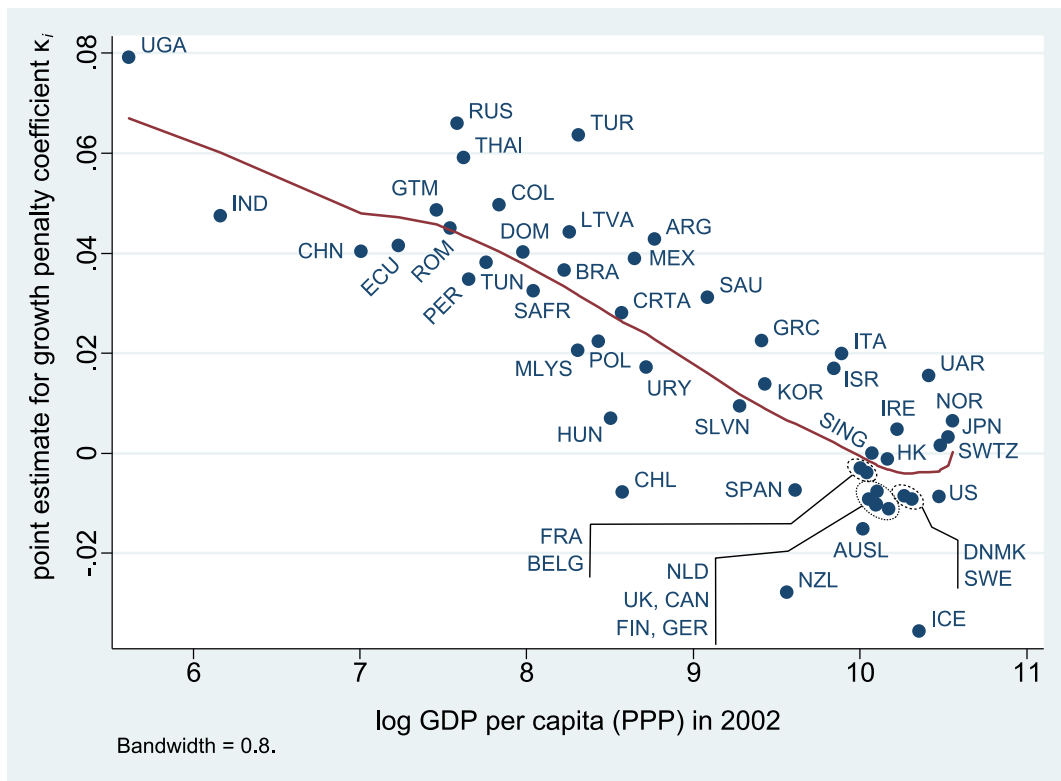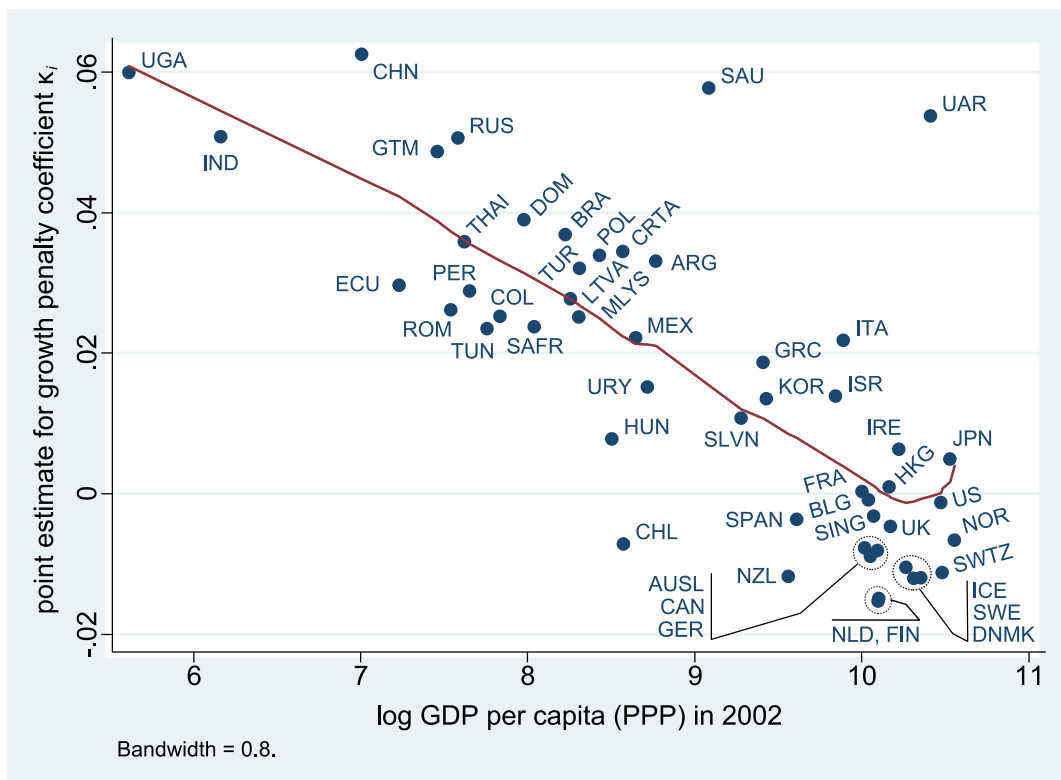**Figure 7: The Relationship between Growth Penalty Coefficient and Income, Based on Regression 7**

Figure 8: The Relationship between Growth Penalty Coefficient and Income, Based on Regression 8

TABLES

Table 1: Countries Included in the Study

Low Income Countries (bottom quartile group)
Bosnia and Herzegovina, China, Colombia, Dominican Republic, Ecuador, Guatemala, India, Peru, Romania, Russian Federation, Serbia, Thailand, Tunisia, Uganda

Middle Income Countries (middle two quartile groups)
Argentina, Australia, Belgium, Brazil, Canada, Chile, Croatia, France, Germany, Greece, Hungary, Israel, Italy, S. Korea, Latvia, Malaysia, Mexico, New Zealand, Poland, Saudi Arabia, Singapore, Slovenia, South Africa, Spain, Turkey, Uruguay

High Income Countries (top quartile group)
Denmark, Finland, Hong Kong, Iceland, Ireland, Japan, Netherlands, Norway, Sweden, Switzerland, United Arab Emirates, United Kingdom, United States

Table 2: Summary Statistics by Income Level

	Low Income		Middle Income		High Income	
Variable	Mean	S.D.	Mean	S.D.	Mean	S.D.
y_{it} = Δlog($GDPPC$)	0.030	0.044	0.018	0.037	0.009	0.033
TEA	15.55	9.128	7.682	4.122	6.507	2.795
Δlog(TEA)	-0.023	0.295	0.018	0.352	0.009	0.226
log($RDworker$)	5.908	1.386	7.315	0.822	8.401	0.340
log($VentureCapAmt$)	-11.79	1.452	-10.35	-10.35	-8.484	1.561
$VentureCapAny$	0.667	0.478	0.979	0.142	0.910	0.287

Notes: Data cover 2001-2011. Refer to Table 1 to see which countries are included in each income group.

Table 3: Differenced OLS Regression Results for Real GDP Growth

Regressor	Regression 1 (Eqn. 4) Coef. (s.e.)	Regression 2 (Eqn. 5) Coef. (s.e.)
$\Delta\log(TEA_{it-1})$	0.014	
	(0.006)**	
$\Delta\log(TEA_{it-1}) \times HighIncome$		-0.003
		(0.010)
$\Delta\log(TEA_{it-1}) \times MiddleIncome$		0.014
		(0.007)*
$\Delta\log(TEA_{it-1}) \times LowIncome$		0.041
		(0.020)**
Constant	0.032	0.020
	(0.003)***	(0.009)**
Year × income group fixed effects (δ_{gt})	Yes	Yes
F statistic for coefficients involving TEA	5.40	2.77
F statistic d.o.f. and p-value	(1, 52); p = 0.024	(3,52); p = 0.051
R^2	0.598	0.604
Adjusted R^2	0.555	0.558
N	271	271

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

Table notes: the dependent variable is $\Delta\Delta\log(GDPPC_{it})$. Standard errors (in parentheses) are robust to heteroskedasticity and clustering on country.

Table 4: Estimated Optimal Rates of Entrepreneurship by Income Group

Income Group	Estimation 3 Group-specific TEA*		Estimation 4 Country-specific TEA*		
	$TEA_g{*}$ Estimate	S.E.	Average $TEA_i{*}$ Estimate	Median $TEA_i{*}$ Estimate	Median TEA gap $(\overline{TEA}_i - TEA_i^{*})$
Low Income	26.255	1.492	31.692	27.366	-11.533
Middle Income	25.133	16.753	13.053	10.273	-3.644
High Income	8.403	3.200	7.252	8.757	0.355

Table notes: estimates are derived from growth regressions based on equation (10) and $TEA{*}$ calculated with equation (11). Standard errors are calculated by the delta method and are robust to heteroskedasticity and clustering on country.

Table 5: Further Differenced OLS Regression Results for Real GDP Growth

Regressor	Regression 5 (Eqn. 7) Coef. (s.e.)	Regression 6 (Eqn. 7) Coef. (s.e.)	Regression 7 (Eqn. 7) Coef. (s.e.)
$\Delta\log(TEA_{it-1})$	0.170	0.215	-0.063
	(0.060)***	(0.162)	(0.054)
$\Delta\log(TEA_{it-1}) \times \log(RDworkers)$	-0.021	-0.027	
	(0.008)***	(0.019)	
$\Delta\log(TEA_{it-1}) \times MiddleIncome$		-0.104	0.036
		(0.182)	(0.061)
$\Delta\log(TEA_{it-1}) \times LowIncome$		-0.039	0.022
		(0.205)	(0.032)
$\Delta\log(TEA_{it-1}) \times MiddleIncome \times \log(RDworkers)$		0.014	
		(0.022)	
$\Delta\log(TEA_{it-1}) \times LowIncome \times \log(RDworkers)$		0.006	
		(0.027)	
$\Delta\log(TEA_{it-1}) \times VentureCapAmt$			-0.006
			(0.006)
$\Delta\log(TEA_{it-1}) \times MiddleIncome \times \log(VentureCapAmt)$			0.002
			(0.007)
$\Delta\log(TEA_{it-1}) \times LowIncome \times VentureCapNone$			(0.843)
			(0.390)**
$\Delta\log(TEA_{it-1}) \times LowIncome \times VentureCapAny \times \log(VentureCapAmt)$			0.067
			(0.031)**
F statistic for coefficients involving TEA	4.08	2.65	1.79
F statistic d.o.f. and p-value	(2,46); $p = 0.023$	(6,46); $p = 0.027$	(7,52); $p = 0.110$
R^2	0.617	0.618	0.625
Adjusted R^2	0.574	0.568	0.575
N	257	257	271

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

See also notes to Table 3. Both estimations include fixed effects for year × income group interactions. See text for definition of the variables.

APPENDIX

This appendix contains explanatory information on the transformation f used in the estimations based on equation (8). We chose a CDF that admits many shapes and allows for thin tails.[1] Let $\Phi_G: \mathbb{R} \to [0,1]$ be the CDF of the generalized Gaussian distribution (also known as the exponential power distribution):

$$\Phi_G(x; \theta) = \frac{1}{2}\left[1 + \text{sgn}(x)\frac{\gamma\left(1/\theta, |x|^\theta\right)}{\Gamma(1/\beta\theta)}\right]$$

where Γ is the gamma function, γ is the incomplete gamma function, and θ is a positive shape parameter. Then the transformation of *TEA* used in equation (8) is $f: [0,100] \to \mathbb{R}$

$$f(t) = \Phi_G^{-1}\left(\frac{t}{100}\right) = \text{sgn}\left(\frac{t}{100} - \frac{1}{2}\right)\left[\gamma^{-1}\left(\frac{1}{\beta}, 2\text{sgn}\left(\frac{t}{100} - \frac{1}{2}\right)\left(\frac{t}{100} - \frac{1}{2}\right)\Gamma\left(\frac{1}{\beta}\right)\right)\right]^{1/\beta}$$

The shape parameter was chosen to maximize the likelihood, which led to using the limiting distribution as $\beta \to \infty$, which is the rectangular distribution on [-1,1]. However, results were qualitatively similar regardless of which value of β above 2 (the threshold for negative excess kurtosis) is used. Results were also qualitatively similar if we begin with the normal or Laplace distributions in place of Φ_G or use the log function for f to make equation more comparable to equation (1),[2] in the sense that higher initial country incomes led to lower estimates of *TEA** on average.

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[1] Exploratory estimations showed that thick-tailed distributions tended to push the estimates of *TEA** to the boundaries of 0 and 100, prompting our desire for a distribution that allows for negative excess kurtosis (i.e., thinner tails than the normal distribution). The generalized Gaussian distribution exhibits thin tails whenever the peakedness parameter β is above 2

[2] Use of the log function can return implied values of *TEA** that are above 100, however. When f is an inverse CDF this difficulty does not arise.

Table A1. Alternative estimations including other variables in the model

Extra variables	Regression Specification	How the extra variables enter the regression	Wald test for extra variables	LR test for extra variables	Test for change in coefficients on Δ log TEA$_{it-1}$ (*)
Law and Order, Government Stability, and Political Risk	Regression 1	In levels	*p*-val = 0.1182	*p*-val =.32745	*p*-val =0.1358
Law and Order, Government Stability, and Political Risk	Regression 1	In differences	*p*-val =0.6024	*p*-val =.09952	*p*-val =0.7936
Law and Order, Government Stability, and Political Risk	Regression 2	In levels	*p*-val = 0.1712	*p*-val =.39595	*p*-val =0.9636
Law and Order, Government Stability, and Political Risk	Regression 2	In differences	*p*-val =.2499	*p*-val =.13235	*p*-val =0.9636
Hofstede's 6 variables	Regression 1	In levels	*p*-val = 0.9329	*p*-val =.99230	*p*-val =0.1943
Hofstede's 6 variables	Regression 2	In levels	*p*-val =0.9621	*p*-val =.99479	*p*-val = 0.6703
Hofstede's individualism variable	Regression 1	In levels	*p*-val = 0.824	*p*-val =0.9130	*p*-val =.8117
Hofstede's individualism variable	Regression 2	In levels	*p*-val = 0.867	*p*-val =0.9341	*p*-val =.9984

Note: the time-varying variables were lagged one period, the same as for *TEA* in the main regressions.

*The test for change in the coefficient on Δ log TEA (for Regression 1) is performed using the suest command in Stata 11. Both regressions use the same reduced sample, defined by non-missing observations for the variables in column one. For Regression 2, the same test is for change in the set of coefficients for the three variables Δlog(TEA_{it-1}) × *HighIncome,* Δlog(TEA_{it-1}) × *MiddleIncome* and Δlog(TEA_{it-1}) × *LowIncome*.