CASE Network
Studies & Analyses

Entrepreneurship and Economic Growth: An Investigation into the Relationship between Entrepreneurship and Total Factor Productivity Growth in the EU

Andrzej Dabkowski

No. 427/2011

Warsaw Bishkek Kyiv Tbilisi Chisinau Minsk

The paper presents findings obtained in a Master's Degree research project under Professor Connell Fanning, Dr John Considine, and Mr John Eakins at University College Cork, Department of Economics.

This publication has been financed thanks to the assistance of the PEKAO SA.

This publication has been prepared due to the help of Dr Ewa Balcerowicz.

Key words: **entrepreneurship, total factor productivity, economic growth, the EU**

JEL codes: **O11, O30, O47, O52, L26**

Graphic Design: Agnieszka Natalia Bury

EAN 9788371785429

Publisher:
CASE-Center for Social and Economic Research on behalf of CASE Network
12 Sienkiewicza, 00-010 Warsaw, Poland
tel.: (48 22) 622 66 27, 828 61 33, fax: (48 22) 828 60 69
e-mail: case@case-research.eu
http://www.case-research.eu

Table of Contents

List of Tables and Figures

Andrzej P. Dabkowski *graduated from University College Cork (National University of Ireland) in 2007 obtaining a degree in Social Sciences. In 2009 he was awarded a Higher Diploma in Economics and a year later a Master's Degree in Economic Science. His academic interests concentrate around the broad topic of entrepreneurship, especially in the area of operational quantification of entrepreneurial activities and their impact on growth. Andrzej Dabkowski has been affiliated with CASE since early 2011.*

Abstract

Endogenous growth theory assigns an important role for entrepreneurship in the process of economic development. This paper sets to formally test the impact of entrepreneurship on economic growth. Entrepreneurship is represented by a number of proxy variables, whereas Total Factor Productivity is used as a measure of economic growth. Panel data of 26 European countries repeatedly sampled over a period of 11 years is used to estimate a Random Effects model. This study finds that entrepreneurship contributes to growth moderately. It is not, nonetheless, a dominant force shaping changes in TFP growth rates. Business Birth Rate, Self-employment Rate, Business Investment and Labour Productivity Growth were all found to be highly significant. The article concludes that more encompassing measure of entrepreneurship needs to be developed, one that would reflect the complexity of the notion.

1. Introduction

There are numerous studies, both theoretical and empirical, aiming at understanding and explaining a relationship between entrepreneurship and economic growth. This paper is yet another attempt to do so, in a coherent and concise manner.

Entrepreneurship is quite an ambiguous concept. It has been studied and explained by many prominent economists making the notion even more complicated and less clear. This has led to diminishing interest and certain negligence of it for the better part of 20th century. Only in the past two decades, it has been reintroduced into the mainstream economic literature, gaining more and more interest especially among business and industrial economists. It is hard to identify its precise definition, however when identifying the origins it can be traced to the early 18th century. An Irish economist - Richard Cantillon, first developed the concept. In 1730s, he argued that in the world of fixed costs there must be a role for 'undertakers' who can bear the uncertainty of non-fixed returns. He stressed the focal role of entrepreneurs in growing decentralised markets; with the decrease of monopolies caused by market growth and rising trade openness, one must observe an emergent number of suppliers – increased competition - and escalating uncertainty of returns. This, according to Cantillon, proves that competition must go hand in hand with entrepreneurship, as it requires constant decision-making and risk-bearing (Cantillon, 1959) – namely entrepreneurial actions.

Entrepreneurial activity, it can be argued, is an intrinsic part of modern society. It is universalistic in nature, as it does not pertain to only selected individuals or organizations. The effects of entrepreneurship can be easily traced on a micro-level, in individuals' behaviour and actions. It is more challenging, however, to measure its effects on a macro-scale. This study tries to quantify the effects of entrepreneurship, testing its relevance in incentivising economic growth.

This paper is divided into five sections. After a brief introduction in Section 1, Section 2 provides a summary of the theoretical framework. It describes previous empirical research that led to this study and introduces the model as well as the hypothesis. Section 3 focuses on the analysis of the variables and gives an overview of the data selected and selection process. Section 4 deals with model estimation, analyses the results obtained through pooled and random effects model regressions. Section 5 briefly discusses the results, considers the impact of this study and its contribution. Finally, it identifies areas in which further academic investigation is necessary.

2. Literature Overview

2.1 Entrepreneurship and its Role in Economic Theory

Much has been said and written on entrepreneurship since Cantillon. In 1921, Frank Knight built upon Cantillon's idea of risk-bearer and introduced his own 'entrepreneur', whose primary objective was to deal with uncertainty and risk. Risk, in contrary to uncertainty, can be calculated, whereas the latter cannot (Knight, 1921). Similarly, this feature of entrepreneur was emphasized in Nathaniel Leff's overview of the concept (1979). Just a decade after Knight's publication, Joseph Schumpeter has introduced a new perspective on entrepreneurship. In his model (1934), an entrepreneur is seen as an agent, who through the process of innovation, brings about social change and economic development. Furthermore, he distinguishes five manifestations of entrepreneurship, "a new good, a new method of production, a new market, a new source of supply of intermediate goods, and a new organization" (Schumpeter, 1934, in Karlsson, Friis, & Paulsson, 2005, pp. 88-89).

Baumol (2008) and Dejardin (2000) point out that entrepreneurial activity may not always lead to increased productivity. Baumol (2008) makes a clear distinction between productive, unproductive, and destructive entrepreneurship. The last one not necessarily meant in Schumpeterian manner. Social entrepreneurs may engage in rent seeking behaviour, which results only in redistribution of profits, and not creation. The two scholars conclude that it is the structure of the environment and incentives that induce an entrepreneur into the different activities (Baumol, 1968; Baumol, 2008; Dejardin, 2000). The role for good institutions can be clearly asserted from this theory (Boettke & Coyne, 2003; Acs & Virgill, 2010).

Izrael Kirzner (1973) shares Schumpeterian acclamation of entrepreneurship as a central process in growing market economy. He, however, does not see entrepreneur as a 'creative destroyer', constantly breaking away from market equilibrium, but rather the opposite, as an agent whose primary role is to identify and correct for market disequilibria inherent in competitive market economy. These two seemingly conflicting actions may not be poles apart as either one would lead to permanent change in the market environment, hence achieving similar outcome (Holcombe, 2008).

Wennekers and Thurik (1999, pp. 46-47) have developed a definition that seems to encompass the characteristics of entrepreneurship mentioned above:

"Entrepreneurship is the manifest ability and willingness of individuals, on their own, in teams, within and outside existing organizations, to:

- *perceive and create new economic opportunities (new products, new production methods, new organizational schemes and new product-market combinations) and to*
- *introduce their ideas in the market, in the face of uncertainty and other obstacles, by making decisions on location, form and the use of resources and institutions."*

This definition may appear attractive from a theoretical point of view, it is not, however, very practical, as number of its aspects are impossible to measure. So far, basing on the macro data available, one could use proxies capturing a single feature and its level as a measurement of entrepreneurship. Commonly used proxy variables would include business start-ups or self-employment (Klapper & Quesada Delgado, 2007; Naude, 2008). These, however, may be criticized for its narrowness and oversimplification, as not every new business is an example of entrepreneurial behaviour, as well as self-employment could be caused by the lack of other opportunities rather than simply entrepreneurial aspirations. Acs & Szerb (2009), Bosma & Levie (2010), and Hancock, Klyver & Bager (2001), suggest using a Global Entrepreneurial Monitor consortium devised measure of entrepreneurship, like TEA (Total Early-stage Entrepreneurial Activity). Acs & Szerb (2009), based on GEM framework, introduce Global Entrepreneurship Index, which captures entrepreneurship in three sub-indexes that comprise of various indicators and variables. The development of this measure is still at its early stage, and empirical application and validity is not yet assessed. Meanwhile, numerous studies confirm the effectiveness of measuring entrepreneurship through proxies like business start-up rates, labour productivity growth or patent applications (Bartik, 1989; Carey, 1996; van Praag, 2003; Salgado-Banda, 2005).

Karlsson, Friis, and Paulsson (2005) have summarized that the definitions of entrepreneurship can be broadly divided into two simple categories: "those that are generally more encompassing theoretically and the more narrow operational ones" (p. 90). They continue by suggesting that in research and discussion it may by more convenient to focus primarily on entrepreneurial activities as it provides attractive feature from operational point of view – simplicity, despite its limited nature. Especially, when few of the operational definitions combined, one might acquire a more encompassing tool of entrepreneurship (Karlsson, Friis, & Paulsson, 2005). This view is shared by Zoltan Acs and Laszlo Szerb in 'Global Entrepreneurship Index (GEINDEX) (2009).

2.2 Entrepreneurship and Growth – Theoretical and Empirical Studies

Classification of theories employed in this paper has been developed by Wennekers and Thurik (1999) and further enhanced by Karlsson, Friis, and Paulsson (2005). It not only presents the most prominent growth theories and links them to entrepreneurship, but also illustrates various entrepreneurial functions with their role defined in growth process.

Table 1, below, is an excerpt from Wennekers and Thurik (1999). It shows the role of entrepreneurship, and its importance, in number of different fields of economics.

Table 1. Role of Entrepreneurship in Economic Activity

Assessment of the role of entrepreneurship, drawn from several fields of research

Field of literature	Specific domain	Competition	Innovation	Firm start-ups	Importance of entrepreneurship for economic growth
Historical views	Schumpeter/Baumol	++	+++	+	++
	Neo-classicals	++	+	0	+
	Austrians	++	+	0	++
Endogenous growth theory		+	+++	0	+
Economic history		++	+++	+	+++
Management literature		+	+++	++	++
Industrial economics	Porter	+++	+++	++	+++
Evolutionary economics	Eliasson	+++	+++	+++	+++

0 Not present in the writings.
\+ Implicitly present in the writings.
++ Explicitly present in the writings.
+++ Pivotal element in the writings.

Source: (Wennekers & Thurik, 1999)

In historical view, Schumpeter (1934) and Baumol (1968) share a similar perception on entrepreneur's role in economic development. They both see entrepreneur as an agent bringing about change through constant innovation, in the process of creative destruction, which introduces instability to 'static' markets, creating disequilibria. This attitude goes against an orthodox view, in which market forces should continuously move towards achieving equilibrium. Schumpeter stresses, however, that the risk of entrepreneurial activities lay predominantly on the capitalist and not on the entrepreneur himself.

Neoclassical growth theory, best represented in the Solow model (1957), has little room for entrepreneurship. In this theory, growth is attributed to accumulation of factors of production, like capital and labour, which in time should lead to reaching a steady-state of economy. After this point, innovation change, or technological progress, is the only reason behind growth. In this model, knowledge, technological progress, is exogenously given, hence there is no need for entrepreneur. Holcombe (2008), however, argues that technology can be produced, and it is the application of it that requires entrepreneurs.

In Austrian school of economics, entrepreneurship has a particularly strong role in promoting growth through perceiving opportunities in the market. Kirzner (1973) describes this function as the ability to profit from market inefficiencies and deficiencies, leading to improvement in market structure. Holcombe (2008) explains Austrian's entrepreneurship in terms of 'entrepreneurial insights'. He argues that entrepreneurial opportunities in the market are caused by entrepreneurial insights of other entrepreneurs. Therefore, change that is created through entrepreneurs' actions leads to more entrepreneurship, i.e. more change.

What neoclassical growth theory takes as given, exogenous technological progress, endogenous growth theory, or 'new growth theory', tries to explain. In this perspective, growth can be attributed to investment in knowledge (Romer, 1990). This does not explicitly assume a role for entrepreneurs, but assigns a simplified function of entrepreneurs to any profit maximizing individual or organization. Peter Howitt (2006) sees Schumpeterian entrepreneurship, and creative destruction, as a force responsible for dynamism of industries, and within the endogenous growth theory framework, a cause behind long-term economic growth.

From economic history perspective, institutions play a crucial role in determining economic growth. Following the early 1990s, institutions have been accredited with a central role in country's growth process. Starting from Mancur Olson (1996), and followed by historical experiments of Daron Acemoglu (2003) and Acemoglu, Johnson and Robinson (2001), economists have realized the importance of 'good' institutions in promoting economic growth. In his 2008 paper, William Baumol, emphasizes the role of institutions for encouragement of 'productive entrepreneurship', which can be identified as a primary source of economic growth, as no other type of entrepreneurship, whether it be 'unproductive' or 'destructive', is responsible for creation of additional output. Wennekers and Thurik (1999) and Robert Lawson (2008) agree with Baumol on principle that the major foundation of long-term economic growth lies with proper, incentivizing institutions rather than simple growth accounting.

In industrial economics, Porter's (1990) diamond model of national competitive advantage provides an interesting insight into the relationship between economic growth and entrepreneurship. Wennekers and Thurik (1999) and Wennekers, Uhlaner, and Thurik (2002) have stipulated that the advantage in a single factor of the model might not be enough to ensure economic development but only the overall interaction between the various factors combined with entrepreneurial activity may ensure prospective growth.

Empirical studies of entrepreneurship and its relationship to economic growth are all relatively recent. Devising a reliable measure of entrepreneurship has proven to be a difficult task. It was one of the major reasons responsible for a 40-year stagnation of academic research in the area of entrepreneurship. Within the last 20 years, however, there have been numerous studies conducted that would test the nature of the relationship. Most empirical studies, nevertheless, focus primarily on a single aspect of entrepreneurship, as it is most difficult form the operational point of view to conduct a research, which could fully encompass the totality of the concept. Nonetheless, "recent empirical studies suggest that entrepreneurship – measured as start-up rates, the relative share of SMEs, self-employment rates, etc. – is instrumental in converting knowledge into products and thereby propelling growth" (Braunerhjelm, 2010).

Entrepreneurship, therefore, can manifest itself in a number of ways, one of which is innovation. Salgado-Banda (2005) has measured innovative entrepreneurship using quality adjusted patent data. He concluded that a positive influence on growth could be asserted for the 22 OECD countries he has studied. Similar results were found by Lee, Dlorida and Acs when studying American economy (2004).

Another important feature of entrepreneurship can be described as business ownership. Thurik (1999) in his 1984 – 1994 cross-sectional study of 23 OECD member countries provided empirical evidence that increased entrepreneurship, as measured by business ownership rates, was associated with higher rates of employment growth at the country level. Also, Carree and Thurik (1999), followed by Audretsch et al (2002), concluded that those OECD countries that show evidence of higher increases in entrepreneurship, exhibited through business ownership rates, are the ones that have enjoyed lower unemployment and greater rates of economic growth.

Most commonly used proxy for measuring entrepreneurship is business start-up rate. Acs and Armington (2002) have investigated the relative contribution of new start-ups to job creation. Their findings suggest that new firms may have a far greater role in new job creation than previously thought. In the study of the U.S. economy, they demonstrated that in the first half of the 1990s new businesses were responsible for a considerably larger share of job creation than previously existing companies. Job creation, in turn, can be directly linked to economic growth. Another study, conducted for the Canadian government, has concluded that "entrepreneurship is a powerful force driving innovation, productivity, job creation and economic growth. Countries with a high level of entrepreneurial activity tend to be better off economically" (Fisher & Reuber, 2010). Fisher and Reuben (2010) used a number of entrepreneurship variables, including business birth rates, death rates and survival rates. All these variables proved significant and exhibit positive impact on growth rates, with the exception of business death rates, which is negatively related.

2.3 Hypothesis and Model

This paper is set to test and estimate the importance of entrepreneurship as a drive of economic growth. To test this hypothesis, a number of proxy variables is introduced that describe entrepreneurship. Economic growth is measured by Total Factor Productivity growth.

In the new growth theory, Total Factor Productivity (TFP) is considered a focal force for economic growth once the economy achieves a steady-state. In the neo-classical view, represented by the Solow growth model, it is the residual that emerges after adjusting the total value added for the impact of labour-capital ratio and the amount of the human capital per unit of labour (Erken, Donselaar, Thurik, 2008). High (2004) suggested that TFP is the variable that captures the effect of entrepreneurship on growth. Therefore, to assess the real influence of entrepreneurship on growth, one should analyze the impact of 'entrepreneurship variables' on TFP growth rates.

The following model has been developed by Erken, Donselaar, and Thurik (2008). It is a standard fixed-effects linear model.

$$\text{Eq.1} \ \ln(TFP_{i,t}) = \beta_0 + \beta_1(X_{i,t}) + \beta_i\, DUM_i + \beta_t DUM_t + \varepsilon_{i,t}$$

In the above equation, TFP (for country i and year t) stands for total factor productivity. 'ln' denotes the natural logarithm, X expresses independent variable(s) for country i and time t. DUMi stands for a dummy variable of country i, while DUMt for time t. εi,t denotes the error term for country i at time t.

The model adopted for this study is altered to include eight proxy variables for entrepreneurship.

$$\text{Eq. 2} \quad TFP\ \%\ growth_{i,t} = \beta_0 + \beta_1\, Patents_{i,t} + \beta_2\, Self-employ_{\,i,t} + \beta_3\, Birth\ Rates_{i,t} + \beta_4\, Survival\ Rates_{i,t} + \beta_5\, Labour\ Product._{i,t} + \beta_6\, Business\ Invest._{i,t} + \beta_7\, Death\ Rates_{i,t} + \beta_8\, R\&D\ EXP._{i,t} + \varepsilon_{i,t}$$

The developed model, however, suffers from severe multicollinearity, as two pairs of independent variables display serial collinearity. After accounting for multicollinearity, the model is transformed to:

Eq. 3 $$TFP\ \%\ growth_{i,t} = \beta_0 + \beta_1\ Patents_{i,t} + \beta_2\ Self - employ_{\ i,t} + \beta_3\ Birth\ Rates_{i,t} + \beta_4\ Survival\ Rates_{i,t} + \beta_5\ Labour\ Product._{i,t} + \beta_6\ Business\ Invest._{i,t} + \varepsilon_{i,t}$$

Description of variables in the specified model is available in the table below.

Table 2. Variables in the Model

TFP % growth	Total Factor Productivity percentage growth
Patents	Total number of applications to the European Patent Organisation per million of inhabitants
Self-employ	Rate of self-employed and employers to the total population
Birth Rates	Rate of business start-ups over the existing business
Death Rates	Rate of business exits over the existing business
Survival Rate	Rate of business survival in two consecutive periods over existing business
Labour Product.	Labour productivity percentage growth
R&D Exp.	Total business expenditure on R&D as a percentage of GDP
Business Invest.	Total business investment as a percentage of GDP

3. Data Selection and Analysis

3.1 Data Selection and Sources

The dataset used in the study covers a period from 1997 to 2007. The reason behind this relatively short interlude is that for most cases, there is no more data available. In addition, before 1997 some of the variables were not yet developed. These would include 'traditional' entrepreneurship variables like enterprise birth rates or survival rates. Furthermore, the data is not completely balanced. There are some observations missing for individual countries or years.

This dataset consists of 26 cross-sections that represent 26 European countries. Selection was based primarily on geographical location of a country, and more precisely, upon its membership in the European Union. The aim of this research is to evaluate the importance of entrepreneurship as one of the key drives of economic growth in Europe. Acs and Szerb (2009) discovered that entrepreneurial activity differs significantly from country to country, depending on its stage of development. The development steps correspond well to Porter's (2002) stages of development, meaning that countries at efficiency-driven stage exhibit different levels and types of entrepreneurship from the innovation-driven ones. This may lead to severe heterogeneity in the sample, causing heteroscedasticity. To minimize the problem, countries selected for the study represent similar development phase; they are mainly at the innovation-driven stage or rapidly approaching it. Nevertheless, selected countries may be divided into two groups: Western Europe – at the innovation-driven stage of development, and Central and Eastern Europe – at the efficiency-driven phase. However, convergence is strongly present in the sample (European Commission, 2010; De Benedictis and Tajoli, 2003), allowing to estimate an average level of entrepreneurship across the EU, with a use of appropriate econometric techniques. In this manner, twenty-four EU countries were chosen and two European Economic Community countries that are not members of the EU – Switzerland and Norway. Three EU countries were excluded from the study, Poland, Malta and Greece. No data was collected for these three countries in the period of interest. Table 3 below identifies the countries qualifying for the study, as well as those excluded.

Table 3. Countries included in the study

EU member states included in the study	Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, the UK
EU member states not included in the study	Greece, Malta, Poland
Non-EU member states (EEC members) included in the study	Norway, Switzerland

This group consists fully of European countries, of which many are member-states of the European Union, Organization for the Economic Co-operation and Development, Organization for Security and Co-operation in Europe. Fourteen countries are part of the Eurozone - single European currency community. The group may seem quite homogenous, it does, however, possess heterogenic features, including different demographics, mainly size, geographic location, islands and continent, or institutional regimes, taxation and legal framework.

Main contributors to data collection were Eurostat online database and the Conference Board Total Economy Database. Both sources are open for public and free use, and specialize in collecting economic data in consistent format, both time-wise and in structure. For these two reason it was the most convenient to use this data resource for this research.

3.2 Description and Summary of the Variables

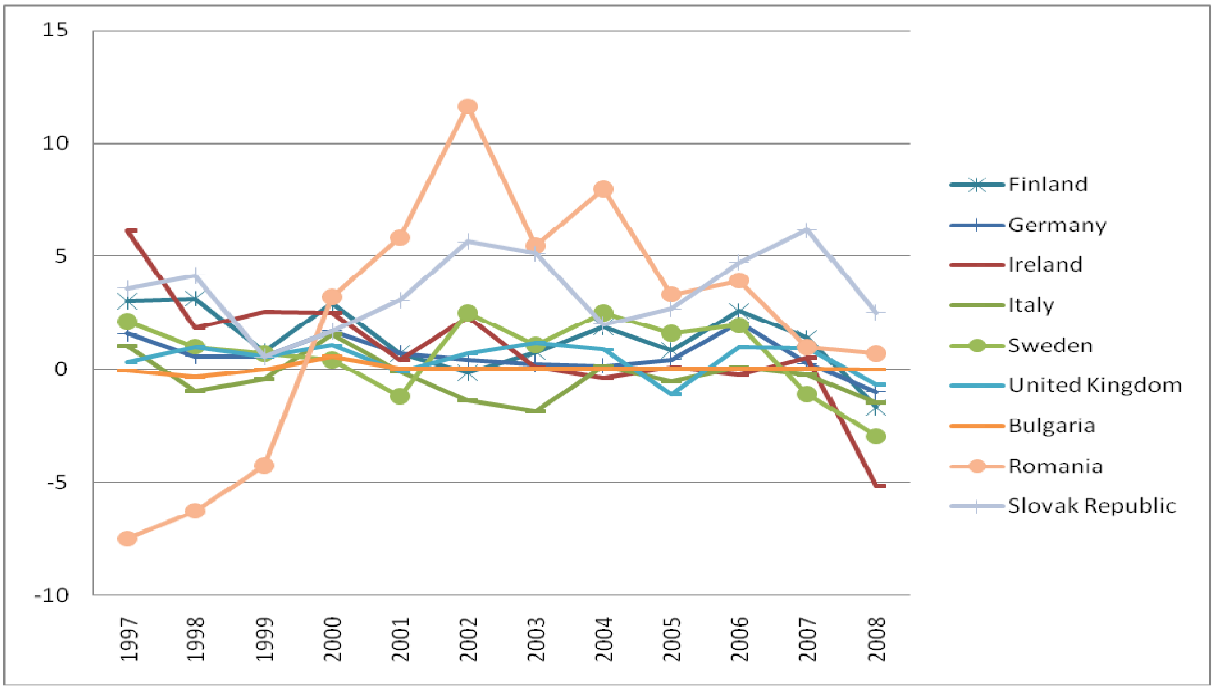
Table 4 summarizes the variables used in the estimation of the model, with their respective descriptive statistics.

Table 4. Variables with description, source, and descriptive statistics

Variable Name	Source	Mean	Median	St. Dev	Min	Max
TFP%growth	Total Economy Database	0.56	0.16	1.78	-7.48	11.64
Patents	Eurostat	98.13	64.58	105.20	0.19	429.34
Self-employment	Eurostat	0.06	0.05	0.02	0.03	0.10
Business Births	Eurostat	10.45	9.90	3.83	0.00	27.21
Business Deaths	Eurostat	8.32	8.06	2.78	0.00	18.79
Business Survival	Eurostat	71.66	72.99	12.62	0.00	90.85
Labour Product.	Eurostat	2.89	2.30	2.83	-5.80	21.70
R&D exp.	Eurostat	1.44	1.25	0.87	0.22	4.17
Business Invest.	Eurostat	19.20	18.80	3.71	9.50	32.70

'TFP %growth' accounts for the changes in output not caused by changes in inputs. "TFP represents the effect of technological change, efficiency improvements, and inability to measure the contribution of all other inputs. It is estimated as the residual by subtracting the sum of two-period average compensation share weighted input growth rates from the output growth rate. Log differences of level are used for growth rates, and hence TFP growth rates are Törnqvist indexes" (The Conference Board Total Economy Database, 2010). Erken, Donselaar and Thurik (2008) have suggested using TFP rather than GDP to describe economic growth, in line with their argument that entrepreneurship is a dominant drive of TFP growth. Figure 1 shows changes in Total Factor Productivity for the selected countries.

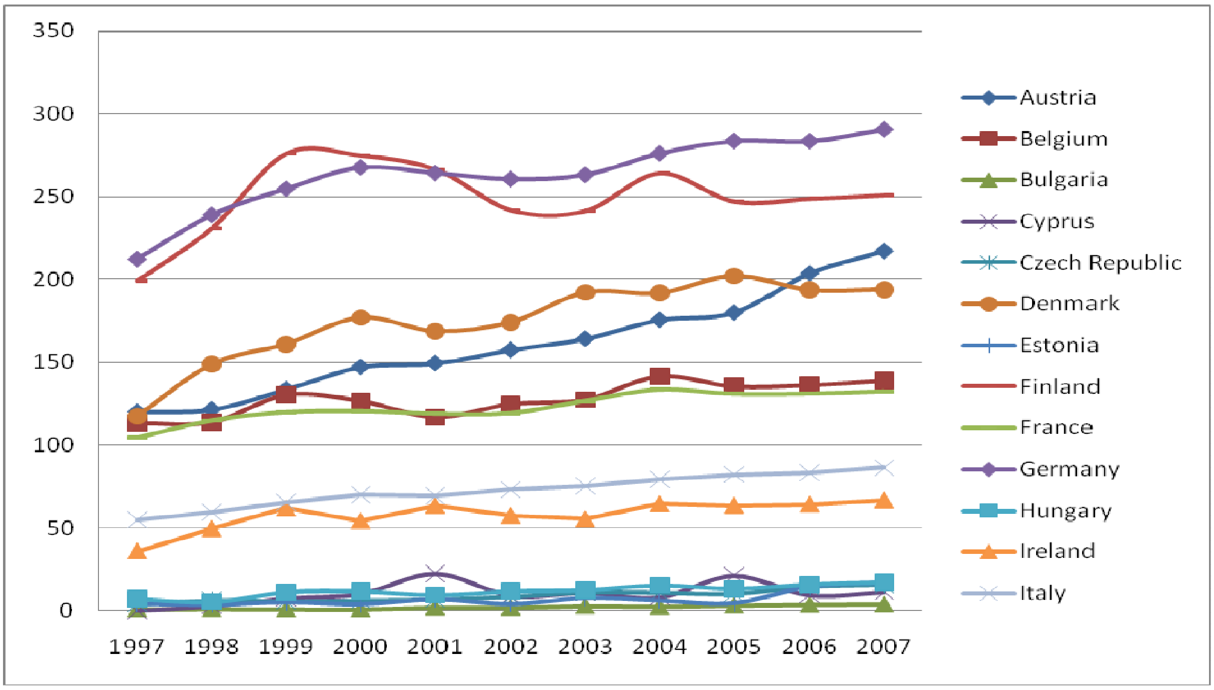
Figure 1. Total Factor Productivity % Growth



Total-factor productivity percentage growth for selected countries introduces two patterns present. One, countries at their efficiency-driven stage of development exhibit large variations in Total Factor Productivity, e.g. Slovakia or Romania. Two, for the innovation-driven economies, TFP growth is quite level over the period, varying from -1 to 4% with a median value of 2%. It is noticed, moreover, that certain level of convergence can be observed. Large country level effects are likely to be present, suggesting individual effects model for the estimation. Over the twelve years recorded, it is Romania that attains the highest percentage growth, in 2002. Ireland exhibits steady decline in TFP growth.

The ‘patents’ dataset is based on the patent counts received by the EPO (EPO Bibliographic Database), adjusted by population. Patents are a key measure of R&D output, and their relative numbers reflect the inventive performance of firms, regions and countries. Among the few available indicators of technology output, patent indicators are probably the most frequently used. Salgado-Banda (2005) used patent data to measure innovative entrepreneurship, and found a positive influence on growth. Therefore, it will serve as one of the proxies of entrepreneurship, together with business R&D expenditure trying to capture innovative entrepreneurship. In Figure 2 (below), one can see the number of applications to the European Patent Office, for selected states, by country and year, and adjusted for the demographic differences between those countries.

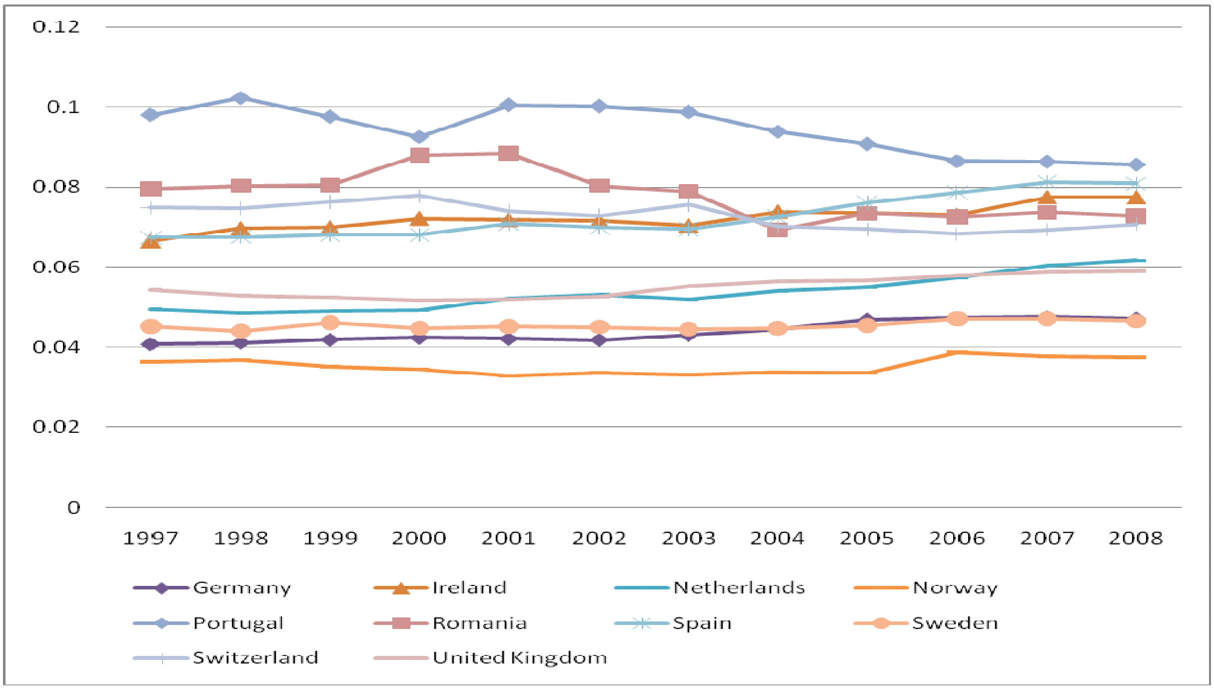
Figure 2. Patent applications to the EPO (per million of inhabitants)



Patent applications variable demonstrates an interesting picture of entrepreneurial countries. It is very noticeable how the 'old Europe' contributes to this count, and how little some of the new EU member countries. All the 2004/2007 accession countries, i.e. Bulgaria, Cyprus, Czech Republic, Estonia and Hungary, are in the same group of low applicants. Nevertheless, there is a trend visible; the numbers are slightly rising throughout the period. It is observed, however, that France and Belgium seem to be exhibiting very similar pattern, suggesting that the innovativeness of both countries is almost the same. Figure 3 may confirm that the twelve new countries are not yet at the innovation-driven stage of development, exhibited through a low utilization of intellectual performance

'Self-employment' covers employers, who can be defined as persons who work in their own business, professional practice or farm for the purpose of earning a profit, and who employ at least one other person. As well as self-employed persons, who are defined as persons who work in their own business, professional practice or farm for the purpose of earning a profit, and who employ no other persons. Self-employment, sometimes referred to as 'business ownership', is a common suggested proxy for entrepreneurship. Studies employing this variable include Braunerhjelm (2010) and Thurik (1999). Both researchers found self-employment to be a good proxy for entrepreneurship.

Figure 3. Proportion of self-employed and employers to the total population



'Business Births', often referred to as 'business entries' or 'business start-ups', is expressed as a ratio of businesses born in a reference period to the total number of businesses. It is the most common measure of entrepreneurship. Acs and Armington (2002) and Bartik (1989) have used this indicator to study the US economy obtaining very promising results. This study introduces two additional variables important in measuring business at its early stage, 'Business Exits' and 'Business Survival Rates'. Both variables have been found significant in number of articles (Audretsch & Keilbach, 2004; Fisher & Reuber, 2010). Gartner and Shane (1995) argue Business Survival Rates to be a valid measurement of entrepreneurial activity, if properly constructed. Those three variables combined can evaluate the extent of successful entrepreneurship.

Figure 4. Business Birth Rates

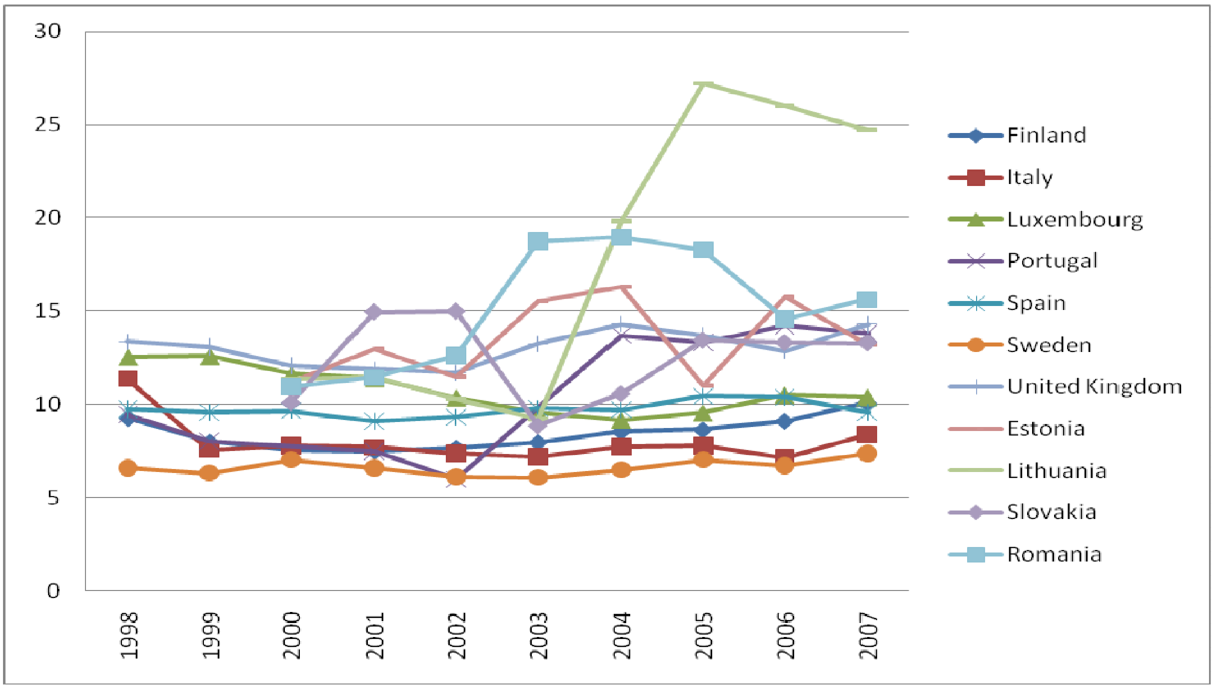
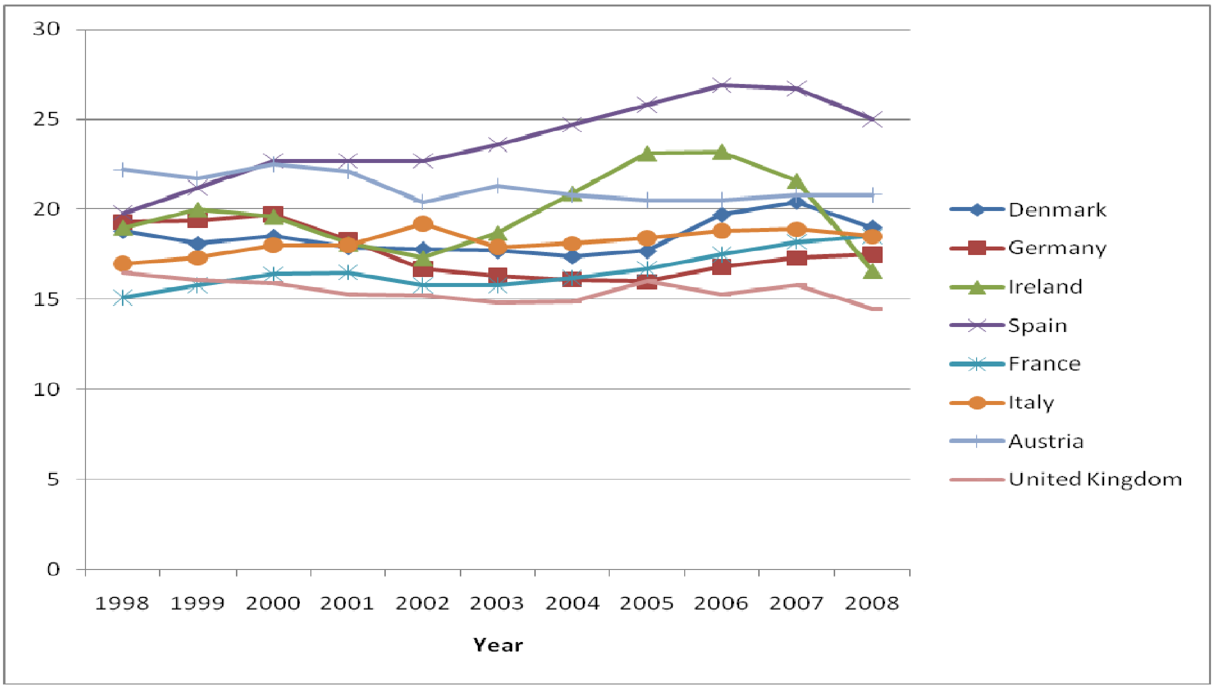


Figure 4 above describes the pattern of business birth rates for selected countries. One can see that the rates have been quite consistent over the years for the Western European countries, except Portugal, which experienced a significant increase between the years 2002-2004, but continuing at this steady level since. The new EU countries exhibit large variations in the business birth rates recorded, especially Lithuania, which noted a massive spike in the entries rate in 2003 and 2004. Mean Business Birth rate is about 10.

Other variables that are included in the study ('Labour Productivity %growth', 'Total Business expenditure on R&D as a percentage of GDP', and 'Business investment as a percentage of GDP'), in this or similar form where introduced by Erken, Donselaar, and Thurik (2008) in order to capture the innovative and productive[1] entrepreneurship (Braunerhjelm, 2010).

[1] Productive entrepreneurship, after Lawson (2008), understood as entrepreneurial actions leading to productivity growth rather than simple redistribution of assets.

Figure 5. Business Investment as a % share of GDP



In Figure 5 above one can notice that the level of business investment is quite level over the period of eleven years studied, and ranges from about 15 to 23 % of GDP. Two most interesting patterns are exhibited by Spain and Ireland. The first country has continuously increased its business investment, measured as percentage share of GDP, which slightly declined in the last year, most likely due to the global recession that started in that year. Ireland has displayed an S-shaped investment pattern, which first rises modestly then declines in the period from 2000 to 2002 after which it strongly ascends to reach its peak in 2005. In the period 2005 – 2008 it sharply declines to attain a record low of just above 16 % share of GDP.

4. Methodology and Results

As presented in the previous section, the economic model intended to be used in this research is as follows:

Eq. 2 $$TFP\ \%\ growth_{i,t} = \beta_0 + \beta_1\ Patents_{i,t} + \beta_2\ Self - employ_{\ i,t} + \beta_3\ Birth\ Rates_{i,t} + \beta_4\ Survival\ Rates_{i,t} + \beta_5\ Labour\ Product._{i,t} + \beta_6\ Business\ Invest._{i,t} + \beta_7\ Death\ Rates_{i,t} + \beta_8\ R\&D\ EXP._{i,t} + \varepsilon_{i,t}$$

However, after accounting for multicollinearity, the model is transformed to:

Eq. 3 $$TFP\ \%\ growth_{i,t} = \beta_0 + \beta_1\ Patents_{i,t} + \beta_2\ Self - employ_{\ i,t} + \beta_3\ Birth\ Rates_{i,t} + \beta_4\ Survival\ Rates_{i,t} + \beta_5\ Labour\ Product._{i,t} + \beta_6\ Business\ Invest._{i,t} + \varepsilon_{i,t}$$

This study utilises cross-sectional time-series approach. It uses a panel data of 26 countries, with periodical observations taken over a period of 12 years, from 1997 to 2008. Gujarati (2003) argues that with repeated observations of enough cross-sections, panel analysis permits to study the dynamics of change with relatively short time series. The combination of time series with cross-sections can enhance the quality and quantity of data in ways that would be impossible using only one of these two dimensions (Gujarati, 2003, p. 638). Additional advantage with having panel data is that “it allows us to test and relax the assumptions that are implicit in cross-sectional analysis” (Maddala, 2001). Cross-sectional time-series analysis can allow to detect for individual effects within the cross-sectional dimension, giving panel data “more informative data, more variability, less collinearity among variables, more degrees of freedom and more efficiency” (Gujarati & Porter, 2009).

Before attempting the estimation using a pooled model, one should take into account various specification problems, especially collinearity among regressors.

4.1 Multicollinearity in the Model

The aim of this research is to estimate the importance of entrepreneurship for determination of economic growth. As outlined in the previous sections, theory suggests Total Factor Productivity captures entrepreneurship; hence, its impact on growth should be measured in changes in TFP. There is no single variable that could completely characterise entrepreneurship; therefore, this research has adopted several proxy variables that are to represent certain aspects of it. This approach, however, may lead to violation of one of the classical assumptions in the basic regression model, namely that the explanatory variables are not to be exactly linearly related.

Maddala (2001) describes multicollinearity as a "problem of high intercorrelations among the explanatory variables" (p. 268). He explains, "when the explanatory variables are highly intercorrelated, it becomes difficult to disentangle the separate effects of each of the explanatory variables on the explained variable" (p. 268). This may lead to very high standard errors, or low t-values, thus leading to wide confidence intervals for the parameters in question (cont.). In a situation like this, the analysis of the regression can be unreliable, meaning that the coefficients may not be estimated precisely (Gujarati & Porter, 2009). Gujarati and Porter (2009) list several consequences of near perfect or high multicollinearity. First, despite the OLS estimators still being BLUE (Best Linear Unbiased Estimator), it leads to large variances and covariances, hence making accurate estimation very difficult. Second, this may contribute to rushed acceptance of "zero null hypothesis", that the true population coefficient is zero. T-ratios may exhibit tendency to fall, becoming statistically insignificant. This effect, however, would not show in the overall R2. Finally, the estimator can be oversensitive to changes in the data (p. 327).

First attempt to detect for multicollinearity is with a simple bivariate correlations matrix. Table 5, below, presents Bivariate Correlations between the Independent Variables.

Table 5. Bivariate Correlations between the Independent Variables

Variable	Patents	Self-employ	Birth Rates	Death Rates	Survival Rates	Labour Product.	R&D Exp.	Business Invest.
Patents	1.0000							
Self-employ	-0.2216	1.0000						
Birth Rates	-0.4039	-0.1228	1.0000					
Death Rates	-0.3579	-0.0651	0.7454	1.0000				
Survival Rates	0.1657	-0.1959	0.1339	0.1291	1.0000			
Labour Product.	-0.3658	-0.2081	0.2598	0.2450	0.0497	1.0000		
R&D Exp.	0.8734	-0.1786	-0.4203	-0.3572	0.1951	-0.3164	1.0000	
Business Invest.	-0.6296	-0.0845	0.1811	-0.0007	-0.2359	0.2838	-0.5618	1.0000

Examination of the pair-wise correlations detects two high values, one for the correlation between Patents and R&D Expenditure, and two, between Birth Rates and Death Rates. Gujarati and Porter (2009) suggest a rule of a thumb that if the pair-wise correlation coefficient between two regressors is in excess of 0.8, multicollinearity could be a serious problem. In this case, Patents-R&D Exp. coefficient is well above the rule, and Birth Rates-Death Rates is dangerously close.

Correlation of the estimated coefficients can provide additional insight into the multicollinearity embedded in the variables. Table 6 displays the matrix correlations of estimated coefficients using Random Effects Model (REM).

Table 6. Correlation of Coefficients in REM

Variable	Patents	Self-employ	Birth Rates	Death Rates	Survival Rates	Labour Product.	R&D Exp.	Business Invest.
Patents	1.0000							
Self-employ	0.1884	1.0000						
Birth Rates	0.0341	0.2084	1.0000					
Death Rates	0.0513	-0.0891	-0.5607	1.0000				
Survival Rates	0.0530	0.1851	-0.0060	-0.0412	1.0000			
Labour Product.	0.0110	0.0796	0.1761	-0.1422	-0.0884	1.0000		
R&D Exp.	-0.7725	-0.0522	0.0040	0.0840	-0.1343	0.0790	1.0000	
Business Invest.	0.2526	0.0326	-0.2226	0.2598	0.0982	-0.1324	-0.0032	1.0000

Results presented in the table above do not differ significantly from these shown in Table 5. There is still high correlation between Patens and R&D Expenditure, as well as in Birth Rates and Death Rates.

Examining the tolerances or VIFs may produce more decisive results than the bivariate correlations of independent variables or their estimated coefficients. Table 7 presents the variance-inflation factor (VIF) and tolerance before and after accounting for multicollinearity.

Table 7. VIF and Tolerance before and after solving for Multicollinearity

Variable	Before		After	
	VIF	Tolerance	VIF	Tolerance
Patents	5.75	0.1739	2.44	0.4100
Self-employ	1.41	0.7089	1.34	0.7438
Birth Rates	2.55	0.3921	1.27	0.7871
Death Rates	2.61	0.3838	-	-
Survival Rates	1.17	0.8535	1.12	0.8901
Labour Product.	1.30	0.7692	1.32	0.7566
R&D Exp.	4.41	0.2267	-	-
Business Invest.	2.24	0.4471	1.86	0.5367
Mean VIF	**2.68**		**1.56**	

VIFs of 10 or higher (or equivalently, tolerances of 0.10 or less) are considered to indicate severe multicollinearity. Some researchers suggest, however, a VIF over 2.5 and tolerance under 0.40 may signify too high collinearity and cause concern. Table above displays VIF values of 5.75 for Patents, 2.55 for Birth Rates, 2.61 for Death Rates, and 4.41 for R&D Expenditure. The mean VIF is 2.68. Tolerance exhibits similar patterns implying possible high multicollinearity.

Eigenvalue, condition index and condition number are used to further test for multicollinearity. Table 8 demonstrates the results of these tests.

Table 8. Eigenvalue and Condition Number

	Eigenvalue	Condition Index
1	7.4213	1.0000
2	0.9542	2.7888
3	0.3257	4.7733
4	0.1383	7.3244
5	0.0550	11.6159
6	0.0448	12.8719
7	0.0309	15.4984
8	0.0263	16.7890
9	0.0034	46.6148
Condition Number		**46.6148**

Condition number (CN) of 15 or above suggests uneasy level of multicollinearity present in the data. CN over 30 is an alarming level signifying serious multicollinearity (Belsley, Kuh, & Welsch, 1980). CN of 46.6148 detected in the test above is well over this threshold, prompting conclusion that severe multicollinearity is indeed present.

Gujarati and Porter (2009), Gujarati (2003), and Maddala (2001) all suggest similar solutions to multicollinearity. One, by providing additional data, which is impossible to apply in case of this research, as more data is simply not available. Two, combining cross-sectional and time series data, i.e. pooling the data; has shown to ease the problem slightly, however not in sufficient measure. Finally, dropping one of the collinear variables. Based on the results obtained, excluding both Death Rates and R&D Expenditure should improve the model ensuing acceptable level collinearity between remaining variables.

VIFs and tolerance indicators in Table 7, as well as bivariate correlations in Table 9, present significant decrease in multicollinearity. Mean VIF has a value of 1.56, much below the required 2.5, with tolerance levels varying from 41% to 81%. After deleting two most troublesome variables – Death Rates and R&D Exp. - Condition Number has dropped to 25.4048, which is well in the acceptable region of collinearity.

Table 9. Bivariate Correlations after solving for Multicollinearity

Variable	Patents	Self-employ.	Birth Rates	Survival Rates	Labour Product.	Business Invest.
Patents	1.0000					
Self-employ.	-0.2587	1.0000				
Birth Rates	-0.3967	-0.1024	1.0000			
Survival Rates	0.2041	-0.1783	0.0023	1.0000		
Labour Product.	-0.3895	-0.1714	0.2693	0.0333	1.0000	
Business Invest.	-0.6252	-0.0395	0.2401	-0.2526	0.3268	1.0000

4.2 Pooled Model - FGLS Regression

First, a Wooldridge Test is performed to test for serial correlation in the panel data model. Under the test's assumption, significant test statistic indicates the presence of serial correlation (Wooldridge, 2002; Drukker, 2003).

H0: no first-order autocorrelation

Table 10 demonstrates the results of the Wooldridge Test.

Table 10. Wooldridge Test for Autocorrelation

F(1, 14)	0.002
Prob > F	0.9690

Application of the test generates an F value of 0.002. Probability of obtaining such a value is close to 97%. This leads to a conclusion not to reject the null hypothesis, stating the same that there is no serial correlation in the panel data model.

Pooled model "treats all observations as though they came from the same regression model" (Koop, 2008). It does not account for heterogeneity, i.e. individuality or uniqueness, of countries in the dataset. As the set contains 26 cross-sections – countries – that exhibit considerable differences in the size of observations, the problem of heteroscedasticity is more than likely to occur (Gujarati & Porter, 2009). Heteroscedasticity, difference in variances of each disturbance term, can lead to inaccurate results of regular OLS estimation, producing unnecessarily larger confidence intervals. Consequently, the t-tests, or F-tests, become unreliable, and regression may produce statistically insignificant coefficients (Gujarati, 2003).

To correct for the heteroscedasticity a Feasible General Least Squares regression is carried. The results are available in Table 11.

Table 11. FGLS Regression Results

Dependent Variable	TFP % growth			
Independent Variables	Coefficients	Std. Err.	Z - Stat	P - value
Patents	.0062888	.0008634	7.28***	0.000
Self-employ.	26.84751	4.892779	5.49***	0.000
Birth Rates	.0550811	.0252399	2.18**	0.029
Survival Rates	-.0042126	.0054172	-0.78	0.437
Labour Product.	.3723613	.0342916	10.86***	0.000
Business Invest.	-.048415	.0163605	-2.96***	0.003
Intercept	-2.048344	.6551133	-3.13***	0.002
Wald chi2	303.93	Prob > chi2	0.0000	

* Significant at 10%, ** Significant at 5%, *** Significant at 1%

The results obtained from the FGLS regression seem quite satisfactory. Five out of six variables are statistically significant, leaving Survival Rates as the only independent variable not significant at any level. Patents, Self-Employment, Labour Productivity, and Business Investment are significant at 1%, whereas Birth Rates at the level of 5%. The signs on the coefficients estimated are mostly as expected, with the exception of Business Investment, which is highly statistically significant, and Survival Rates – insignificant at any level. Both variables reveal negative signs indicating adverse relationship to Total Factor Productivity growth. Overall, the regression produces high Wald Chi2 value of 303.93, with probability approaching zero.

Gujarati (2003) and Gujarati & Porter (2009) stipulate, however, there is a major problem with pooled regression model, as it does not distinguishes between the various cross-sections and their individual effects. They argue the heterogeneity should be taken into account when estimating a cross-sectional time-series model; otherwise, the estimated coefficients may be biased and inconsistent. Individual Effects Models are introduced to help solve this problem.

4.3. Individual Effects Models

"There are two main individual effects models, the Fixed Effects Model (FEM) and the Random Effects Model (REM)" (Koop, 2008). The FEM "allows for heterogeneity among subjects by allowing each entity to have its own intercept value. (…) The term 'fixed effects' is due to the fact that, although the intercept may differ across subjects, each entity's intercept doe not vary over time, that is, it is time-invariant" (Gujarati & Porter, 2009, p. 596). In the REM, the intercepts are treated "as random variables rather than fixed constants" (Maddala, 2001, p. 575). They are assumed to be mutually independent, as well as independent of the error terms (cont.).

Statistically, the fixed effects model always gives consistent results, although they may not be the most efficient. Random effects model, on the other hand, should generate better P-values as it is a more efficient estimator. To decide which of the individual effects model is more appropriate for the sample a Hausman Test is carried; the results of which are available in Table 12.

Table 12. Hausman Test Results

Dep. Var.: TFP % growth	Coefficients			
Independent Variables	FEM	REM	Difference	S.E.
Patents	.010472	.002615	.007857	.009947
Self-employ.	43.91168	28.92261	14.98907	22.27228
Birth Rates	.0830283	.0722454	.0107829	.0270996
Survival Rates	-.0078484	-.0023071	-.0055413	.0207347
Labour Product.	.328839	.3460685	-.0172295	.015483
Business Invest.	-.2511747	-.1703243	-.0808504	.0518666
Chi2	3.85	Prob>chi2	0.6970	

The Hausman Test verifies the hypothesis that the Fixed Effects Model estimators do not differ substantially from the Random Effects Model estimators. A Chi2 value of 3.85 is obtained, with almost 70% probability of attaining such a chi2 value. This leads to a conclusion that the null hypothesis should not be rejected; therefore, the REM is a more appropriate individual effects model for the sample2.

The REM estimation results are found in Table 13.

[2] The results of the estimation using Fixed Effects are shown in Table 15, available in the Appendix.

Table 13. Random Effects Model Results

Dependent Variable	TFP % growth			
Independent Variables	Coefficients	Std. Err.	Z - Stat	P - value
Patents	0.002615	0.0030333	0.86	0.389
Self-employ.	28.92261	15.37272	1.88*	0.060
Birth Rates	0.0722454	0.0368683	1.96**	0.050
Survival Rates	-0.0023071	0.0141907	-0.16	0.871
Labour Product.	0.3460685	0.0418999	8.26***	0.000
Business Invest.	-0.1703243	0.0580609	-2.93***	0.003
Intercept	0.5308452	2.052602	0.26	0.796
Overall R^2	0.3529	Prob > chi2	0.0000	

* Significant at 10%, ** Significant at 5%, *** Significant at 1%

The results presented in Table 13 show that in general, the regression is found to be significant, and the hypothesis that all the coefficients of explanatory variables are jointly equal to zero is rejected; with Wald chi2 value of 77.07 and probability approaching zero. Four explanatory variables are statistically significant. Two, Labour Productivity and Business Investment, are significant at 1% level. Birth Rates is significant at 5% level, whereas Self-employment at 10% level. Both Patents and Survival Rates are insignificant at any level. Most signs on coefficients are as expected, with the exception of Survival Rates and Business Investment, which have negative signs. The overall R2, which measures how much of the variation in the dependant variable is explained by the independent variables included in the model, has a value of 0.3529. Over 35% of variations in the percentage growth of Total Factor Productivity is explained by the estimated REM model.

Lee at al. (2004) have found Patents, measured as the total number of patents per 100 thousand of population, to be insignificant at 1%, 5% or even 10% level. After conducting detail analysis, however, he discovered Patents to have marginal positive effect when taken only for manufacturing industry, with the level of significance at 10%. The insignificance of Survival Rates may be due to a slightly different character of the variable. It does not measure the level of entrepreneurship or entrepreneurial activity, as all other variables do by proxy, but rather the level of ‘success’ of entrepreneurial actions. C. Mirjam van Praag (2003) believes survival rate is not the best measure of entrepreneurial success, as it does not differentiate between ‘forced exits’ and ‘entrepreneurial failures’. Van Praag, as well as Gartner and Shane (1995), have also found it insignificant in some cases, i.e. when tested in short time periods.

The model concludes, the greater the ratio of self-employed and employers to the population, the more TFP grows. Business Birth Rates and Labour Productivity growth have similar positive effect on TFP % growth, likewise the total number of patent application to the EPO per million of inhabitants. Marginal negative effect is noted for Business Survival Rates and Business Investment as a percentage of GDP. Kevin Carey (1996) has discovered analogous relationship between business investment and TFP growth. He argues that investment, especially in the form of inventory accumulation, and Total Factor Productivity growth are negatively related, as inventories are depleted when productivity growth is high.

To determine which model is the most appropriate for the sample, pooled or random effects, the Breusch and Pagan Lagrange Multiplier Test is conducted to test the hypothesis that there are no random effects present.

$$H0: \delta_u^2 = 0$$

The results of the test are shown in the Table 14.

Table 14. Breusch-Pagan LM Test for Random Effects

	Var	SD = sqrt(Var)	
TFP % growth	3.815725	1.953388	
e	.9488458	.9740872	
u	1.582822	1.258102	
chi2	90.55	Prob > chi2	0.0000

Application of the test produces a chi-square value of 90.55. The probability of obtaining a chi-square value of 90.55 is close to 0%. Therefore, the null hypothesis is rejected, and one may conclude that random effects are present; hence, the REM is the most appropriate model for this sample. These results are in line with the Hausman Test, confirming the validity of Random Effects Model.

Comparing the results of the two models used, it is noticed that the pooled regression produces more significant coefficients and at the higher level of significance. First, Patents variable is highly significant in the Pooled Estimation, at the level of 1%, whereas it is not significant even at the 10% level in the REM. Self-employment and enterprise Birth Rates are still significant, however at lower levels, while both Labour Productivity and Business Investment stay significant at the 1% level. Signs on the coefficients follow the same patter in either of the models.

5. Conclusions

There has been a significant theoretical contribution on the topic of entrepreneurship and economic growth. Section 2 of this paper described number of economic schools of thought assigning different roles to entrepreneurship and its part in stimulating growth. The neo-classical growth theory, whether it be in the form of growth accounting (Denison, 1985) or theory of long-run tendencies (Solow, 1970) does not fully explain the economic growth recorded, leaving a considerable residual of unexplained variations of the growth in the model. This approach does not leave much space for entrepreneurship, as it describes the residual to be an effect of exogenous technological progress. Van de Klundert and Smulders (1992) stress that the technological change, in real terms, stays much unaccounted for, like Biblical "manna from heaven" (Van de Klundert & Smulders, 1992), it is exogenously given. The new growth theory, however, "puts emphasis on the endogenous role of innovation and human capital formation in explaining economic growth" (Wennekers & Thurik, 1999, p. 36). This theory gives entrepreneurship a strong, nonetheless implicit, role in growth stimulation, drawing largely from entrepreneurial innovation and efficiency. Endogenous growth theory has provided academia with a theoretical framework allowing for empirical investigations into the complicated relationship of entrepreneurship and economic growth.

The study conducted in this paper is primarily based on the Erken, Donselaar and Thurik (2008) research. It has found entrepreneurship, expressed in the form of business ownership, a highly significant variable in explaining economic growth, as represented by Total Factor Productivity growth. Auxiliary studies have indicated other 'entrepreneurship' variables that may explain productivity growth (Salgado-Banda, 2005; Braunerhjelm, 2010; Thurik, 1999; Acs & Armington, 2002; Acs & Szerb, 2009; Naude, 2008), most of which were included in the model, after accounting for multicollinearity. The regression results produced in this study have, for the most part, confirmed the initial hypothesis.

Entrepreneurship, realised through proxies, explains changes in Total Factor Productivity to some extent. Overall R2 produced in the Random Effects model reached over the value of 0.35, meaning the model applied can explicate the growth rates of TFP in over 35%. This result is not enough to stipulate that TFP changes be primarily caused by variations in entrepreneurship in a country. It can, nevertheless, shed some light on the nature and intensity of the relationship between entrepreneurship and economic growth.

In the future, a similar study can be conducted with increased number of observations. Extending the time frame is a natural development, as the measurement of some variables does not expand before 1997. Observation for 2009 should be available shortly through the Eurostat. In addition, identifying ‘better’ proxies for various entrepreneurial activities should become a priority. Number of initiatives has been set to deliver a more encompassing measure of entrepreneurship, on which the most prominent and promising is the Global Entrepreneurship Monitor. This consortium’s goal is to study entrepreneurship not only through entrepreneurial actions (which proved to be comparatively easy to measure), but also through entrepreneurial attitudes and aspirations (Acs & Szerb, 2009; Acs & Armington, 2002; Bosma & Levie, 2010; Hancock, Klyver, & Bager, 2001; Thurik, Wennekers, & Uhlaner, 2002; Acs Z. J., 2007). Unfortunately, the research findings are not readily available from the consortium, and so is the data.

References

Acemoglu, D. (2003). Root Causes: a historical approach to assessing the role of institutions in economic development. *Finance and Development*, 40 (2), 27-30.

Acemoglu, D., Johnson, S., & Robinson, J. A. (2001). The Colonial Origins of Comparative Development: An Empirical Investigation. *The American Economic Review*, 91 (5), 1369-1401.

Acs, Z. J. (2007). How is entrepreneurship good for economic growth? *Innovations*, 1 (1), 97-107.

Acs, Z. J., & Szerb, L. (2009). The Global Entrepreneurship Index (GEINDEX). *Foundations and Trends in Entrepreneurship*, 5 (5), 341-435.

Acs, Z. J., & Virgill, N. (2010). Entrepreneurship in Developing Countries. *Foundations and Trends in Entrepreneurship*, 6 (1), 1-68.

Acs, Z., & Armington, C. (2002). *Economic Growth and Entrepreneurial Activity.* Washington D.C.: Center for Economic Studies, U.S. Bureau of the Census.

Audretsch, D. B., & Keilbach, M. (2004). Entrepreneurship and regional growth: an evolutionary interpretation. *Journal of Evolutionary Economics*, 14 (5), 605-616.

Audretsch, D., & Fritsch, F. (2002). Growth Regimes over Time and Space. *Regional Studies*, 36, 113-124.

Bartik, T. (1989). Small business start-ups in the United States: estimates of the effects of characteristics of states. *Southern Economic Journal*, 55, 1004-1018.

Baumol, W. J. (1968). Entrepreneurship in Economic Theory. *The American Economic Review*, 58 (2), 64-71.

Baumol, W. J. (2008). Entrepreneurship: Productive, Unproductive, and Destructive. In B. Powell, *Making Poor Nations Rich: Entrepreneurship and the Process of Economic Development* (pp. 79-111). Stanford, CA: Stanford University Press.

Belsley, D., Kuh, E., & Welsch, R. (1980). *Regression Diagnostics.* New York: John Wiley & Sons.

Boettke, P. J., & Coyne, C. J. (2003). Entrepreneurship and Development. In R. Koppl, J. Birner, & P. Kurrild-Klitgaard (Eds.), *Advances in Austrian Economics: Austrian Economics and Entrepreneurial Studies* (Vol. 6, pp. 67-87). Bingley, UK: Emerald Group Publishing Ltd.

Bosma, N., & Levie, J. (2010). *GEM 2009 Executive Report.* Global Entrepreneurship Monitor. GEM Consortium.

Braunerhjelm, P. (2010). *Entrepreneurship, Innovation, and Economic Growth: Past experiences, current knowledge and policy implications (Working Paper).* Stockholm: Swedish Entrepreneurship Forum, Royal Institute of Technology.

Cantillon, R. (1959). *Essai sur la Nature du Commerce in Général (Essay on the Nature of Trade in General).* (H. Higgs, Ed., & H. Higgs, Trans.) London: Frank Cass and Co., Ltd.

Carey, K. (1996). The relationship between inventory investment and total factor productivity growth: Cost shocks or Demand shocks? *Economics Letters*, 51 (2), 219-223.

Carree, M., & Thurik, R. (1999). Industrial Structure and Economic Growth. In D. Audretsch, & R. Thurik (Eds.), *Innovations, Industry Evolution, and Employment.* Cambridge: Cambridge University Press.

De Benedictis, L., & Tajoli, L. (2003). Economic Integration, Similarity and Convergence in the EU and CEECS Trade Structures. Presented at the 6th Conference on the Current Trends in Economics, Society for the Advancement of Economic Theory, Rhodes, June 30 – July 6, 2003.

Dejardin, M. (2000). Entrepreneurship and Economic Growth: An Obvious Conjunction? *Working Paper.* Bloomington: Indiana University.

Denison, E. F. (1985). *Trends in American Economic Growth 1929 - 1982.* Washington, D.C.: Brookings Institute.

Drukker, D. M. (2003). Testing for serial correlation in linear panel-data models. *STATA Journal*, 3, 168-177.

Erken, H., Donselaar, P., & Thurik, R. (2008). Total Factor Productivity and the Role of Entrepreneurship. *Jena Economic Research Papers*, 019, 2-55.

European Commission (2010). Convergence Report 2010. *European Economy*, 3, 2010.

Fisher, E., & Reuber, R. (2010). *The State of Entrepreneurship in Canada.* Industry Canada. Ottawa: Public Works and Government Services.

Gartner, W. B., & Shane, S. A. (1995). Measuring Entrepreneurship over time. *Journal of Business Venturing*, 10 (4), 283-301.

Gujarati, D. N. (2003). *Basic Econometrics* (Fourth Edition ed.). New York: McGraw-Hill.

Gujarati, D. N., & Porter, D. C. (2009). *Basic Econometrics* (International Fifth Edition ed.). New York: McGraw-Hill.

Hancock, M., Klyver, K., & Bager, T. (2001). *GEM Danish National Executive Report - 2000.* Global Entrepreneurship Monitor. Copenhagen: Danish Agency for Trade and Industry.

High, J. (2004). The roles of entrepreneurship in economic growth: toward a theory of total factor productivity. In H. L. de Groot, P. Nijkamp, & R. Stough, *Entrepreneurship and regional* *economic development: a spatial perspective* (pp. 46-78). Northampton, MA: Edward Elgar Publishing Ltd.

Holcombe, R. G. (2008). Entrepreneurship and Economic Growth. In B. Powell, *Making Poor Nations Rich: Entrepreneurship and the Process of Economic Development* (pp. 54-78). Stanford, CA: Stanford University Press.

Karlsson, C., Friis, C., & Paulsson, T. (2005). Relating Entrepreneurship to Economic Growth. In B. Johansson, C. Karlsson, & R. R. Slough (Eds.), *The Emerging Digital Economy: Entrepreneurship, Clusters and Policy* (pp. 83-111). Berlin: Springer-Verlag.

Kirzner, I. M. (1973). *Competition and Entrepreneurship.* Chicago, IL: The University of Chicago Press.

Klapper, L., & Quesada Delgado, J. M. (2007). ViewPoint: Entrepreneurship - New Data on Business Creation and How to Promote It. *Note No. 316.* Washington DC: The World Bank Group.

Knight, F. H. (1921). *Risk, Uncertainty, and Profit* (1st Edition ed.). Boston, MA: Hart, Schaffner & Marx; Houghton Mifflin Co.

Koop, G. (2008). *Introduction to Econometrics.* Chichester: John Wisley & Sons.

Lawson, R. A. (2008). Economic Freedom and Property Rights: The Institutional Environment of Productive Entrepreneurship. In B. Powell, *Making Poor Nations Rich: Entrepreneurship and the Process of Economic Development* (pp. 112-133). Stanford, CA: Stanford University Press.

Lee, S. Y., Florida, R., & Acs, Z. J. (2004). Creativity and Entrepreneurship: A Regional Analysis of New Firm Formation. *Regional Studies*, 38 (8), 879-891.

Leff, N. H. (1979). Entrepreneurship and Economic Development: The Problem Revisited. *Journal of Economic Literature*, 17 (1), 46-64.

Maddala, G. S. (2001). *Introduction to Econometrics* (Third Edition ed.). Chichester, England: John Wiley & Sons.

Naude, W. A. (2008). Entrepreneurship in Economic Development. *UNU-WIDER Research Paper No. 2008/20.* Helsinki: United Nations University.

Olson, M. (1996). Big Bills Left on the Sidewalk: Why Some Nations are Rich and Others Poor. *Journal of Economic Perspectives*, 10 (2), 3-24.

Porter, M. E. (2002). Building the Microeconomic Foundations of Prosperity: Findings from the Microeconomic Competitiveness Index. *WEF Global Competitiveness Report*, 1-23.

Porter, M. E. (1990). *The Competitive Advantage of Nations.* London: MacMillan.

Romer, P. M. (1990). Endogenous Technical Change. *Journal of Political Economy*, 98, 71-102.

Salgado-Banda, H. (2005). Entrepreneurship and Economic Growth: An Empirical Analysis. *Research Paper* (pp. 1-46). Mexico City: Banco de Mexico.

Schumpeter, J. A. (1934). The Theory of Economic Development. In M. Casson, *Entrepreneurship* (pp. 105-134). Hants: Edward Elgar.

Solow, R. M. (1970). *Growth Theory: An Exposition.* Oxford: Oxford University Press.

Solow, R. M. (1957). Technical Change and the Aggregate Production Function. *The Review of Economics and Statistics*, 39 (3), 312-320.

The Conference Board Total Economy Database. (2010). *Total Economy Database.* Retrieved August 2010, from The Conference Board: http://www.conference-board.org/data/economydatabase/

Thurik, R. (1999). Entrepreneurship, Industrial Transformation and Growth. In G. D. Liebcap (Ed.), *The Sources of Entrepreneurial Activity* (pp. 29-66). Stamford: JAI Press.

Thurik, R., Wennekers, S., & Uhlaner, L. M. (2002). Entrepreneurship and Economic Performance: A Macro Perspective. *International Journal of Entrepreneurship Education*, 1 (2), 1-20.

Van de Klundert, T., & Smulders, S. (1992). Reconstructing Growth Theory: A Survey. *De Economist*, 140, 177-203.

van Praag, C. M. (2003). Business Survival and Success of Young Small Business Owners. *Small Business Economics*, 23 (1), 1-17.

Wennekers, S., & Thurik, R. (1999). Linking Entrepreneurship and Economic Growth. *Small Business Economics*, 13 (1), 27-55.

Wennekers, S., Uhlaner, L. M., & Thurik, R. (2002). Entrepreneurship and Its Conditions: A Macro Perspective. *International Journal of Entrepreneurship Education*, 1 (1), 25-68.

Wooldridge, J. M. (2002). *Econometric Analysis of Cross Section and Panel Data.* Cambridge: MIT Press.

Appendix

Table 15 Fixed Effects Model Results

Dependent Variable	TFP % growth			
Independent Variables	Coefficients	Std. Err.	T - Stat	P - value
Patents	.010472	.0103992	1.01	0.317
Self-employ.	43.91168	27.06242	1.62	0.108
Birth Rates	.0830283	.0457565	1.81*	0.073
Survival Rates	-.0078484	.0251258	-0.31	0.756
Labour Product.	.328839	.0446691	7.36***	0.000
Business Invest.	-.2511747	.0778538	-3.23***	0.002
Intercept	.8532845	2.768618	0.31	0.759
Overall R^2	0.1678	Prob > chi2	0.0000	

* Significant at 10%, ** Significant at 5%, *** Significant at 1%