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Abstract

What is the "growth penalty" when a country's entrepreneurship deviates from its optimal level? We use data on entrepreneurship for a panel of developed and developing countries over 2003-2011 to estimate growth equations. We treat the impact of entrepreneurship on real GDP growth as heterogeneous across countries. The methodology accounts for unobserved heterogeneity among countries in the optimal entrepreneurship rate and other factors affecting growth. In less developed countries, there is not enough entrepreneurship, and increases in the entrepreneurship rate have a sizeable positive effect on growth. In high income countries, entrepreneurship appears to be close to the optimum. We also explore how the growth penalty varies across countries. Higher levels of R&D capability decrease the growth penalty of having too few entrepreneurs, suggesting that R&D and entrepreneurship are substitutes. Corruption increases the opportunity cost of having a suboptimal entrepreneurship level, a finding that is in accord with the hypothesis that corruption can "grease the wheels" of commerce by speeding up bureaucratic processes. Countries with greater entrepreneurial capability suffer a higher growth penalty: the higher the ability of the marginal entrepreneur, the higher is the opportunity cost to the economy of not taking advantage of her talents.

1   Introduction

In recent decades there has been growing interest in the role of entrepreneurship in stimulating economic growth in knowledge economies. Small and medium-sized companies play a vital role in the modern entrepreneurial economy, in conjunction with the ICT revolution, globalization, and changes in organizational structure and the competitive milieu after the transformation of managed economies (Audretsch & Thurik 2001, 2002; Thurik et al. 2011). While the literature strongly suggests that entrepreneurship contributes to growth in developed nations (Robbins et al. 2000; Audretsch & Thurik1; Mueller 2007; Acs et al. 2012), less is known about the role of entrepreneurs in middle and low income nations. The relationship between entrepreneurship and growth in less developed countries (LDCs) is complex.[1]   If entrepreneurship is identified with self-employment, then it is negatively correlated with income per capita (Acs 2006), largely because LDCs have many self-employed individuals and low income.   The real question, which the simple correlation cannot answer, is whether increasing (appropriately defined) entrepreneurial activity within a country would increase economic growth.   The present study indicates that developing nations are still below their optimal levels of entrepreneurship.

We   investigate   whether   a   country   suffers   a   "growth   penalty"   when

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[1] We use the term LDC to refer generically to low and middle income countries.

entrepreneurship deviates from its optimal level. 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. Unlike Audretsch et al. (2002), who examine OECD countries, we include developed and developing countries in our examination. Our data on entrepreneurship, from the Global Entrepreneurship Monitor (GEM), cover a more recent period (2003-2011) than previous studies. 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. The methodology accounts for unobserved country- and year-specific confounding factors in 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.

We show that in LDCs and middle-income countries, entrepreneurship appears to be below its optimal level. Notwithstanding that LDCs generally have more of their population running nascent small firms—the definition of entrepreneurship adopted in this study—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, the empirical results suggest that entrepreneurship is close to its desirable level.

We also explore how the growth penalty varies with characteristics of the country, allowing us to test theories in the literature 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). Higher levels of corruption also appear to increase the opportunity cost of having a suboptimal entrepreneurship level. The finding is in accord with the hypothesis that corruption can "grease the wheels" and speed up bureaucratic processes (Aidt 2003; Méon & Weill 2010), which may be especially important for entrepreneurs starting new enterprises and bringing new products and services to market. Finally, the results also suggest that countries with higher perceived entrepreneurial capability suffer a higher growth penalty when the right amount of that talent is not tapped. The higher the ability of the marginal entrepreneur, the higher is the opportunity cost of not taking advantage of her talents in the economy.

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 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). Empirical work in the last 40 years shows that R&D, technical change, and investment in human capital are needed to produce a fertile environment for economic

growth (Barro 2000; Durluaf et al. 2005; Eberhardt & Teal 2011). More recently, attention has turned to the role of the entrepreneur in seizing opportunities in this dynamic environment to produce growth. The entrepreneur's creation of new market niches provides the link to growth (Holcombe 1998).

To define entrepreneurship for purposes of this study, begin with two related individuals: the small business owner and the Schumpeterian entrepreneur. 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). 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). A Schumpeterian view of entrepreneurship also implies intense and continuous competition between new products and ideas that leads to the selection of the best option (Wennekers & Thurik 1999). Finally, some empirical research shows that identifying entrepreneurship with self-employment alone may lead to misleading results, since self-employment is negatively associated with economic growth in some samples (Salgado-Banda 2007). Given these considerations, we focus on the entrepreneur as the starter and owner of

new businesses.

2.1　The Size of the Firm and Stages of Economic Development

The role of the small entrepreneur changes with the level of development of an economy.　To paint economic history with a broad brush, one can distinguish three stages in the relationship between the structure of the industry and economic development. Until the industrial revolution, self-employment was the norm in Western countries and the majority of people worked in agriculture (Acs 2006). The second stage begin with the transition to modern industrial economies, where the implementation of large scale projects coupled with the growth in production and volume of transactions required larger firms.　During this period, up to the 1970's, entrepreneurial activity became increasingly identified with large firms (Chandler 1990; Thurik, Wennekers, and Uhlaner 2002).　The theoretical literature describing the relationship between the size of the firm and country income level during this period, beginning with Lucas (1978), predicts that the average size of firms increases with progressive economic development. Congregado et al. (2012, p.7) explain the microfoundations of Lucas's hypothesis: "higher capital per capita ratios raise the opportunity costs of managing a firm (i.e., wages) relative to the marginal managerial rents, which, in turn, would lead 'marginal' managers (entrepreneurs) to become employees and reduce entrepreneurship activities."

The third stage of industry structure and development began with the reversal of the trend towards centralization, identified by Blau (1987) as beginning in the mid-1970s. The shift from a "managed to an entrepreneurial economy" (Audretsch & Thurik 2001) revived the importance and prevalence (Loveman & Sengenberger 1991; Acs &

Audretsch 1993) of the small entrepreneur. 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).

2.2   The Differing Contributions of Small Entrepreneurs and Larger Incumbents

The evolution of the role of the small firm in the economy points out that empirical analyses looking for monotonic effects of entrepreneurship on growth are likely to be misspecified.   The optimal fraction of individuals devoted to entrepreneurship in the economy is neither zero nor one.   While large incumbent firms produce the most new knowledge through R&D (Scherer 1992), by taking advantage of scale and scope in R&D, the Schumpeterian entrepreneur is required to turn knowledge into profitable business activity (Schumpeter 1911; Braunerhjelm et al. 2010).

The necessity of both entrepreneurship and larger incumbent firms implies an interior equilibrium in the entrepreneurship rate. As Wennekers and Thurik (1999) discuss, when there are too few small, innovative business owners, competition in the economy may suffer, with attendant loss of efficiency.   With too many small entrepreneurial firms, on the other hand, the average scale of production will be inefficiently low.   Thus we follow Audretsch et al. (2002), Carree et al. (2002) and Carree et al. (2007) in adopting an empirical model that accounts for an interior optimal entrepreneurship rate and therefore potentially nonmonotonic effects on growth of the actual entrepreneurship rate.

2.3   The Contribution of Entrepreneurship to Growth and Unemployment

Many empirical studies measure the contribution of entrepreneurship rates to subsequent 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 (Robbins et al. 2000; Audretsch & Thurik 2001; 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. McMillan & Woodruff (2002) found that job creation was one of the main contributions of new firms to the growth of transition economies. 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. Valliere & Peterson (2009) find that high-growth entrepreneurs contribute to growth in developed countries only. 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. 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 countries that shifted away from large firms experienced higher growth rates. Carree et al. (2002) reach similar conclusions for a sample of 23 OECD countries between 1976 and 1996. Finally, Carree et al. (2007) examine OECD countries further and conclude that the growth penalty exists only for countries where entrepreneurial activity is below the optimal 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).[2] GEM surveys collect data from individuals around the world regarding entrepreneurial activity, and include countries across the range of national income, although coverage is more complete for developed nations. We use nationally aggregated data for 2001-2011 from 53 countries (the most allowed by the availability of data), although data are not observed for all years for some countries. Of the nine years used for estimation,[3] there is an average of 5.1 observations per country.   The countries are placed into low, middle,[4] and high income groups using a set of indicators for the level of development of the country at the beginning of the sample (taken from the World Bank).[5]   Three of the countries included have low income,

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

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

[4] Our middle income category conflates the World Bank's lower and upper middle income categories.

[5] World Bank Country Classification published in July 2012. See

http://www.healthsystemsglobal.org/Portals/0/files/World_bank_list_july2012.pdf

and the rest are roughly evenly split between middle and high income levels (see Table 1). 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.[6] 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).[7]

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.[8]   We measure corruption in the country with a transformed index from the International Country Risk Guide (ICRG).[9] Higher values of the variable,

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[6] 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/docs/download/414.

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

[8] 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.

[9] The ICRG index assesses corruption within the political system, including "demands for special payments and bribes connected with import and export licenses, exchange controls, tax assessments, police protection, or loans," as well as "actual or potential corruption in the form of excessive patronage, nepotism, job reservations, 'favor-for-favors', secret party funding, and suspiciously close

corruption, indicate more corruption; the variable is centered at zero and scaled so that it has unit standard deviation.[10]   The final variable used to model heterogeneity in the growth penalty is the perceived capabilities of entrepreneurs, collected by the GEM. This variable, *EshipAbility*, is defined as the percentage of subpopulation aged 18-64 who believe they have the required skills and knowledge to start a business.[11]

Figure 1 illustrates the mean rate of entrepreneurship (TEA) by income level in the sample. Lower income countries tend to have more of their working age population engaged in entrepreneurship than in middle income countries, although given the small size of the low income sample there is a high degree of variation. Over all years, *TEA* averages 16.9% in low income countries and 10.7% 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 six of those nations (Australia, Canada, Iceland, New Zealand, South Korea, and the United States) is greater than 10%.   *TEA* for six middle-income nations is below 6% (Croatia, Malaysia, Romania, Russia, South Africa, and Turkey).

Summary statistics by income level for all variables used in the estimations are in Table 2.   Growth in national output per capita averages 2.8% for low income countries during this time, 2.5% for middle income countries, and 1.1% for the high income group.

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ties between politics and business" (PRS Group, http://www.prsgroup.com/ICRG_methodology.aspx).

[10]   The original variable ranged from one to six and had lower values for more corrupt countries.

[11]   Refer to footnote 6 for the source for the definition.

The entrepreneurship rate also grows on average for each income group, with higher growth in *TEA* the higher is national income. High income countries have the lowest levels of corruption and perceived capability for entrepreneurship and the highest percentage of workers engaged in research.

4   Empirical strategy

In this section the foundation for the empirical work is described. We base our empirical analysis on extensions to the growth penalty model developed by Audretsch et al. (2002). 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 assumed to be constant within a country during the short time period studied here, but can differ freely among countries. 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, such as 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., Barro 1991; de la Fuente 1997).

Taking the first difference of the equation above cancels the unobserved optimal entrepreneurship rate and all the other unobserved country-specific factors captured in α_i. 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, 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.

Small and statistically insignificant estimates of κ likely indicate that

entrepreneurship is close to its optimal level. There are two reasons for this. 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 estimates, and are less likely to be significant.

Furthermore, one can view the parameterization of the growth penalty in equation (1) as

an approximation (adopted for convenience to difference out the unobserved quantities)

to the true functional form for how the term (TEA_{it} - TEA_i*) enters the growth equation.

If the true growth penalty is differentiable at TEA_{it} = TEA_i*, as one may well expect, then

by definition its derivative (the marginal impact of a deviation from optimal

entrepreneurship rate) is zero there. Therefore a small estimate of κ in our model may

reflect that TEA_{it} is close to TEA_i*

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 level of the country. This leads to an equation

feasible for use in our first estimation:

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

where δ_{gt} is a fixed effect for income group g (= low, mid, high) in year t.

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, in our third specification we model directly the heterogeneity in the growth penalty by writing κ as a function of a vector of time-constant[12] 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

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

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

For element j of vectors π and Z_i, $\pi_k = \partial \partial \Delta y_{it} / \partial Z_{ij} \partial \Delta \log TEA_{it-1}$, and thus the interaction coefficients modify the impact of deviations from optimal *TEA* on growth. When $\bar{\kappa}_i$ is positive (negative), $\pi_k > 0$ implies that marginal increases in Z_{ij} increase (decrease) the magnitude of the growth penalty. 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.

Our inclusion of few regressors other than *TEA* follows the approach of the

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[12] 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.

entrepreneurship literature (e.g., Audretsch et al. 2002). However, the reader more familiar with the growth literature in macroeconomics will find specification (7) unusually parsimonious. Literally hundreds of other 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 double 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 effects control for all trending factors in the world economy that affect the growth of countries within the same stage of development equally.

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. 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*.[13]

5 Results

Table 3 presents the results of our empirical specifications, all of which are estimated by 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. Although the coefficient looks small, the magnitude of the effect is not trivial. The size of the estimate, 0.016, 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 0.016 percentage points. For example, consider a middle income country with output growing at the sample average for such countries of 2.5% per annum that has an optimal *TEA* of 15%. If its actual *TEA* decreases from 13.5% to 12%, so that the relative deviation of *TEA* from *TEA** increases from 10% to 20%, then output growth falls by 0.16 percentage points to 2.34% per annum. That is a 6.4% decline in the growth rate, and the forgone growth in output per capita compounds over the years.

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[13] 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.

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).   The growth penalty decreases with the development level of the country and there evidence that entrepreneurship rates are too low only in low and middle income countries.[14]   The coefficient for high income countries is very small and insignificant, which (as discussed above) suggests that these countries have close to their optimal industrial structure.   The nations considered high-income by the start of our sample are those that led the way in adjusting their industrial structure to changes in the competitive and political environment—what Audretsch & Thurik (2000, 2001) call the replacement of the managed economy with the entrepreneurial economy.   Thus it is perhaps unsurprising that there is no evidence that high-income economies suffer a growth penalty from not having enough entrepreneurs.[15]   The growth penalty coefficient for low income countries, 0.099, is between three and four 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.

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[14]   The small number of observations in the low income category required that we combine the yearly fixed effects for the low and middle income groups (i.e., we restrict $\delta_{low,t} = \delta_{lmid,t}$ in equation (5)) to enable calculation of the standard error for κ_{low}.   This affects only this regression.

[15]   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.

5.3 Country-specific growth penalties: R&D capacity

The final four regressions are based on equation (7) and model the heterogeneity of the growth penalty coefficient as a function of covariates. To be consistent with equation (6), the time averages of the variables discussed in this subsection and the next are used (see footnote 12). In regression 3, reported in Table 3, κ is a function of a constant and log *RDworkers*. The coefficient on *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. 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 of Braunerhjelm et al. (2010), in which entrepreneurship and R&D are substitute determinants of growth and for which they find empirical support.[16] 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 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.

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[16] In their model, the marginal individual switching between entrepreneurship and R&D work has no impact on the balanced growth path. Thus, at least around the steady-state equilibrium in the economy, entrepreneurship and R&D are substitutes.

5.4 Country-specific growth penalties: Corruption and entrepreneurial capability

In Regression 4, *corruption* and *EshipAbility* replace *RDworkers* as the covariates determining the growth penalty.[17] The results, reported in Table 4, show that the coefficients on *corruption* and *EshipAbility* are positive and significant (although the latter is significant only at the 10% level). Thus in lower income countries, where κ is positive, increased corruption is associated with a *smaller* growth penalty. The finding suggests that in the second best situation in which such countries with too little entrepreneurship and weak institutions find themselves, corruption can blunt the impact of having too few entrepreneurs. This is in accord with Méon and Weill's (2010) empirical finding that corruption is less detrimental to—or may even improve—economic efficiency in countries where institutions are ineffective.

LDCs tend to have high levels of corruption (see Table 2) and a higher growth penalty (refer to Regression 2). Even though corruption is expected to harm long term economic growth compared to the first best, it can improve small businesses' productivity when institutions are defective. Aidt (2003) reviews the argument that corruption can increase efficiency to allocate resources through two channels. First, corruption speeds up the bureaucratic process--often referred to as "greasing the wheels" of commerce. Second, corruption introduces competition for scarce government

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[17] We do not include all three variables in the same regression because there are several missing observations for *RDworkers* and also because the correlation between *RDworkers* and the two new covariates, *corruption* and *EshipAbility*, is high enough to cause concerns about multicollinearity.

resources, resulting in the more efficient provision of services than otherwise would obtain. Either reason may explain our finding that corruption ameliorates the growth penalty.

To test further the hypothesis that corruption greases the wheels for entrepreneurship, in Regression 5 we allow the coefficient for the interaction of *TEA* and *Corruption* to vary by income group. If a role of corruption is to improve the ability of entrepreneurs to start and grow new businesses in countries with weak institutions, then the impact of corruption on the growth penalty should be greatest in low income countries and least in high income countries.   This is indeed the case, as Regression 5 shows.   The coefficients on the interactions between *TEA*, *corruption*, and income group are all positive and rise as income falls.   Our results for the impact of corruption are similar in spirit to other recent empirical work.   Dreher & Gassebner (2011) find that corruption reduces the negative impact of regulations on entrepreneurship in highly regulated economies.   Vial & Hanoteau (2010) study plant-level data from Indonesia and also find evidence supporting that corruption greases the wheels.

The positive coefficient for *EshipAbility* signifies that untapped entrepreneurial capability increases the opportunity cost of not having enough entrepreneurs. For marginal increases in entrepreneurship to improve economic growth, there must be a pool of individuals capable of starting and growing new business ventures. When more people believe they have valuable business skills, it is likely that the marginal entrepreneur who did *not* create a start-up is indeed more talented and would have contributed even more to GDP growth.   Our finding is in accord with the large literature

emphasizing the links between the capabilities of firms to create new knowledge, the development of organizational capabilities within the firm, and subsequent firm and economic performance.[18]

In Regression 6, the interactions between the income group and log *TEA* (δ_{gt} from equation (4)) are added to the specification from Regression 4 to check for omitted variable bias. The coefficients and significance levels for the interactions with *corruption* and *EshipAbility* change little.

5.5   Country-specific growth penalties: A closer look

Using the results of Regression 6, we can (with reference to equation (6)) compute the mean growth penalty coefficient for each country as $\widehat{\kappa}_i = \hat{\pi}'Z_i$. Figure 2 contains the distribution of the country-specific estimates, ranging from small and negative values of $\widehat{\kappa}_i$ on the left to larger and positive values on the right. As suggested by the results of Regression 2, the countries represented closer to the left side of the graph, where the coefficients are small and mostly insignificant,[19] are generally more developed countries. All but 13 estimates, out of 51, have positive κ, and the only two that are significantly negative are Finland and Denmark, both highly developed countries. In 22 out of 51 countries, κ is significant at the 5% level; in 29 countries, it is significant at the 10% level.

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[18] Refer to the literature review in Zhang, Tansuhaj, and McCullough (2009) for citations.

[19] The vertical bars are the 95% confidence intervals for the point estimates, and insignificance can be determined by the interval spanning the horizontal line at zero.

The relationship between the level of development of the country and the growth penalty coefficient is further explored in Figure 3. The curve in the figure is a smoothed scatterplot of initial *GDPPC* and the estimated $\bar{\kappa}_i$ from Regression 6. The figure shows 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, on the right side of the figure there is a cluster of high income countries with widely varying κ. This shows the importance of the other factors besides income—corruption and entrepreneurial capability—in the link between industry structure and growth.

6   Discussion and Conclusions

The results above uncover a conundrum. LDCs have more entrepreneurs than wealthier countries. At the same time, the estimations suggest that LDCs need more entrepreneurs while high-income countries do not. How are we to reconcile the apparent contradiction? The answer lies in the fact that although we cannot observe or estimate[20] the optimal industry structure in each country, there are several 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

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[20] Recall that *TEA*$_i$* drops out of the estimating equation after differencing.

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. 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.[21] Therefore, even though LDCs have higher entrepreneurship rates, it is entirely possible their optimal industry structure requires even more small firms.

In this paper, we have analyzed the impact of being above or below the optimal rate of entrepreneurship on economic growth. The study provides empirical evidence that low and middle income countries do not have enough entrepreneurs while most developed countries appear to be close to an optimal industry structure. Given that our sample includes only three low income countries, our results for that group may not be representative, and we await further data as GEM continues to expand its coverage. Regardless, the growth penalty is also heterogeneous in dimensions other than income. 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

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[21] Emerson (2002) shows in a rent-seeking model of imperfect competition that the higher the degree of corruption, the fewer and larger are the firms in the formal sector of the economy and the lower is social welfare.

capacity for R&D. This suggests that entrepreneurship and R&D can be alternative factors for national growth. A high level of corruption decreases the cost of lacking entrepreneurs in developing nations. Indeed, in places where formal institutions are weak, corruption is one of the few ways available to speed up transactions and can thus a positive factor for doing business. The opportunity cost of having too few entrepreneurs rises with a high level of perceived capabilities.

Our results should not be viewed as reducing the relationship between entrepreneurship and growth to a mechanistic process. Not every entrepreneur will innovate or create jobs and wealth in communities (Shane, 2009). Nevertheless, 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; Reynolds et al. 2000). As Audretsch & Thurik (2001) point out, 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 explicit policy to encourage entrepreneurship (Gilbert et al. 2004) or through reforming the myriad related policies that discourage entrepreneurship indirectly (Baumol et al. 2009), policy makers can promote innovation and remove roadblocks to national economic growth.

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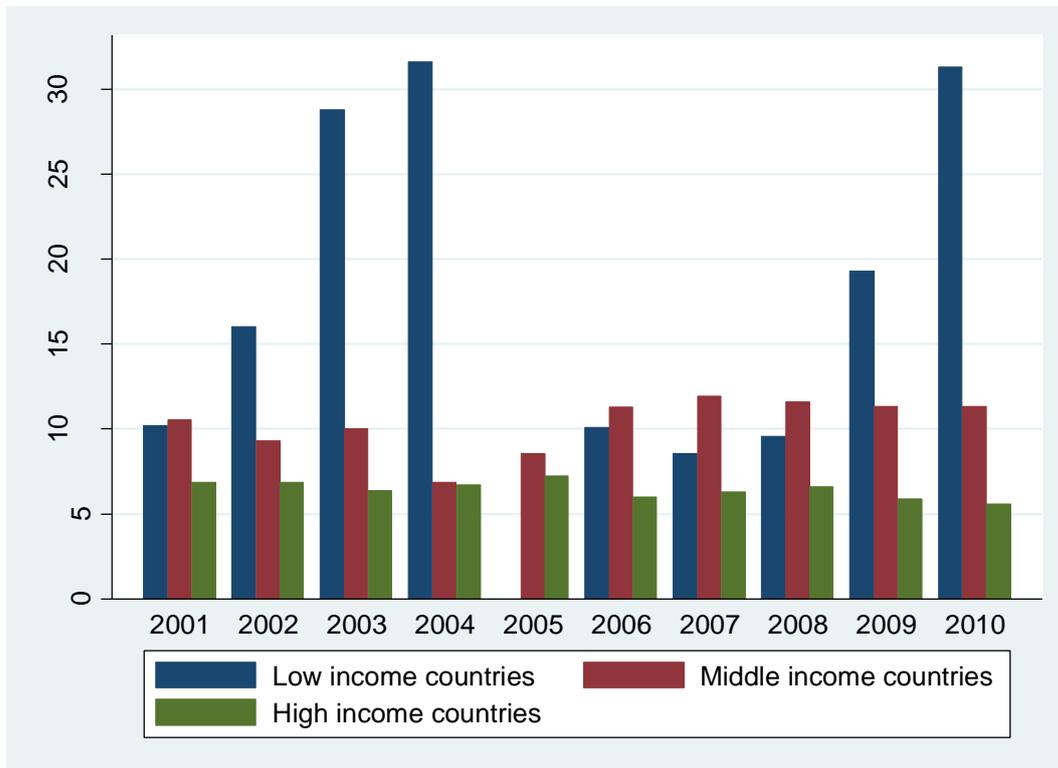**Figure 1: Entrepreneurship Rates in the Estimation Sample, by Income Class**

Figure 2: The Distribution of Country-Specific Growth Penalty Coefficients
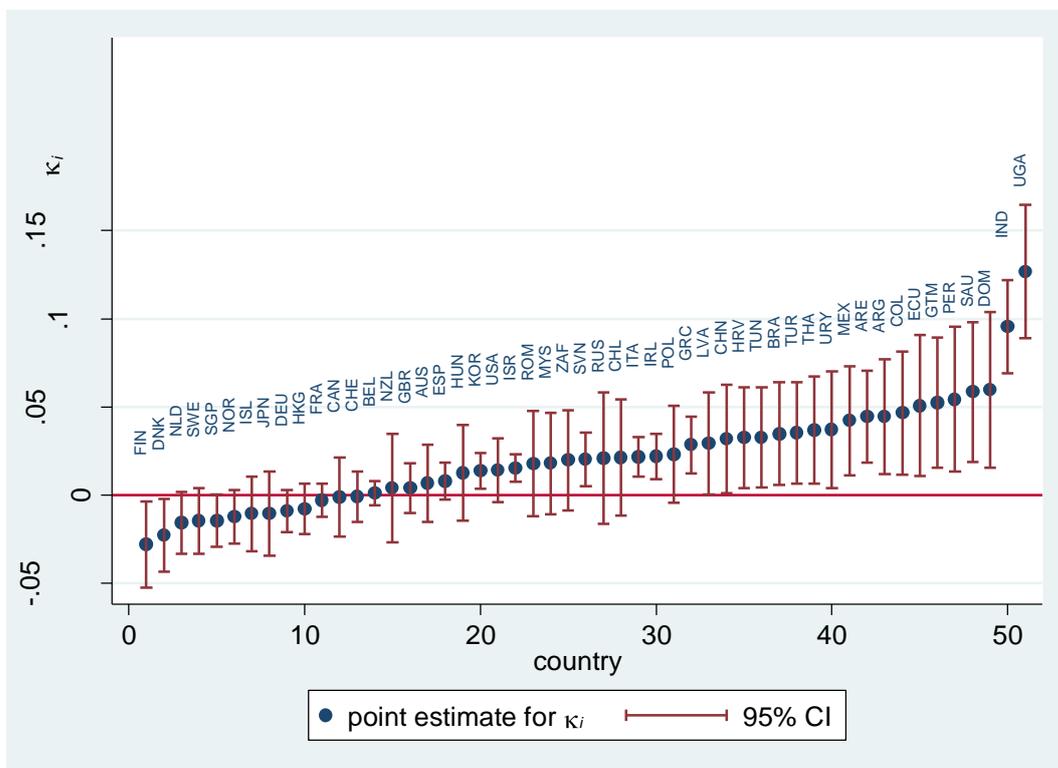
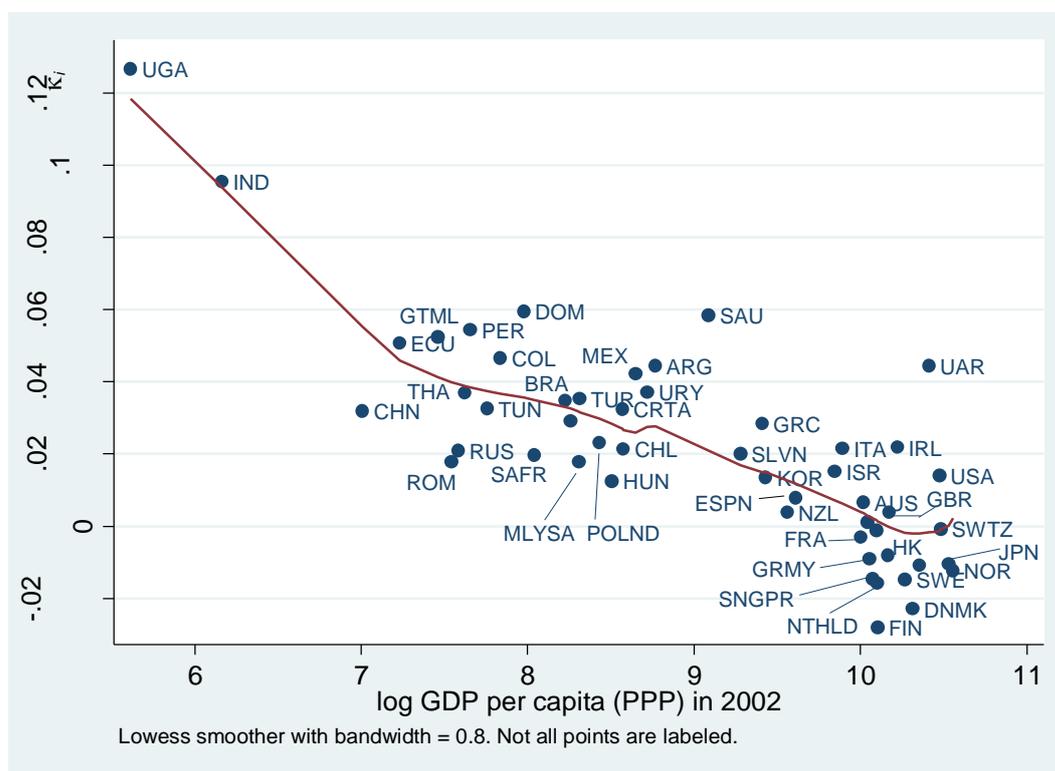## Figure 3: The Relationship between Growth Penalty Coefficient and Income

Lowess smoother with bandwidth = 0.8. Not all points are labeled.

Table 1: Countries Included in the Study

Low Income Countries
India, Serbia, Uganda

Middle Income Countries
Argentina, Bosnia & Herzegovina, Brazil, Chile, China, Colombia, Croatia, Dominican Republic, Ecuador, Greece, Guatemala, Hungary, Latvia, Malaysia, Mexico, Peru, Poland, Romania, Russian Federation, Saudi Arabia, Slovenia, South Africa, Thailand, Tunisia, Turkey, Uruguay

High Income Countries
Australia, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, S. Korea, Netherlands, New Zealand, Norway, Singapore, Spain, Sweden, Switzerland, United Arab Emirates, United Kingdom, United States

Table 2: Summary Statistics by Income Level

Variable	Low Income Mean	Low Income S.D.	Middle Income Mean	Middle Income S.D.	High Income Mean	High Income S.D.
Δlog(*GDPPC*)	0.028	0.032	0.025	0.047	0.011	0.029
TEA	16.90	11.03	10.70	6.578	6.477	3.208
Δlog(*TEA*)	0.005	0.302	0.008	0.311	0.012	0.307
Corruption	1.174	0.188	0.771	0.440	-0.619	0.771
EshipAbility	66.52	12.97	50.93	13.18	40.89	10.79
log(*RDworker*)	5.630	1.155	6.579	0.976	8.214	0.412

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)	Regression 2 (Eqn. 5)	Regression 3 (Eqn. 7)
$\Delta\log(TEA_{it-1})$	0.016		0.157
	(0.007)**		(0.052)***
$\Delta\log(TEA_{it-1}) \times HighIncome$		0.004	
		(0.004)	
$\Delta\log(TEA_{it-1}) \times MiddleIncome$		0.027	
		(0.014)*	
$\Delta\log(TEA_{it-1}) \times LowIncome$		0.099	
		(0.042)**	
$\Delta\log(TEA_{it-1}) \times \log(RDworkers)$			-0.019
			(0.006)***
Constant	0.031	0.031	0.009
	(0.003)***	(0.030)	(0.010)
Year × income group interactions	Yes	Yes	Yes
F statistic for coefficients involving TEA	5.53	5.60	4.60
F statistic d.o.f. and p-value	(1, 52); $p = 0.023$	(3,52); $p = 0.002$	(2,46); $p = 0.015$
R^2	0.632	0.630	0.649
Adjusted R^2	0.596	0.600	0.615
N	271	271	257

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

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

Table 4: Further Differenced OLS Regression Results for Real GDP Growth

Regressor	Regression 4 (Eqn. 7)	Regression 5 (Eqn. 7)	Regression 6 (Eqn. 7)
$\Delta\log(TEA_{it-1})$	-0.027	-0.026	-0.027
	(0.018)	(0.019)	(0.018)
$\Delta\log(TEA_{it-1}) \times HighIncome$			
$\Delta\log(TEA_{it-1}) \times MiddleIncome$			0.001
			(0.014)
$\Delta\log(TEA_{it-1}) \times LowIncome$			0.056
			(0.018)***
$\Delta\log(TEA_{it-1}) \times Corruption$	0.018		0.018
	(0.007)**		(0.006)***
$\Delta\log(TEA_{it-1}) \times Corruption \times HighIncome$		0.013	
		(0.006)**	
$\Delta\log(TEA_{it-1}) \times Corruption \times MiddleIncome$		0.026	
		(0.016)	
$\Delta\log(TEA_{it-1}) \times Corruption \times LowIncome$		0.076	
		(0.017)***	
$\Delta\log(TEA_{it-1}) \times EshipAbility$	0.001	0.001	0.001
	(0.000)*	(0.000)	(0.000)*
Constant	0.021	-0.005	-0.004
	(0.006)***	(0.006)	(0.006)
Year × income group interactions	Yes	Yes	Yes
F statistic for coefficients involving TEA	3.32	14.77	17.09
F statistic d.o.f. and p-value	(3,50);	(5,50);	(5,50);
	$p = 0.027$	$p = 0.000$	$p = 0.000$
R^2	0.656	0.657	0.656
Adjusted R^2	0.620	0.619	0.619
N	267	267	267

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

See notes to previous table.