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Entrepreneurship, Innovation and Economic Growth: Evidence from GEM data

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ABSTRACT. Studies on the impact of technological innovation on growth have been largely mute on the role of new firm formation. Using cross-sectional data on the 37 countries participating in GEM 2002, this paper uses an augmented Cobb–Douglas production to explore firm formation and technological innovation as separate determinants of growth. One area of interest is the contrast between different types of entrepreneurial activities as measured using GEM Total Entrepreneurial Activity (TEA) rates – high growth potential TEA, necessity TEA, opportunity TEA and overall TEA. Of the four types of entrepreneurship, only high growth potential entrepreneurship is found to have a significant impact on economic growth. This finding is consistent with extant findings in the literature that it is fast growing new firms, not new firms in general, that accounted for most of the new job creation by small and medium enterprises in advanced countries.

KEY WORDS: entrepreneurship, economic growth.

JEL CLASSIFICATION: O10, O11, O30

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1. Introduction

The contribution of technological innovation to national economic growth has been well established in the economic literature, both theoretically (Solow, 1956; Romer, 1986) as well as empirically (Mansfield, 1972; Nadiri, 1993). However, a closely related concept, entrepreneurship, has for a long time not found a proper place in mainstream empirical economic research on the sources of economic growth. Although copious amounts have been written theoretically and descriptively on how entrepreneurship affects the economy (Porter, 1990; Baumol, 1993; Lumpkin and Dess, 1996), there is dearth of evidence based on empirical data. This is partially due to the difficulty in defining the role of the entrepreneur and formalising its measurement for empirical modelling. The work of the Global Entrepreneurship Monitor (GEM) potentially closes this gap by providing new empirical data on entrepreneurship as a process of forming new businesses (Reynolds et al., 1999). This paper leverages on the GEM data to explore the impact of entrepreneurship (as defined by new business creation), in conjunction with innovation, on macro level economic growth.

Section 2 of the paper describes the literature linking entrepreneurship and innovation to economic growth. Firstly, we describe studies that explore the contribution of technological innovation to growth. The second part of the literature review discusses both the theoretical and empirical literature linking firm formation to economic growth. In Section 3, we firstly develop the research questions and hypotheses and thereafter describe the model and data used to empirically test these hypotheses. The results of the analysis are presented in Section 4, while the discussions of the findings are presented in Section 5.

2. The literature on the role of entrepreneurship and innovation in economic Growth

The early work of Schumpeter (1911) established conceptually the "entrepreneur as innovator" as a key figure in driving economic development. The innovative activity of entrepreneurs feeds a creative "destruction process" (Schumpeter, 1942) by causing constant disturbances to an economic system in equilibrium, creating opportunities for economic rent. In adjusting to equilibrium, other innovations are spun-off and more entrepreneurs enter the economic system. In this way, Schumpeter's theory predicts that an increase in the number of entrepreneurs leads to an increase in economic growth.

This theory, while influential, is largely descriptive and difficult to formalise econometrically. Consequently, entrepreneurship is missing from most empirical models explaining economic growth. Arising from Schumpeter's original theory, subsequent empirical economic literature have seized on the idea of innovation as a source of economic growth. A considerable body of empirical evidence now exists across countries (Lichtenberg, 1993; Coe and Helpman, 1995; Engelbrecht, 1997; Guellec and van Pottelsberghe de la Potterie, 2001). In contrast, conceptual and descriptive literature on the role of entrepreneurs has flourished, but the empirical literature has for a long time remained mute on this subject. This is in part due to the difficulty in measuring and operationalising entrepreneurial activities.

2.1. *Innovation and economic growth*

The attraction of innovation as a determinant of growth in empirical research is its straightforward measurement. Researchers may use either input measures such as R&D expenditures (Mansfield, 1972) or innovation outcomes such as patents (Griliches, 1990). A large body of empirical work has evolved from this focus on technological progress and innovation. These studies have established that the level of technological innovation contribute significantly to economic performance, particularly at the firm and industry level.

Studies on the impact of technological innovation on growth have been predominantly based on the neo-classical tradition established by Solow (1956), where growth is driven by enhancements to capital and labour inputs, whether in terms of quantity or quality and productivity. Nadiri (1993), provided a summary of studies in this tradition, where a Cobb–Douglas production function is used to link innovation to output and productivity growth. Permanent long-run growth depends on the growth rate of inventions, which is exogenously determined.

More recently, researchers have begun to examine growth that is endogenously determined by technical change resulting from decisions of profit-maximising agents. Verspagen (1992) and Ruttan (1997), provide surveys of such innovation and R&D based endogenous growth models. The latest class of models developed in this tradition has arisen from the works of Romer (1986, 1990), Grossman and Helpman (1991) and Aghion and Howitt (1992). In contrast to the Solow-like models, productivity growth results from intentional innovation by rational, profit-maximising agents and is therefore endogenously determined. Endogenous growth models emphasise the importance of knowledge, knowledge spillovers and technological substitution in the process of economic growth, conceptually parallel to Schumpeter's early growth theory.

Such research, especially the Solow (1956) neo-classical models of economic growth, does not explicitly address the issue of entrepreneurship, which is the underlying cause for technological innovation in the Schumpeterian context. The new class of endogenous growth model pioneered by Romer (1990) recognises some aspect of entrepreneurship by modelling the process of invention and deriving the motives for invention from the microeconomic level. We can summarise that the Schumpeterian tradition has given rise to models that are focused on innovation as a source of economic growth. Unlike the original Schumpeterian theory, however, these models do not provide any direct test of the effect of entrepreneurial firm-formation activities on economic growth.

2.2. *Entrepreneurship and economic growth*

Davidsson (2003) discusses various current views of entrepreneurship from different perspectives and supports Kirzner's (1973) notion that "entrepreneurship consists of the competitive behaviours that drive the market process". This view includes any introduction of new economic activity to the marketplace as an instance of entrepreneurship. As such, entrepreneurship is manifested not only by market entry of new firms, but also by innovative and imitative entries into new markets by established firms. From this perspective, technological innovation is a form of entrepreneurship. This implies that existing models linking innovation to growth have in fact addressed a specific aspect of entrepreneurship, that of innovative entry. The contribution of this paper is to additionally include another aspect of entrepreneurship, that of new firm entry and new business creation, as a determinant of growth. To avoid confusion over terminology, future references to this new business creation aspect of entrepreneurship will make specific mention of it.

2.2.1. *Theoretical literature linking entrepreneurship to economic growth*[1]

Stemming from the historical views of entrepreneurship, theoretical and descriptive arguments linking entrepreneurship and economic growth have emerged from various fields of economics and management study, including economic history, industrial economics and management theory. Wennekers and Thurik (1999) and more recently Carree and Thurik (2003) provide extensive surveys of the diverse literature on the relationship between entrepreneurship and economic growth. In essence, the literature suggests that entrepreneurship contributes to economic performance by introducing innovations, creating change, creating competition and enhancing rivalry.

Writings on pre-20th century economic history offer the strongest descriptive affirmation that entrepreneurship is crucial to long-term economic growth (Cipolla, 1981; Lazonick, 1991), showing that entrepreneurs adopted new production techniques, reallocated resources to new opportunities, diversified output and introduced competition by penetrating new markets. In the mid-20th century, entrepreneurship lost its lustre in the face of mounting evidence that large-scale production increased efficiency (Weiss, 1976). In the last two decades, the knowledge and information revolution has revitalised theoretical thinking linking entrepreneurship to growth, with new theories emerging from the field of industrial evolution or evolutionary economics (Jovanovic, 1982; Audretsch, 1995). From the viewpoint of evolutionary economics, entrepreneurs serve as agents of change, bring new ideas to markets and stimulate growth through a process of competitive firm selection.

Wennekers and Thurik (1999) made a significant contribution to the study of entrepreneurship by synthesising these disparate strands of the literature to construct an operational framework linking entrepreneurship and economic growth. They highlight the multiple roles of the entrepreneur beyond that of the innovator. They also show the general innovative role of entrepreneurs that includes not only newness (implementing inventions), but also new entry (start-ups and entry into new markets). In their final framework for linking entrepreneurship to economic growth, Wennekers and Thurik clearly show the myriad effects and conditions taking place at different levels for entrepreneurial activities to have ultimate impact on economic growth. The direction of the impact is not a foregone conclusion in this framework. However, a working assumption is that ceteris paribus, a rise in the number of entrepreneurs should lead to increased economic growth at the national level.

Addressing a lack of formal growth models that explicitly focus on the entrepreneur, Schmitz (1989) conceptualised a model motivated by the endogenous growth models developed by Romer (1986). In the spirit of such models, new firm formation is an endogenised determinant of economic growth and arises from rational decision-making on the part of individuals who choose between the roles of employee or entrepreneur. This theoretical model concludes that increasing levels of entrepreneurship in an economy generates additional input in the economy. This result is however a theoretical derivation and not based on empirical data.

2.2.2. *Empirical evidence linking entrepreneurship (new business creation) to economic growth*

There are only a limited number of empirical studies devoted to the econometric link between economic growth at the national level and entrepreneurship in the form of new firm start-ups. This has been partly due to the difficulty in obtaining a measure of the national level of entrepreneurship that can be appropriately correlated to national economic growth as measured in terms of output, productivity or wealth. As shown in the framework formulated by Wennekers and Thurik (1999), the macro measurement of entrepreneurship needs to operationalise entrepreneurship as a multi-dimensional concept from typologies that are developed at the micro-level.

While not always couched in the language of economic growth, the literature on job creation provides ample empirical evidence that small businesses and newly formed firms create a substantial number of new jobs, with some studies showing that small and new firms are the source for the majority of new jobs created. This conclusion has been reached in studies on job creation in numerous countries such as the United States (Birch, 1979, 1987), Sweden (Davidsson et al., 1998) and Canada (Baldwin and Picot, 1995).

Several authors have conducted within-country regional-level studies linking economic growth and well-being with business dynamism in terms of firm entry and exit. These studies offer the closest parallels to this present paper's effort to link new firm creation with national economic growth. Using data on firm birth and deaths in 382 labour market areas in the United States, Reynolds (1999) found a clear association between creative destruction as manifested by firm formation dynamics and economic growth as proxied by job creation. However, creative destruction does not by itself appear to be a cause of economic growth. In response to criticisms that jobs created by new and small firms are of lower quality (Harrison, 1994), Davidsson et al. (1995) studied six groups of regions in Sweden and found support for the hypothesis that the formation of new, independent firms is important for the development of regional economic well-being, as measured by income-growth and net migration surplus.

Outside of the literature on job creation, numerous studies examine the ambivalent causality between formation of new firms and (un)employment level. Audretsch et al. (2001) provide an overview of the conflicting bi-directional forces underlying this relationship. The effect of increased unemployment on start-up activity may be positive (according to the push effect theory of income choice) or negative (according to the pull effect theories on entrepreneurial capability and risk attitude). The reversed causality relationship is similarly ambiguous. New start-up firms provide employment opportunities in themselves and also create employment in existing firms (Fritsch and Muller, 2004). However, the low survival and growth rates of new firms suggest that their contribution to reducing unemployment would be limited.

Empirical studies find support for differing relationships in both directions of causality. An early survey by Storey (1991) documents the ambiguous empirical evidence on the unidirectional impact of unemployment on firm start-up. Some studies such as Picot et al. (1998) have found a "Schumpeter" effect where new firms enhance employment levels by stimulating economic activity and creating new jobs. On the other hand, a "refugee" or "shopkeeper" effect was discovered by Evans and Leighton (1989, 1990) and Reynolds et al. (1994) among others, where unemployment leads to individuals seeking self-employment, thus stimulating entrepreneurial activities. Van Stel and Storey (2004) further emphasised that this "refugee" push effect coupled with low entry barriers may lead to start-ups that guarantee employment for the business owners but generate no growth.

More recent empirical studies have embraced this two-way causality and modelled entrepreneurship as an endogenous determinant of employment. These studies posit that there is both a "Schumpeter" effect and a "refugee" effect. It is suggested that the "Schumpeter" effect would be most likely observed in advanced countries while the "refugee" effect is likely to be found in lower-income nations with less-developed social security systems. In time series models, the refugee effect occurs when there is a decline in the business cycle. Audretsch and Thurik (2000) applied these assumptions to construct an estimation equation with change in business ownership as a causal factor in change in unemployment rate. Using data for 23 OECD countries from 1974 to 1994, they concluded that growth in the number of entrepreneurs leads to reduction in the rate of unemployment.

The most recent of these studies have expanded the analysis to include economic growth as measured by per capita output (GDP). Carree et al. (2002) developed an error correction model to determine the equilibrium rate of entrepreneurship as a function of the stage of development of an economy. The idea of the equilibrium rate has its roots in the choice between self-employment and wage-employment that exists in the labour market. Also using data for 23 OECD countries, this study derived the equilibrium rates of entrepreneurship and showed that deviations from these rates significantly and negatively influence GDP growth. In a related area, Audretsch et al. (2002) applied this formulation to study the impact of small business prevalence and reached a similar conclusion. Any country deviating from the equilibrium rate of entrepreneurship incurs a growth penalty in terms of foregone economic growth. In this way, depending on whether a country's actual rate of entrepreneurship is above or below its equilibrium rate, there is technically both a negative and positive relationship between economic growth and the rate of entrepreneurship.

In the studies that utilise data on 23 OECD countries, entrepreneurship is operationalised as business ownership or self-employment, following Storey (1991). Carree et al. (2002) acknowledge that business ownership is not synonymous with entrepreneurship but argue that in modern economies, the trend of business ownership level is a fair reflection of developments in entrepreneurship level. The advantage of using business ownership as a proxy for entrepreneurial activity is the availability of comparable cross-country data on this measure from the Compendia 2000.1 dataset that uses OECD Labour Force statistics and other country-specific sources.[2] However, the drawback of this measure is that data outside of OECD nations are not readily available and thus, extension of the investigation to developing countries is constrained. Business ownership also measures the total stock of self-employed businesses and not the start-up of new ones. While the two may correlate well in advanced countries, this is unlikely to be the case for developing countries where start-up activity is expected to be more volatile.

These concerns may potentially be addressed by the availability of new empirical data from the GEM (Reynolds et al., 1999). So far however, analysis of the link between entrepreneurial activity rates as measured by GEM and economic growth has been limited to bivariate correlations with short term GDP rates, with no attempt to control for other factors (Reynolds et al., 2000, 2001, 2002).

3. Estimation model for entrepreneurship (new firm creation), innovation and economic growth

In this paper we propose to empirically test a model that incorporates new firm creation and innovation as separate aspects of entrepreneurship and determinants of economic growth rates. As discussed, the Schumpeterian tradition has coupled the concepts of entrepreneurship and innovation such that in much of the work linking technological innovation to economic growth, the role of entrepreneurship is implicit as an underlying cause of innovation. However, innovation is not solely the domain of entrepreneurs. The evolution of modern markets has seen the emergence and proliferation of professional innovators and innovation facilities controlled by established large companies, rather than entrepreneurs. Similarly, the definition of the entrepreneur has also expanded beyond its role as an innovator to embrace, among others, risk taking and managerial responsibilities, as explained by Wennekers and Thurik (1999). Given the nature of contemporary markets, we would argue that when business creation activities and innovation activities are aggregated to the national level, there is not likely to be substantive overlap between the two constructs. Hence, in a macroeconomic formulation of the determinants of national economic growth, business creation and innovation are treated as two distinct and separate factors that manifest different facets of the entrepreneurship phenomenon. This approach is also in line with Davidsson's (2003) and Kirzner's (1973) view of entrepreneurship as embodying both new firm entry, and imitative and innovative entries by established firms.

3.1 *Premise of model and hypothesised relationships*

3.1.1. *Innovation*

Both the neo-classical (Solow, 1956) and endogenous growth (Romer, 1986) models of economic growth acknowledge the importance of technological innovation in stimulating growth, through generating technological progress and raising productivity. Following these well-established theories, our first hypothesis posits that

Hypothesis 1: Countries with higher levels of technological innovation will have faster growth rates.

3.1.2. *Entrepreneurship (new business creation)*

A key outcome of the GEM project is the consistent and internationally comparable measures of entrepreneurship, the Total Entrepreneurship Activity (TEA) rates. The TEA rate measures the proportion of working-age adults in the population who are either involved in the process of starting-up a business or are active as owner-managers of enterprises less than 42 months old. This measurement is consistent with the expanded definition of entrepreneurs to include "true" Schumpeterian entrepreneurs as well as managerial business owners. This measurement also recognises the creation of new businesses as arising from the choice optimisation decision of individuals, consistent with the theoretical framework of Schmitz (1989).

In addition, three sub-types of TEA rates are used to assess the influence of different types of entrepreneurial business creation activities on economic growth. We expect the impact of business creation to be different according to the type of TEA rate. Opportunity and Necessity TEA rates differentiate between entrepreneurs that are motivated to pursue perceived business opportunities and those that are driven to become entrepreneurs as a last resort, when other options for economic activity are absent or unsatisfactory. As shall be fully described later, High Growth TEA rate identifies the sub-set of entrepreneurs that are involved in businesses that have "high growth potential".

Following Reynolds et al. (2000, 2001, 2002), the overall TEA rate and economic growth are conjectured to be positively related. This contrasts with the work of Carree et al. (2002) that hypothesised the relationship to be possibly positive or negative depending on whether a country's entrepreneurship rate is above or below the equilibrium level that is a function of its stage of development. Career et al. did not directly address the actual absolute rate of entrepreneurship and focused on modelling the equilibrium adjustment mechanism. This approach is not applicable to the present context, as our hypothesis concerns relating TEA and growth across a number of countries and not over-time. Additionally, the time series data required to model the adjustment mechanism of Carree et al. is not available in the GEM dataset. In our context, the stage of economic development (and by association the equilibrium level of entrepreneurship) is a control construct. We expect that ceteris paribus, countries with higher TEA rates will experience better growth performance. However, we note that this is subject to the composition of entrepreneurial activities in each country. As we shall discuss shortly, Opportunity and Necessity TEA are expected to have different impacts on growth.

Hypothesis 2: Countries with higher levels of overall TEA will have faster growth rates.

Opportunity TEA rates reflect the existence of economic rent to be derived in an economy. Such rents ideally arise from implementing or creating knowledge and technology. As such, we anticipate that high Opportunity TEA rates will be associated with high growth.

Hypothesis 3: Countries with higher levels of opportunity TEA will have faster growth rates.

Unlike other types of TEA, we expect Necessity TEA to either have no significant relationship or a negative relationship with economic growth rates. Individuals motivated by necessity are driven to become entrepreneurs due to lack of other employment opportunities. This type of entrepreneurship reflects the "refugee" effect described by Audrestch et al. (2001). The individuals in this "refugee" position tend to possess fewer endowments of human capital and entrepreneurial capability, as argued by Lucas (1978). They are less likely to sustain new business venture that will contribute to growth. Hence, we expect that countries with higher Necessity TEA rates will have growth rates that are lower or at least not significantly different than in other countries.

Hypothesis 4: Countries with higher levels of necessity TEA will have slower growth rates or growth rates similar to countries with lower levels of necessity TEA.

Several empirical studies suggest that not all new firms contribute equally to economic growth. Kirchhoff (1994), Storey (1994), Westhead and Cowling (1995) and Birch et al. (1997) maintain that it is rapidly growing firms, rather than small firms in general, that generate the vast majority of new jobs. The task of identifying such firms is daunting because they typically represent less than 5% of new firms formed. The 2002 round of the GEM survey incorporated questions that could be used to identify individuals involved in high growth potential new ventures and start-up attempts. Rather than analysing firms that have already achieved high growth, Autio et al. (2003) explain that it is of greater interest to examine ex-ante firms that have the potential for growth. The ambitions and growth expectations of entrepreneurs are a likely antecedent to achieving future high performance. The high potential TEA rate is derived by operationalising these expectations along four characteristics: (1) potential for employment growth, (2) market impact, (3) globalised customer base and (4) use of new technology, where all four criteria must be fulfilled.[3]

Naturally, it is envisaged that higher rates of High Potential TEA would be associated with higher levels of economic growth. Additionally, as argued in the literature on fast growing firms, we hypothesise that the influence of High Potential TEA would be stronger than for the other measures of TEA. This will be reflected in a larger positive value of the estimated coefficient on High Potential TEA in the estimation model.

Hypothesis 5: Countries with higher levels of high potential TEA will have faster growth rates.

Hypothesis 5a: The estimated coefficient on high potential TEA in the regression equation will be higher than those for other types of TEA.

3.2. *Model and data sources*

The main data source used for analysis is the GEM 2002 dataset. This comprises entrepreneurship propensity data on 37 countries. The GEM data are further supplemented by macroeconomic indicators collated from national and international statistical sources. These are normalised to a per capita basis to be consistent with the TEA rates and to allow for hypothesis testing across the cross-section of 37 countries. The list of 37 countries is given in appendix A (Table A.1).

The model used for hypothesis testing is an extension of the neo-classical growth model based on a variant of the Cobb–Douglas production function with Constant Return to Scales. The derivation of the estimation model from the Cobb–Douglas production function is shown in Appendix B. New firm creation and innovation are entered explicitly as exogenous determinants of national economic growth, representing two aspects of entrepreneurial activities. In this formulation, new firm creation and technological innovation may be considered as augmenting factors of production, with technological innovation representing knowledge capital and new firm creation representing a form of entrepreneurial capital. Because of the relatively small sample of 37 cases, we have been parsimonious with the choice of independent variables, focusing on key control variables and the predictors of interest. Summary descriptive statistics on these variables are given in Appendix A (Table A.2).

The generic form of regression model used is

Rate of Economic Growth	$= \alpha_0 + \alpha_1$	Base year GDP per worker	$+ \alpha_2$	Growth in Capital per worker	$+ \beta_1$	New Firm Creation	$+ \beta_2$	Technological Innovation intensity
	Controls				Predictors			

Rate of Economic Growth, the dependent variable, is measured using the growth in GDP per employed person over a 5-year period.[4] Growth rate is computed by taking the average of annual compound growth rates between 1997/1998 and 2001/2002. Average growth over a 5-year period is used to smooth out temporal fluctuations in annual growth rates.[5] GDP data are obtained from the World Economic Outlook by the International Monetary Fund (IMF). Data on employed persons are from Euromonitor Global Market Information Database (GMID), compiled from national sources.

Base year GDP per worker is included to control for the "conditional convergence" effect described by Barro (1991) where, in cross-country regression models, high-income countries experience lower rates of growth. The sign of the coefficient α_1 is expected to be negative. In the estimation equation, this variable enters in logarithmic form.

Growth in Capital per worker controls for economic growth due to increases in capital as a factor of production. This growth rate is computed by taking the average of annual compound growth rates between 1997/1998 and 2001/2002. The sign of the coefficient α_2 is expected to be positive. Data on capital and employed persons are from Euromonitor GMID, compiled from national sources.

New Firm Creation is measured using the TEA rates computed from the GEM 2002 dataset. High Potential TEA, Necessity TEA, Opportunity TEA and overall TEA rates are alternated as the measures of entrepreneurship. TEA rates for 2002 are used because of the larger number of cases, 37, and because that is the first year for which data were collected to compute the High Potential TEA index. The sign of the coefficient β_1 is expected to be positive in all cases except when Necessity TEA is used as the measure of entrepreneurship.

Ideally, TEA rates used as explanatory variables would be for a period preceding the time period of the dependent variable. This was not possible as GEM TEA rates for a sufficiently large sample of countries are not available for any earlier years. However, it may be argued that TEA rates do not vary significantly from year to year. To verify this, the correlation between TEA rates for 2001, 2002 and 2003 were computed for countries that participated in the GEM survey in 2002 and at least one of the other two years. The correlation coefficients are shown in Appendix A (Table A.3) and confirm that there is a high degree of correlation between TEA rates in different years.

Technological innovation intensity is measured using the ratio of patents to GDP over a 5-year period. The ratio is computed by dividing the total number of patents granted between 1997 and 2001 with the sum of GDP from 1997 to 2001. Patents included in this measure are utility patents granted by the US Patents and Trademark Office (USPTO), with the nationality of a patent being determined by the nationality of its first named inventor. This measure was preferred to ratio of Gross R&D expenditure to GDP as the latter is an input measure, whereas patenting in the USPTO implies greater proximity to commercialisation. In practice, we also found the patents to GDP ratio to give the highest association and yield the best model fit.[6] The sign of the coefficient β_2 is expected to be positive.

4. Estimation results

The equation constructed for hypothesis testing is estimated using linear least squares regression, alternating four different TEA indices as the measure for entrepreneurship. The results for the four estimated equations are presented in Table I below.

Overall, the postulated equation appears to be reasonably defined, with significant F statistics and adjusted R squared values above 60%. Collinearity statistics indicate no problems of multicollinearity between independent variables. The control variables are found to be significant and explain around 56% of national economic growth in the 37 countries. The negative sign on base year GDP per worker confirms the convergence effect with lower income nations experiencing higher GDP growth rates. Growth in capital per worker is as expected a significant and positive determinant.

Our first hypothesis, that innovation is positively related to GDP growth, is supported. Regardless of the measure of entrepreneurship used, technological innovation intensity is found

TABLE I
Result of linear regression

df = 32	Type of TEA measure: High Growth Potential TEA		Opportunity TEA		Necessity TEA		Overall TEA	
Average (%) across 37 countries	1.03		5.62		1.95		7.99	
	Value	Sig.	Value	Sig.	Value	Sig.	Value	Sig.
Adj *R* sq (control)	0.559		0.559		0.559		0.559	
Adj *R* sq	0.648		0.603		0.605		0.602	
F change	5.305**	0.010	2.893*	0.070	2.971*	0.066	2.858*	0.072
F	17.571**	0.000	14.676**	0.000	14.769**	0.000	14.634**	0.000
	Std. Beta	Sig.	Std. Beta	Sig.	Std. Beta	Sig.	Std. Beta	Sig.
Control variables								
(Constant)	t = 5.995**	0.000	t = 4.048**	0.000	t = 4.019**	0.000	t = 3.593**	0.001
Log of base year GDP per worker	−0.536**	0.000	−0.475**	0.001	−0.529**	0.001	−0.491**	0.001
Growth in capital investment per worker 1997/1998–2001/2002	0.602**	0.000	0.625**	0.000	0.597**	0.000	0.614**	0.000
Predictors								
Entrepreneurship (TEA)	0.207*	0.050	0.029	0.806	−0.066	0.663	−0.007	0.958
Innovation (Ratio of USPTO granted Patents to GDP 1997–2001)	0.284**	0.013	0.275**	0.023	0.268**	0.028	0.275**	0.023

Dependent variable = growth in GDP per worker 1997/1998–2001/2002.
* Significant at 10%.
** Significant at 5%.

to be a significant and positive determinant of GDP growth. This is consistent with numerous previous studies that have established and confirmed this positive link. We also note that the innovation construct is most significant and the value of estimated the coefficient is highest when High Potential TEA is used as the entrepreneurship construct, although the differences are marginal.

We do not find support for the second hypothesis that higher levels of overall TEA will be associated with higher GDP growth rates. Similarly, the estimated coefficients on Opportunity and Necessity TEA rates are found to be insignificant, although the signs of the coefficients are in the expected direction (positive for Opportunity TEA and negative for Necessity TEA). The insignificance of Opportunity TEA could be due to the presence of lower-income nations in the sample, where the economic rents to be exploited arise from market imperfections rather than unexploited stocks of knowledge and information.

Of the four types of new business creation activities, only high growth potential entrepreneurship is found to have a significant impact on economic growth.[7] This finding is consistent with extant findings in the literature that it is fast growing new firms rather than new firms in general that accounted for most of the new job creation by small and medium enterprises in advanced countries (Kirchhoff, 1994; Storey 1994). As hypothesised, the influence of High Potential TEA on GDP growth is stronger than the other types of TEA. This is seen from the estimated coefficient value of 0.207 for High Potential TEA, compared to values that are close to zero for the other TEA measures.[8]

Additional analysis has been conducted to determine whether interaction effects exist between new business creation and innovation. If a significant interaction effect is found, this may be indicative of substantive overlap between business creation prevalence and innovation output. Based on the GEM data, such an interaction effect is not detected. Additionally, analysis was conducted to determine if the effect of new business creation on economic growth is moderated by the income level of nations. In our model formulation, we did not find the income effect to be significant. However, using the same GEM dataset but a different model specification, Van Stel et al. (2004) found that the contribution of entrepreneurship (Overall TEA) to economic growth differs for countries in different stages of economic development. We also tested for differences between high and low income nations both by introducing a dummy variable controlling for income level and repeating the regression analysis on separate subsets of the data. In both instances, we found that the sample size was too small for this type of analysis.

5. Discussion and conclusions

Having a higher degree of entrepreneurship or new business creation prevalence does not guarantee enhanced economic performance and faster rates of economic growth. This is seen from the insignificance of the overall TEA rate which defines entrepreneurship in broad terms: the propensity to be involved in start-up attempts and to manage-own newly created businesses. This suggests that at the microeconomic level, only certain activities and functions of entrepreneurs may stimulate growth. As the present analysis is conducted at the aggregative macroeconomic level, we are not able to distinguish between these different roles of the entrepreneurs but highlight this as an area that warrants empirical investigation.

The insignificance of overall TEA suggests the existence of entrepreneurial activities that do not contribute to growth. This is consistent with previous findings of the "refugee" or "shopkeeper" phenomenon. This finding may also be interpreted as supporting the proposition by Carree et al. (2002) that it is the deviation of entrepreneurship levels from the equilibrium rate that influences economic growth, and not just the existence of entrepreneurial activities.

Our analysis also concludes that at the national level, technology innovation and new business creation can be regarded as two separate phenomena. This is in contrast with neo-classical models of growth that have tended to implicitly consider innovation as a proxy for entrepreneurship as defined by firm formation. In our analysis, the absence of collinearity between innovation and new business creation, and the insignificance of the introduced interaction term between innovation and new business creation, suggests that the overlap between the two is not substantial. This confirms what is often described anecdotally and concluded intuitively: that only a very small proportion of entrepreneurs engage in true technological innovation.

The main finding from the analysis is the significance of High Potential TEA as the sole form of entrepreneurship that has any explanatory effect on differing rates of economic growth across nations. This offers some support for the suggestion from several studies that truly significant contributions are made by the fast growing "gazelle" firms (Birch et al., 1997), rather than new firms in general. This provides food for thought for policy makers in terms of targeting entrepreneurial activation measures. Furthermore, there is need for more empirical work focused on such high potential entrepreneurial efforts, such as that done by Autio et al. (2003). Additionally, it would be worthwhile to conduct tracer studies on high potential start-ups to establish whether such firms fulfil their promised potential and what factors influence their subsequent success or failure. Such research would cast light on the nature of the phenomenon, including the characteristics of individuals, the effect of environmental factors and the mechanism of the development path of high potential firms. Understanding these allows more effective policies to be drawn to encourage and stimulate entrepreneurial activities with growth potential.

However, as pointed out by Davidsson and Delmar (2003), the importance of high growth firms has not been universally established. They refer to two earlier studies using Swedish data (Davidsson et al., 1994, 1996; referenced in Davidsson and Delmar, 2003) that suggested that small changes in employment in a large number of business units accounted for large employment change effects overall. The later study by Davidsson and Delmar (2003) established that the top ten percent fastest growth firms in Sweden contributed modestly to employment growth. Furthermore, less than half of employment growth generated by such firms is classified as organic growth (i.e. not resulting from acquisition).

The findings in this paper serve to highlight that the prevalence of high-growth potential new firms can help to explain differing rates of economic growth observed in countries. However, this is not to suggest that other forms of entrepreneurial start-ups do not contribute to generating economic growth; merely that they do not differentiate countries with varying growth rates. Moreover, due to data constraints, the analysis has been confined to a cross-sectional approach, rather than the ideal time-series based analysis where causality can be more conclusively investigated. Also due to data constraints, the temporal specifications for variables in the present estimation model are problematic. Data on TEA should ideally be for a period preceding the period for the dependent variable; this is not possible as TEA data for sufficiently large number of countries are only available for recent years. As such, the findings in this paper should be regarded as exploratory, and await further confirmation in the future when a longer time-series of TEA data are available.

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Notes

[1] There is some overlap between this literature and studies on the impact of firm size and industry structures, with small business as a concept that is related but not synonymous with entrepreneurship. Thurik and Wennekers (2004) describe the historical context for the development of small business and its importance as a vehicle for entrepreneurship. For the purposes of this paper, the focus is on entrepreneurship as defined by involvement in starting and owning-managing new businesses, and not explicitly on small firms.

[2] Van Stel (2003) provides detailed description of the Compendia dataset.

[3] The full definition of a high-potential innovative start-up attempt in the GEM dataset is a venture that fulfils all of the following criteria: (1) the venture plans to employ at least 20 employees in 5 years; (2) the venture indicates at least some market creation impact; (3) at least 25% of the customers of the venture normally live abroad; and (4) the technologies employed by the venture had not been widely available more than a year ago.

[4] While GDP per capita is the most commonly used measure of economic growth, we have used GDP per worker instead. The two components of GDP per capita (GDP/N) are productivity as measured by GDP per worker (GDP/L) and labour participation rate (L/N). In our cross-national context, GDP per worker captures economic growth due to productivity gains, after controlling for differences in labour participation rates across different countries.

[5] Analysis using different time periods for the dependent variable was carried out. It was found that shortening the period over which GDP growth was measured reduced significantly the explanatory properties of the regression model. However, using different time periods of relatively longer lengths yielded relatively consistent results.

[6] Another measure used to proxy technological innovation is the Innovative Capacity Index reported in the Global Competitiveness Report published by the World Economic Forum. This Index quantifies the conditions that enable a nation to innovate at the global technological frontier. Using this measure yielded slight poorer fit than when a patents-based measure was used. However, similar conclusions in terms of hypothesis testing were reached.

[7] The insignificance of other forms of TEA could be due to the fact that for these types of new firms (without expectations for high growth), there is typically a lag between the period of firm formation and the period of achieving high growth. In principle, this can be addressed using a lagged variable for TEA, where the TEA variable is measured for a period preceding the dependent variable by several years. However, it is not possible to obtain TEA rates prior to 1997/1998.

[8] It is noted that this difference in the estimated coefficient could be due to the scaling effect of levels of High Potential TEA being generally much lower than levels of Opportunity TEA and Overall TEA. In order to address this, we have reported and tested for differences between the standardized regression coefficients. The differences between the standardized coefficients for High Potential TEA and other TEA rates were tested and found to be significantly different. Difference between coefficients for High Potential TEA and (a) Overall TEA, $P = 0.024$; (b) Opportunity TEA, $P = 0.029$; (c) Necessity TEA, $P = 0.0135$. Tests are one-sided. However, the use of standardized coefficients has its critics. As an alternative, we have repeated the analysis using standardized values for the different forms of TEA, allowing for the unstandardized estimated coefficient on TEA to be compared across the four equations. We similarly found that the estimated coefficient for High Potential TEA is significantly higher than the coefficients for the other forms of TEA.

Appendix A:

TABLE A. List of countries in GEM 2002 survey with associated TEA levels

Countries	Overall TEA	Opportunity TEA	Necessity TEA	High Potential TEA
Argentina	14.15	7.13	6.77	0.44
Australia	8.68	1.53	6.69	1.46
Belgium	2.99	0.31	2.35	0.64
Brazil	13.53	7.50	5.78	0.25
Chinese Taipei (Taiwan)	4.27	0.71	3.33	0.89
Canada	8.82	1.10	7.36	1.67
Chile	15.68	6.74	8.53	2.93
China	12.34	6.97	5.61	1.22
Croatia	3.62	0.85	2.18	0.65
Denmark	6.53	0.43	5.90	0.96
Finland	4.56	0.33	4.10	0.72
France	3.20	0.09	2.84	0.57
Germany	5.16	1.15	3.92	1.47
Hong kong	3.44	1.19	2.25	0.50
Hungary	6.64	2.11	4.00	0.76
Iceland	11.32	0.92	8.62	3.97

Appendix A: TABLE A. (Continued)

Countries	Overall TEA	Opportunity TEA	Necessity TEA	High Potential TEA
India	17.88	5.04	12.42	0.04
Ireland	9.14	1.38	7.77	1.52
Israel	7.06	1.40	5.22	1.14
Italy	5.90	0.53	3.34	0.71
Japan	1.81	0.51	1.24	0.16
Korea	14.52	4.12	8.55	2.11
Mexico	12.40	2.70	8.28	0.31
New Zealand	14.01	2.25	11.57	3.15
Netherlands	4.62	0.50	4.03	0.73
Norway	8.69	0.37	7.42	1.25
Poland	4.44	1.27	2.84	0.19
Russia	2.52	0.56	1.90	0.12
South Africa	6.54	2.38	3.30	0.00
Singapore	5.91	0.86	4.94	1.33
Slovenia	4.63	1.37	3.26	1.51
Spain	4.59	1.02	3.42	0.64
Sweden	4.00	0.67	3.33	0.63
Switzerland	7.13	0.87	6.03	1.07
Thailand	18.90	3.35	15.31	0.70
United Kingdom	5.37	0.69	4.38	0.99
United States of America	10.51	1.15	9.11	0.81

Source: GEM 2002 Master Database.

TABLE A.2
Pearson correlation coefficients between variables in estimation equation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Average compound growth in GDP per employed person 1997–2002							
(2) Log of base year GDP per worker (1998)	−0.475**						
(3) Average compound growth in capital investment per worker 1997–2002	0.668**	−0.163					
(4) High Growth Potential TEA	0.130	0.208	0.036				
(5) Opportunity TEA	0.023	−0.345**	−0.214	0.401**			
(6) Necessity TEA	0.064	−0.636**	−0.193	0.059	0.429**		
(7) Overall TEA	0.035	−0.524**	−0.239	0.335**	0.908**	0.753**	
(8) Ratio of USPTO patents to GDP, 97 to 01	0.013	0.407**	−0.104	0.047	−0.130	−0.340**	−0.250

Source: TEA rates from GEM 2002 Master Database, patents data from USPTO, economic data from World Competitiveness Yearbook, Euromonitor GMID and national sources.
** Significant at 5%.

TABLE A.3
Correlation Between TEA rates in 2001, 2002 and 2003[a]

	Pearson Correlation Coefficient		Spearman's Rank rho	
	TEA Overall 2002	TEA Overall 2003	TEA Overall 2002	TEA Overall 2003
(1) Overall TEA				
TEA Overall 2001	0.778 (n = 28)	0.748 (n = 21)	0.823 (n = 28)	0.849 (n = 21)
TEA Overall 2002		0.929 (n = 27)		0.893 (n = 27)
	TEA Opportunity 2002	TEA Opportunity 2003	TEA Opportunity 2002	TEA Opportunity 2003
(2) Opportunity TEA				
TEA Opportunity 2001	0.643 (n = 28)	0.775 (n = 21)	0.671 (n = 28)	0.774 (n = 21)
TEA Opportunity 2002		0.870 (n = 27)		0.899 (n = 27)
	TEA Necessity 2002	TEA Necessity 2003	TEA Necessity 2002	TEA Necessity 2003
(3) Necessity TEA				
TEA Necessity 2002		0.978 (n = 27)		0.896 (n = 27)

[a] Correlation between High Growth Potential TEA rates from different years is not available. High Growth Potential TEA was introduced in 2002 and is not available for earlier years. High Growth Potential TEA for 2003 has not yet been released by GEM coordinators with access to detailed data from all 31 countries.

Appendix B: Derivation of estimation model

Cobb–Douglas production function of the general form:

$$Y = A^{o} K^{\alpha} L^{\beta},$$

where Y = output; A^{o} = disembodied factor productivity; K = stock of physical capital; L = labor employed.

Dividing both sides by L:

$$\frac{Y}{L} = A^{o} K^{\alpha} L^{\beta-1}$$

Multiplying right hand side by $\frac{L^{\alpha}}{L^{\alpha}}$:

$$\frac{Y}{L} = A^{o} \left(\frac{K}{L}\right)^{\alpha} L^{\alpha+\beta-1}$$

Assuming Constant Returns to Scale, $\alpha + \beta = 1$. Hence

$$\frac{Y}{L} = A^{o} \left(\frac{K}{L}\right)^{\alpha}. \quad (1)$$

Taking natural logs on both sides:

$$\ln\left(\frac{Y}{L}\right) = \ln A^{o} + \alpha \ln\left(\frac{K}{L}\right). \quad (2)$$

Take first differences in order to obtain growth in Y/L as the dependent variable. For small% changes, $\Delta \ln\left(\frac{Y}{L}\right) = \%$ change in $\left(\frac{Y}{L}\right)$.

$$\Delta \ln\left(\frac{Y}{L}\right) = \Delta \ln A^{o} + \alpha\left[\Delta \ln\left(\frac{K}{L}\right)\right]. \quad (3)$$

We assume the growth in disembodied factor productivity, A^{o}, to be explained by stock of knowledge capital (technological innovation) and entrepreneurs (Total entrepreneurial activity rate):

$$\Delta \ln A^{o} = B^{o} + \phi Pat + \lambda \text{TEA}, \quad (4)$$

where
B^{o} = Constant; Pat = patent intensity (patents per dollar of GDP) measuring Technological Innovation Intensity; TEA = Total Entrepreneurial Activity measuring Entrepreneurship Rate.
Substituting (4) into (3):

$$\Delta \ln\left(\frac{Y}{L}\right) = B^{o} + \phi Pat + \lambda TEA + \alpha\left[\Delta \ln\left(\frac{K}{L}\right)\right]. \quad (5)$$

For cross-country context, we also include the base year value of $\left(\frac{Y}{L}\right)$, in order to control for the convergence effect of lower income nations having faster growth rates:

$$\Delta \ln\left(\frac{Y}{L}\right) = B^{o} + \delta \ln\left(\frac{Y}{L}\right)_{t-1} + \alpha\left[\Delta \ln\left(\frac{K}{L}\right)\right] + \phi Pat + \lambda TEA. \quad (6)$$

When operationalising the model for estimation, we use

$$\Delta \ln\left(\frac{Y}{L}\right) = \%\text{ growth rate in } \left(\frac{Y}{L}\right)\text{and}$$

$$\Delta \ln\left(\frac{K}{L}\right) = \%\text{ growth rate in } \left(\frac{K}{L}\right)$$

averaged across a 5-year period, in order to smooth out yearly fluctuations.

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