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The Two-Way Relationship Between Entrepreneurship and Economic Performance

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Abstract:

This paper examines the two-way relationship between entrepreneurship and economic performance, using a harmonized data set covering 21 OECD countries in the period 1981-2006. While the relation between entrepreneurship and economic performance has been investigated extensively, most papers in this research field suffer from one or more methodological flaws, so that the important question: "does entrepreneurship cause economic performance?" can still not be answered up till the present day. In this paper we investigate the relationship in a Vector Error Correction Model (VECM) framework. We find evidence for the existence of a long-run equilibrium relation between the level of business ownership and per capita income. We also find evidence that increases in business ownership actually cause economic growth. However, our impulse response analysis reveals that the effect depends on the number of business owners already present in the economy, i.e. we find decreasing marginal returns to entrepreneurship. We also find that the effect depends on the size of the shock (i.e. the increase in entrepreneurship), where too big shocks may lead to negative effects on GDP due to 'overshooting'.

Keywords: entrepreneurship, economic performance, endogeneity, long-run equilibrium relationship, Vector Error Correction Model, Impulse Response Function

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1. Introduction

While the relation between entrepreneurship and economic performance has been investigated extensively, most papers in this research field suffer from one or more methodological flaws, so that the question: "does entrepreneurship cause economic performance?" can still not be answered up till the present day. The question is important because insight into the links between entrepreneurship and economic performance can help policy makers decide whether or not they should stimulate entrepreneurship in order to achieve higher rates of economic growth in the short and the long run. One important aspect of the relation between entrepreneurship and economic growth which is not yet known is whether the relation is causal. Besides establishing the direction of causality, five more empirical and theoretical aspects are of importance when studying the complex relation between entrepreneurship and economic performance, i.e. (i) the counter-effects within the same direction of causality; (ii) the lag structure between entrepreneurship and economic performance; (iii) dealing with the level of economic performance versus the change in economic performance; (iv) dealing with country- and time-effects; and (v) measurement issues regarding economic performance and entrepreneurship.

Most studies to date only (and often only implicitly) deal with one or a few of these aspects. In this paper we investigate the relationship in an integrated framework, accounting for the direction of causality, the lag structure, the short-run dynamics and the long-run equilibrium relation. More specifically, we estimate a Vector Error Correction Model (VECM) with cointegration which imposes no prior assumptions on the endogeneity of entrepreneurship (business ownership) and economic performance (GDP growth). The VECM with cointegration allows us to unravel the genuine relationship between entrepreneurship and economic performance. We estimate our model using a harmonized dataset covering 21 OECD countries in the period 1981-2006. We find evidence for the existence of a long-run equilibrium relation between the level of business ownership and per capita income. We also find evidence that increases in business ownership actually cause economic growth. However, the effect depends on the number of business owners already present in the economy, i.e. we find decreasing marginal returns to entrepreneurship. Finally, we find that the effect depends on the size of the shock (i.e. the increase in entrepreneurship), where too big shocks may lead to negative effects on GDP due to 'overshooting'.

The organisation of this paper is as follows. In the next section, we provide an overview of the most important contributions to the literature regarding entrepreneurship and economic performance, focusing on the six aspects mentioned above. This theoretical background is followed by a description of the data set that will be used for our analyses. The next section deals with the methods that are used to identify the relationship between entrepreneurship and economic performance, followed by the estimation results. Finally, we discuss the conclusions of this research.

2. Theoretical background

This section reviews the theoretical and empirical literature on the relation between entrepreneurship and economic performance focusing on the six aspects identified in the introduction.

2.1 Direction of causality

Empirically, several studies have paid attention to the relationship between entrepreneurship and economic performance. The direction of causality is of great importance then. Does entrepreneurship affect economic performance, is it the other way around or are both true at the same time, i.e. does there exist a two-way causality between both factors? On the one hand, economic growth is expected to drive entrepreneurship as high rates of economic growth lead to increasing wealth, which in turn stimulates consumption and investment. This implies an enhanced consumer demand for variety (increasing the market size), which creates more entrepreneurial opportunities (Audretsch and Keilbach, 2004). On the other hand, entrepreneurship may promote economic performance as more entrepreneurs imply more competition, which increases productivity and efficiency, and encourages innovation. This, in turn, generates more economic growth (Van Stel, Carree and Thurik, 2005; Fritsch, 2008). Although a two-way relationship between entrepreneurship and economic performance seems plausible, most studies only investigate one direction of causality. Moreover, one direction of causality, viz. the effect of entrepreneurship on economic performance, has been explored more often than the opposite direction of causality, the impact of economic performance on entrepreneurship. Below, we briefly address the effect of entrepreneurship (E) on economic performance (Y), the opposite direction of causality, as well as the two-way relationship between entrepreneurship and economic performance.

One-way relationship

Many scholars tried to measure the impact of entrepreneurship on economic performance. This relationship is studied at the country level by Audretsch, Carree, Van Stel and Thurik (2002), Van Stel, Carree and Thurik (2005), Carree and Thurik (2008) and Erken, Donselaar and Thurik (2008) among others. The focus was on the regional level in studies done by Fritsch and Mueller (2004) and Van Stel and Suddle (2008). The opposite direction of causality, the impact of economic performance on entrepreneurship, is investigated by Reynolds, Storey and Westhead (1994), Wennekers, Van Stel, Thurik and Reynolds (2005), Van Stel, Storey and Thurik (2007) and Wennekers, Thurik, Van Stel and Noorderhaven (2007) amongst others.

Wennekers, Van Stel, Thurik and Reynolds (2005) tried to explain the variation in nascent entrepreneurship by employing three different approaches. The first approach relates to a country's gross inflow into entrepreneurship (i.e. nascent entrepreneurship) to its level of economic output (measured by per capita income). The second approach is used to investigate the relationship between nascent entrepreneurship and the innovative capacity index. The third approach hypothesises that nascent entrepreneurship depends upon several non-economic determinants. For our research, the first approach is the most relevant one. For this approach three different functional forms of the relationship are investigated: a linear relation, a U-shaped one, and an L-shaped relationship between entrepreneurship and per capita income. Wennekers et al. (2005) find that the linear relationship is clearly rejected and that "the statistical fit of the quadratic specification (U-curve) is somewhat better than that of the inverse specification (L-curve)" (p. 301). Nevertheless, the difference is not significant. This result means that a country's rate of entrepreneurial activity declines as per capita income increases, up to a certain level of economic output. From this point onwards, entrepreneurship starts to increase when a country's level of economic output further increases.

The 'left' part of the U-curve shows a negative relationship between economic performance and the self-employment rate (referred to as the Schumpeter Mark II regime, as explained later). This is explained by Lucas (1978) in terms of the opportunity cost of self-employment relative to the expected return on investment. Assuming an uneven distribution of 'managerial' talent (or entrepreneurial ability) among the working population, rising real wages lead to an increasing opportunity cost for self-employment. This in turn encourages marginal entrepreneurs to become employees, resulting in a larger average firm size and a lower number of business owners.

The 'right' part of the U-curve shows a reversal of the negative relationship between economic performance and the rate of self-employment (which corresponds to the

Schumpeter Mark I regime, as will also be explained later). This specification holds in particular for countries with an advanced level of economic development. Over time, the share of manufacturing in terms of employment has declined in these countries, while the share of the services sector started to increase with the level of per capita income. This led to more entrepreneurial opportunities for potential business owners, explaining the recent revival of the self-employment rate as related to the level of per capita income. As explained by Jackson (1984), growing levels of economic development also provide an increasing need for self-realization which enhances consumer demand for variety. This in turn provides more opportunities for (small) business ownership, which also explains the changing relationship as described by the U-curve.

Van Stel, Storey and Thurik (2007) not only examined the determinants of nascent entrepreneurship, but also those of young business entrepreneurship. For this purpose, they estimated two separate equations while taking the interrelationship between the two variables into account. When explaining nascent entrepreneurship, they distinguished between opportunity entrepreneurship and necessity driven entrepreneurship. Opportunity-based entrepreneurship is driven by opportunity-based motives, which means that this type of entrepreneurs will start a business because they have perceived a business opportunity. On the other hand, necessity-driven entrepreneurship is based on necessity-based motives, which means that this type of entrepreneurs will start a business because they see entrepreneurship as their last resort. Necessity entrepreneurship occurs more often in developing countries, while opportunity-based entrepreneurship occurs more in developed countries. Van Stel, Storey and Thurik (2007) find substantial differences between the determinants of opportunity and necessity entrepreneurship. One of their findings, for example, is that higher education plays an important role for opportunity entrepreneurship, but not for necessity entrepreneurship. Another finding is that economic growth positively influences opportunity nascent entrepreneurship, while it does not play a significant role in determining necessity nascent entrepreneurship.

Two-way relationship

While the literature regarding the relationship between entrepreneurship and economic performance suggests that there exists a two-way relationship, most empirical studies paid attention to one side of the relationship only. In other words, most of the researchers (implicitly) assumed that one of these variables is exogenous whereas the other is assumed endogenous, implying only one direction of causality. Still, there are a few exceptions.

When we interpret economic performance in a broad sense, we may also use unemployment as a (reverse) performance indicator. This brings us to a study of Thurik, Carree, Van Stel and Audretsch (2008) who investigated the two-way relationship between self-employment and unemployment by estimating a two-equation Vector Autoregressive (VAR) model. The dependent variables in these equations are the change in unemployment and the change in self-employment. By including lagged dependent variables as explanatory variables, they were able to test the direction of causality using Granger Causality tests[1]. After estimating the two relations simultaneously using weighted least squares (WLS), they found that lagged levels of unemployment significantly drive the rate of business ownership and vice versa. They explain this finding in terms of the so-called *'refugee' effect* and *'entrepreneurial' effect*. They illustrate that, on the one hand, rising unemployment rates have a positive effect on subsequent rates of self-employment as high unemployment rates may encourage individuals to start their own business (the 'refugee' effect). On the other hand, increases in the self-employment rate have a negative effect on subsequent unemployment rates (i.e. a positive effect on employment), as higher rates of

[1] Using Granger causality tests one can explore the direction of causality between two variables by regressing one variable on its lagged values, and testing whether adding lagged values of the other variable contributes significantly to the explanation of the dependent variable.

self-employment may indicate increased entrepreneurial activity and competition, reducing unemployment rates in subsequent periods (the 'entrepreneurial' effect). They conclude that the latter effect is significantly stronger than the former. One of the limitations of this study, however, is that they did not incorporate any control variables in the model, which therefore does not enable them to explore other factors that determine changes in the self-employment and unemployment rates.

On the contrary, Audretsch and Keilbach (2004) did account for control variables when they investigated the two-way relationship between entrepreneurship capital and economic performance (measured as GDP) at the regional level. For this purpose, they simultaneously estimated two equations capturing both causes and impacts of entrepreneurship using three-stage least squares (3SLS). The main findings are that entrepreneurship capital has a significantly positive impact on economic output and that "the degree of spatially specific entrepreneurship capital is shaped by regional-specific factors" (p. 6). The magnitudes of these effects are found to be different for knowledge-based and non-knowledge-based entrepreneurship capital.

While both Thurik et al. (2008) and Audretsch and Keilbach (2004) investigated two directions of causality, they did not investigate long-run (equilibrium) relationships. This shortcoming is not present in studies done by Carree, Van Stel, Thurik and Wennekers (2002, 2007) as they investigated both the impact of the number of business owners on economic performance and the opposite relationship, *and* took the long-run *equilibrium* relation into account. The two relationships are, however, not estimated simultaneously. Furthermore, the number of control variables is limited. Nevertheless, they find that the business ownership rate affects economic growth via deviations from the equilibrium rate. To give an example, countries that are in disequilibrium regarding the business ownership rate, experience lower economic growth. Regarding the speed of convergence towards the equilibrium rate of business ownership, the authors find that the convergence process is essentially slow. The reason for this is that it demands structural, cultural as well as institutional modifications from the supply side of the economy. Their long-run equilibrium relation between a country's per capita income and the number of business owners can best be described by an L-shaped curve. When additional data was available (up to 2004), Carree, Van Stel, Thurik and Wennekers (2007) revisited the relationship studied by the same authors in 2002. They conclude that the longer time series "do not provide evidence of a superior statistical fit of a U-shaped 'equilibrium' relationship when compared to an L-shaped one" (p. 3). This finding is in line with Wennekers et al. (2005).

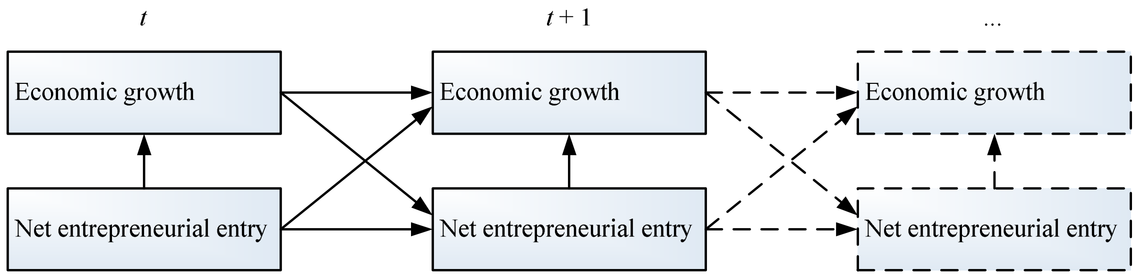
2.2 Counter-effects within the same direction of causality

As we have just seen, when analyzing the relationship between entrepreneurship and economic performance, two different directions of causality can be investigated. There may, however, also be counter-effects within the same direction of causality. This means that positive and negative effects of a certain variable on another one can exist at the same time. In the study of Thurik, Carree, Van Stel and Audretsch (2008), for instance, in which the effect of unemployment on self-employment (and vice versa) is investigated, both necessity-push and prosperity-pull factors are at play. On the one hand, unemployment has a positive impact on self-employment, because individuals experience a lack of employment options in the wage sector when unemployment rates are high (necessity-push). On the other hand, in times of economic downturns unemployment may negatively influence self-employment since the circumstances to start a business are detrimental, hence restricting new business formation (prosperity-pull). Hence, economic mechanisms that are consistent with positive and negative relations exist next to each other. From a policy perspective, it is important to know which of these mechanisms is dominant.

2.3 Lag structure

Based on empirical and theoretical studies about the effects of lags in the relationship between entrepreneurship and economic performance, assumptions have to be made regarding the lag structure. Focusing on this lag structure between entrepreneurship and economic growth (capturing the short-run dynamics), we can either take a look at the immediate effects of these variables on one another at a certain time *t* or the effects of the current variables on one another at time *t*+1, *t*+2 etcetera. As a country's GDP is defined as the total market value of all goods and services produced within a country in a given period of time (say a year), we expect entrepreneurship at time *t* to have an impact on economic growth (measured by the change in GDP per capita) at the same point in time. In contrast, based on the definition of the GDP we do not expect growth in per capita income at time *t* to affect the rate of net entrepreneurial entry at the same point in time. GDP can, however, have an impact on entrepreneurship measured in future points in time, say at time *t*+1, *t*+2, etcetera. Furthermore, current economic growth and entrepreneurship are also expected to affect their values in future points in time. See Figure 1 for an overview of the expected short-run interrelationships.

Figure 1 Expected short-run relationships between economic growth and net entrepreneurial entry.

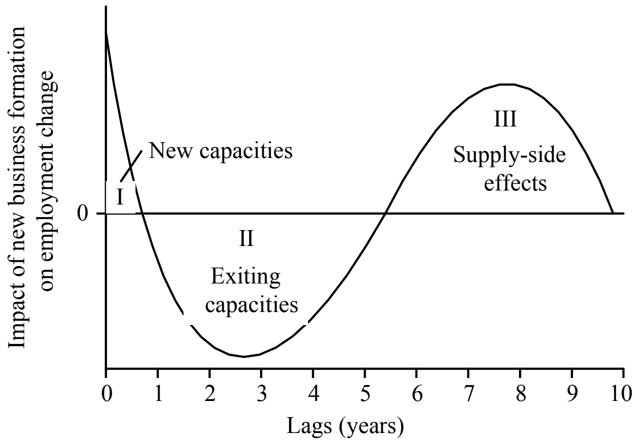


As it seems plausible that the effect of entrepreneurship on economic growth will last for a number of years (before it dies out), it is interesting to investigate the impacts of multiple lags of entrepreneurship on economic performance. In the literature, distinctions have been made between 'regular' and polynomial lag structures. For instance, Carree and Thurik (2008) paid special attention to the lag structure of the effect of business ownership on three measures of economic performance (namely employment growth, GDP growth and labour productivity growth) during different periods of time, by including a relatively large number of lags. They find that, in the long-run[2], business ownership affects employment and GDP in a positive way, whereas it has no influence on the labour productivity. The authors distinguish three short-run market impacts of new enterprises entering the market (see also Fritsch and Mueller, 2004; Van Stel and Suddle, 2008; Fritsch, 2008). As can be seen in Figure 2, the first, immediate market impact of new start-ups on the change in employment is positive due to their immediate job creation (area I in the figure). This period of *new capacities* is followed by a period of *exiting capacities* that is characterized by a negative impact on the market, due to a crowding-out effect of competitors (both young and incumbent firms). This corresponds to area II in the figure. In the final stage, the effects of new businesses are positive again as a result of direct and indirect *supply side effects*: firms which survive the first stages will improve their market position by applying innovative activities to their products and processes that benefit the market (area III in the figure). Carree and Thurik (2008) also explain how incumbent firms need to cut costs by reducing employment in this final stage in order to

[2] Note that we speak of economic *growth* in the long-run here.

keep up with the competitive and innovative new businesses. This implies that business ownership has different impacts on economic growth (measured as the change in employment) during different periods of time.

Figure 2 Short-run effects of new business formation on employment growth.



Source: Fritsch and Mueller (2004).

Fritsch and Mueller (2004) and Van Stel and Suddle (2008) used a polynomial lag structure to investigate the effect of new firm formation on regional economic development over time. To be precise, they applied the Almon polynomial lag procedure to avoid multicollinearity due to high correlation coefficients between start-up rates over time. When studying the effects of new business formation on regional development over time, Fritsch (2008) points out that the basic pattern of the effect of new business formation on market processes itself is quite similar in different countries and regions over time. In contrast, the magnitude of the overall effect of market entries on regional development can be far from identical across all regions and may even be negative. Fritsch and Mueller (2004) find that the overall effect of new entrants on regional development (i.e. the effect of start-ups on regional employment) can be either positive or negative. The impact of the indirect effects of new business formation on regional development (like failure of new businesses, crowding-out of incumbents, changed supply-side effects and improved competitiveness) is larger than that of the direct effect. Furthermore, they found that it takes almost a decade for new businesses to reach their maximum effect on regional development. Van Stel and Suddle (2008) investigated the impact of new firm formation on regional development in the Netherlands and they found a maximum effect of new firm formation after six years. They explored the relationship between new business formation and regional development at an even lower aggregation level by looking at different effects across sectors and areas with varying levels of urbanisation.

Since the lag structure of the relationship between entrepreneurship and economic performance (i.e. the short-run dynamics) provides insight into the direction of causality between these variables, it is important to take this into consideration.

2.4 Level of economic performance versus change in economic performance

As explained before, there is an important distinction between the level of economic performance and the change in economic performance. The relationship between the *level* of economic output and entrepreneurship often relates to a long-run (equilibrium) relation. If one focuses on the relationship between the *change* in economic output and entrepreneurship, conclusions can be drawn regarding the direction of causality. Before we discuss some contributions to the literature with respect to the relationships based on the level of economic output, we first introduce Schumpeter's notion of entrepreneurship. This also helps us understand why (the impact of) entrepreneurship on economic growth shows dissimilar patterns in countries at different stages of economic development (e.g. Van Stel, Carree and Thurik, 2005), as will be discussed in the next section.

From a Schumpeterian point of view, two different technological regimes can be distinguished. In the so-called Schumpeter Mark I regime, the main characteristic of technology can be described as *creative destruction*. This process suggests that innovating entrepreneurs encourage incumbent firms to introduce innovative products as well, which will lead to obsolete existing technologies, products and processes. In this regime Schumpeter (1934) states that the entrepreneur is the main creator of economic development. In the second regime, the so-called Schumpeter Mark II regime, the main characteristic of technology can be described as *creative accumulation*. This process implies that – making use of scale advantages – large firms are able to create stronger positive feedback cycles between Research & Development (R&D) and innovation than smaller firms and, consequently, that larger firms will outperform their smaller counterparts regarding innovation and appropriation (Schumpeter, 1950). So, while the focus in the Schumpeter Mark I regime is on small firms, in the Schumpeter Mark II regime the focus lies on innovative activities by large and established firms. Several factors such as the knowledge level required to innovate, the level of economies of scale and scope, the level of uncertainty in the economy, etc, determine to which extent one of these two regimes exist in a certain industry at a certain time period.

Audretsch, Carree, Van Stel and Thurik (2002) describe the changing role of small firms in the industry structure. They explain that the industry structure is shifting from large firms towards an industry in which small enterprises play an increasingly important role. They find that countries which deviate from or not adjust to the optimal industry structure (in terms of the share of small firms) will pay a penalty in terms of a decline in economic growth. The longer the country deviates from the optimal industry structure, the higher the penalty will be. In contrast, the larger the shift towards the optimal industry structure, the faster economic growth will increase. Audretsch and Thurik (2001) describe this process of the changing industry structure as a shift from the 'managed economy' towards the 'entrepreneurial economy'. In Schumpeterian terms, the 'entrepreneurial economy' and the 'managed economy' correspond to the Schumpeter Mark I and Mark II regimes, respectively.

This difference between the 'managed' and the 'entrepreneurial' economy can also be derived from the long-run (equilibrium) relationship, found by Wennekers, Van Stel, Thurik and Reynolds (2005). They find a U-shaped relationship between a country's per capita income (i.e. the *level* of economic performance) and its business ownership rate (as a measure of entrepreneurship). An L-shaped equilibrium curve is found by Carree, Van Stel, Thurik and Wennekers (2002, 2007). Although one is tempted to draw conclusions with respect to the causal effect of entrepreneurship on economic performance from this U- or L-shaped curve, the curve is nothing more than a stylized fact. Thus, no directions of causality can be derived from this graph, even if the U-shaped curve suggests the existence of a long-run relationship between entrepreneurship and economic performance. What can be derived from the U-shaped curve, however, is the existence of two different economies, namely the 'managed' and the 'entrepreneurial' economy. As already mentioned, the short-run effects (in terms of changes in the variables) are needed to make statements concerning the direction of causality.

2.5 Differences across countries and over time

The fundamental shift from the managed economy to the entrepreneurial economy took place in many developed countries (OECD countries) since the 1970s/80s onwards (e.g. Wennekers and Thurik, 1999; Audretsch and Thurik, 2001; Wennekers, Van Stel, Carree and Thurik, 2009) and led to different impacts of entrepreneurship on economic growth in 'poor' and 'rich' countries and over time. Van Stel, Carree and Thurik (2005) investigated the cross-country effects of entrepreneurship on economic growth, where they defined entrepreneurship as the Total Entrepreneurial Activity (TEA) rate (as employed by the Global Entrepreneurship Monitor (GEM) research consortium). This rate measures the proportion of nascent entrepreneurs and business owners of enterprises up to 3.5 years at the country level. The authors find that entrepreneurship influences economic growth in a positive way for developed countries, whereas its effect is negative for developing countries. Thus, the effect of entrepreneurial activity in a certain country seems to depend upon the present level of GDP per capita.

Two possible explanations for the conjecture that entrepreneurship may have a negative effect on per capita income in relatively poor countries are (1) that there is a deficit of large firms in these countries causing many 'marginal' individuals to start their own (inefficient) business, because there are no employment options in the wage sector (i.e. in the large firms); and (2) that the level of human capital in these countries is on average lower as compared to the level in relatively rich countries. These explanations imply that developing countries should invest in large firms as these enterprises can transform a developing economy into a developed one by exploiting economies of scale and scope and employing many people. Once these workers improved their labour productivity and learned enough from these large firms, they might consider starting their own (small) enterprise. For developed countries, however, the emphasis should be on stimulating self-employment and innovation in order to shift towards the 'entrepreneurial economy' (Van Stel, Carree and Thurik, 2005; Wennekers, Van Stel, Thurik and Reynolds, 2005; Wennekers, Van Stel, Carree and Thurik, 2009).

A study of Wennekers, Thurik, Van Stel and Noorderhaven (2007) specifically deals with cultural attitudes towards uncertainty on the rate of business ownership across several developed countries. Focusing on the historically negative relationship in these countries between GDP per capita and the business ownership rate, they find substantial differences across countries in terms of high and low uncertainty avoidance. Wennekers, Van Stel, Thurik and Reynolds (2005) also considered country effects in the relationship between entrepreneurship and the level of economic performance. They showed the existence of a long-run U- or L-shaped curve across countries at one point in time. On the contrary, Carree, Van Stel, Thurik and Wennekers (2002, 2007) find a long-run association between entrepreneurship and economic performance for single countries over time. The shape of the curves is shown to be quite similar among countries over time, while the level of the curves (i.e. the constant in the graph) essentially depends on country-specific aspects (see Freytag and Thurik, 2007). Accounting for country- and or time-effects may therefore be of great importance when investigating the relationship between entrepreneurship and economic performance.

2.6 Measurement issues

The five aspects discussed before are mainly theoretical aspects. The sixth and final aspect concerns the empirical world of measuring the variables entrepreneurship and economic performance. There is a number of different ways of measuring entrepreneurship, like Total Entrepreneurial Activity (TEA) (e.g. Van Stel, Carree and Thurik, 2005), nascent entrepreneurship (e.g. Wennekers, Van Stel, Thurik and Reynolds, 2005; Van Stel, Storey and Thurik, 2007), the start-up or firm birth rate (Reynolds, Storey and Westhead, 1994; Van Stel and Suddle, 2008), the number of business owners or the business ownership rate (e.g. Carree and Thurik, 2008; Wennekers, Van Stel, Thurik and Reynolds, 2007; Carree, Van Stel, Thurik and Wennekers, 2002, 2007) amongst others. There is also a wide range of indicators for economic performance, for example per capita income or GDP per capita (e.g. Wennekers, Van Stel, Thurik and Reynolds, 2005; Carree, Van Stel, Thurik and Wennekers, 2002, 2007), GDP growth (Audretsch, Carree, Van Stel and Thurik, 2002; Van Stel, Carree and Thurik, 2005; Carree and Thurik, 2008), (un)employment indicators (Carree and Thurik, 2008; Thurik, Carree, Van Stel and Audretsch, 2008), labour productivity growth or Total Factor Productivity (TFP) (Carree and Thurik, 2008; Erken, Donselaar and Thurik, 2008). Thus, there are various ways in which entrepreneurship and economic performance can be measured, which also have its implications for the empirical results.

2.7 Integrating the six aspects

To summarise, several scholars have explored the relationship between entrepreneurship and economic performance at the country or regional level. See Table 1 for an overview. This table pays specific attention to the contribution of each study in terms of relevant model characteristics. The first three columns focus on the direction of causality, in particular whether a one-way or a two-way relationship between entrepreneurship and economic performance is investigated. In addition, it can be seen whether the studies have corrected for reversed causality by means of lagged dependent and/or independent variables, or by means of Instrumental Variable (IV) estimation or a two-equation simultaneous model. Note that the last two correction methods are a better option than the former two. The fourth column of Table 1 shows whether the studies take the lag structure between entrepreneurship and economic performance into consideration. We speak of a lag structure if the model includes a variable with at least two lags. This aspect is therefore more sophisticated than the second column in the table. The fifth column indicates whether the studies take a long-run relation between entrepreneurship and economic performance into account. If yes, it shows whether or not this long-run relation has been modeled in an equilibrium framework. The sixth column of Table 1 indicates whether country- and/or time-dummies (either intercept or slope dummies) are incorporated in the model[3]. The next column shows the unit of analysis, that is, what type of dataset is used in the study. The final two columns represent the definitions used for entrepreneurship (E) and economic performance (Y).

As can be seen from Table 1, there are no studies to date that considered all these aspects together. It follows that most researchers only investigated the effects of entrepreneurship on economic growth or only the way economic development affects entrepreneurship, thus a one-way relationship[4]. The two-way relationship between entrepreneurship and economic performance, that is *both* the effect of entrepreneurship on economic performance *and* the effect of economic performance on entrepreneurship, has not thoroughly been investigated. We are aware of 'only' four studies that investigated the two-way relationship between entrepreneurship and economic performance, but also these studies have their limitations. *First*, Thurik, Carree, Van Stel and Audretsch (2008) explored the two-way relationship between self-employment and unemployment by estimating a VAR model, but without including any control variables. *Second*, Audretsch and Keilbach (2004) estimated a two-equation model with controls using 3SLS. They did,

[3] With country- and/or time-effects we mean that either the level of entrepreneurship or economic performance is allowed to vary by country or time period, or the relation between entrepreneurship and economic performance. The former is measured by incorporating country- and/or time-dummies in the model (i.e. intercept dummies), while the latter is captured by including interaction terms between dummies and variables in the model (i.e. slope dummies).

[4] It is remarkable that no study corrected for reversed causality by means of IV estimation, while it is a very appropriate way to account for the (possible) endogeneity of entrepreneurship and economic performance.

however, not take the lag structure between entrepreneurship and economic performance into consideration. In addition, both Thurik et al. (2008) and Audretsch and Keilbach (2004) did not estimate a long-run (equilibrium) relation. *Finally*, the two studies of Carree, Van Stel, Thurik and Wennekers (2002, 2007) concerned both the two-way relationship *and* the short-run effect plus the long-run equilibrium relation. Disadvantages of their studies are, however, that they did not take the lag structure into consideration, and that they did not estimate the two-equations for business ownership and per capita income simultaneously. In other words, for each equation the direction of causality is imposed on the model.

Furthermore, Table 1 shows that only a few studies took the lag structures into account when exploring the effect of either entrepreneurship on economic performance or economic performance on entrepreneurship. In addition, insufficient attention has been paid to a possible long-run equilibrium relation between entrepreneurship and economic performance. As far as the country- and/or time-effects are concerned, we are aware of only one study that incorporated both country- and time-dummies in the model (given the availability of a panel dataset). Some other researchers incorporated either time-effects or country-effects in the model. The majority of the studies did not take differences across countries and over time into consideration[5].

In short, there are many aspects that have to be accounted for when investigating the relationship between entrepreneurship and economic performance, like the direction of causality, the lag structure, short- and long-run dynamics, country- and/or time-effects, etcetera, and they all increase the degree of complexity of the research model. As becomes clear from Table 1, there are no studies take have taken all these aspects into consideration. The aim of our study is to contribute in filling the existing gap in this field of research by taking all these aspects into account, in one integrated model. More specifically, we want to investigate the two-way relation between entrepreneurship and economic performance simultaneously, without imposing any assumptions on the endogeneity of the variables and their lags. We also allow for differences across countries and over time. For this purpose, we use a completely different approach than used so far. More precisely, we make use of a Vector Error Correction Model (VECM) with cointegration. This approach does not only identify the genuine direction(s) of causality between entrepreneurship and economic performance, but also allows the effects of several economic variables in our analysis to be different for each direction of causality (in case more directions are found). Effects of these variables may also vary for each lag incorporated in the model. In addition, our approach will enable us to capture both short-run dynamics and the long-run equilibrium relation, and the way entrepreneurship and economic growth adjust when the economy is out of equilibrium. So, we will investigate the (possibility of a) long-run equilibrium relation between entrepreneurship and economic performance as well as the path that describes the 'road' towards this equilibrium (the short-run dynamics). Based on the results we find, we will conclude our analysis with some policy implications and possibilities for future research.

[5] We are aware that the desirability of including dummy variables depends on the specific research question employed in a paper. In other words, it is not always optimal to include dummy variables.

Table 1 Overview of studies in terms of their consideration of relevant model characteristics (E=entrepreneurship, Y=economic performance).

	Direction of causality			Lag structure	Long-run relationship between E and the *level* of Y	Country- and/or time-effects	Unit of analysis	Definition of	
	one-way or two-way relation between E and Y	using lagged dependent and/or independent variables	using IV estimation or a two-equation simultaneous model					E	Y
Audretsch, Carree, Van Stel and Thurik (2002)	One-way (E on Y)	yes	no	no	no	no	panel (country × year)	industry structure (i.e. small firm presence)	GDP growth
Fritsch and Mueller (2004)	One-way (E on Y)	yes	no	yes (Almon lags)	no	no	panel (region × year)	start-up rate	regional employment growth
Van Stel, Carree and Thurik (2005)	One-way (E on Y)	yes	no	no	no	yes (rich vs. poor countries)	cross-section of countries	TEA rate	GDP growth
Carree and Thurik (2008)	One-way (E on Y)	yes	no	yes	no	no	panel (country × year)	number of business owners	employment growth, GDP growth and labor productivity growth
Van Stel and Suddle (2008)	One-way (E on Y)	yes	no	yes (Almon lags)	no	no	panel (region × year)	start-up rate	regional employment growth
Erken, Donselaar and Thurik (2008)	One-way (E on Y)	yes	no	yes	no	yes (country and time)	panel (country × year)	ratio of actual and 'equilibrium' business ownership rate (with latter based on Carree et al. (2007))	total factor productivity
Reynolds, Storey and Westhead (1994)	One-way (Y on E)	no	no	no	no	no	panel (country × year)	firm birth rate	GDP growth

Table 1, continued.

	Direction of causality			Lag structure	Long-run relationship between E and the *level* of Y	Country- and/or time-effects	Unit of analysis	Definition of	
	one-way or two-way relation between E and Y	using lagged dependent and/or independent variables	using IV estimation or a two-equation simultaneous model					E	Y
Wennekers, Van Stel, Thurik and Reynolds (2005)	One-way (Y on E)	no	no	no	yes, but *not* modeled in an equilibrium framework	no	cross-section of countries	nascent entrepreneurship and TEA	per capita income
Van Stel, Storey and Thurik (2007)	One-way (Y on E)	no	no	no	no	no	panel (country × year)	opportunity and necessity nascent entrepreneurship rates and young business entrepreneurship rate	GDP growth
Wennekers, Thurik, Van Stel and Noorderhaven (2007)	One-way (Y on E)	yes	no	no	no	yes (time)	panel (country × year)	business ownership rate	per capita income
Audretsch and Keilbach (2004)	Two-way	no	two-equation simultaneous model	no	no	no	cross-section of regions	entrepreneurship capital	GDP per region
Carree, Van Stel, Thurik and Wennekers (2002, 2007)	Two-way	yes	two-equation model, but *not* estimated simultaneously	no	yes, modeled in an equilibrium framework	no	panel (country × year)	number of business owners per labor force	per capita income (for Y on E) and growth of per capita income (for E on Y)
Thurik, Carree, Van Stel and Audretsch (2008)	Two-way	yes	two-equation simultaneous model (VAR)	yes	no	yes (rich vs. poor countries + time)	panel (country × year)	self-employment	unemployment

3. Data

3.1 Main source and variable definitions

In order to unravel the genuine relationship between entrepreneurship and economic performance accounting for the six aspects described in the previous section, we primarily use EIM's COMPENDIA data base. This acronym stands for COMparative ENtrepreneurship Data for International Analysis. The data base contains harmonised data on the number of business owners and the business ownership rate (number of business owners as share of labour force) for 23 OECD[6] countries in the period 1972-2007[7]. Business ownership rates have been made comparable across countries and over time. For that purpose figures from the *OECD Labour Force Statistics* have been corrected for different self-employment definitions being used in different countries, and for trend breaks (Van Stel, 2005). Data is available for a variety of variables for the countries: Austria, Belgium, Denmark, Finland, France, Germany[8], Greece, Ireland, Italy, Luxembourg, The Netherlands, Portugal, Spain, Sweden, United Kingdom, Iceland, Norway, Switzerland, USA, Japan, Canada, Australia and New Zealand.

Variables of particular interest for this research are the following.

Business Ownership Rate (BOR)

As an indicator of entrepreneurship we use the business ownership rate. Business owners include unincorporated and incorporated self-employed, and exclude unpaid family workers. The business ownership rate is derived by dividing the number of business owners outside agriculture by the total labour force. The business ownership rate is taken from EIM's COMPENDIA data base (Van Stel, 2005).

GDP per capita

As an indicator of economic performance we use Gross Domestic Product (GDP) per capita, measuring per capita income in millions of purchasing power parities (PPP) per US dollar at 1990 prices. In the analyses, we incorporate the logarithm of per capita income. GDP per capita is taken from COMPENDIA.

Factors of production

In economics, the Cobb-Douglas production function is often used to relate output to certain input factors. Historically, economic output (GDP) is mainly written as a function of labour and capital[9], but nowadays, R&D is also seen as a relevant input factor in the production process. From a theoretical point of view, we are therefore also interested in the variables labour, capital and R&D. As an indicator of labour, we use data on total employment, derived from COMPENDIA. As an indicator of a country's physical capital we use real total net capital stock as a percentage of real GDP, which is based on gross investment data from the OECD Analytical Database (Version: June 2002) and estimated thereafter. See Kamps (2004) for details. Data is available for 22 OECD countries in the period 1972-2006 (Luxembourg is missing). To account for the R&D intensity of a country's economy, we use total gross domestic expenditure on R&D as a percentage of GDP. The main source of this variable is OECD, providing total R&D expenditures in millions of national currency (OECD Science and Technology Database) as well as values of GDP (market prices) in national currency (OECD Economic Outlook No. 82). Data is available for 22 OECD in the period 1981-2006 and for Luxembourg in the period 2000-2006. As we will see later, one of the variables to be

[6] Organisation for Economic Cooperation and Development.

[7] Downloadable at www.entrepreneurship-sme.eu.

[8] For Germany, all variables in EIM's COMPENDIA measured prior to 1991 refer to West-Germany.

[9] The Cobb-Douglas functional form of a traditional production function is given by $Y = AL^{\alpha}K^{\beta}$, where Y is the total output, L denotes labour input, K denotes capital input and A indicates the total factor productivity. The sum of the output elasticities α and β indicate whether there are constant ($\alpha + \beta = 1$), increasing ($\alpha + \beta > 1$) or decreasing ($\alpha + \beta < 1$) returns to scale.

explained in the VECM is the (relative change in) GDP per capita (i.e. GDP divided by population). Therefore, we will rework the three input factors so that they are entered in the model as fractions of the population.

Labour income share

The share of labour in GDP is used as reverse proxy for entrepreneurial income relative to the wage rate. This labour income share, taken from COMPENDIA, is estimated by [compensation of employees] times [total employment divided by employment of employees] divided by [compensation of employees plus gross operating surplus and gross mixed income], with employment in fulltime equivalents (FTEs).

Educational attainment

Besides physical capital there is also human capital. Countries with a higher educated population are more likely to benefit in terms of higher economic development. On the other hand, countries with a low educated population are expected to enjoy less economic growth (at the same time, it is easier to grow for less developed countries since economies can grow faster when the current level of economic development is relatively low – catch up growth). The effect of educational attainment on entrepreneurship seems to depend on a countries level of economic development. In higher developed countries, secondary education is likely to affect the rate of self-employment in a negative way, while tertiary education positively influences entrepreneurship (e.g. Uhlaner and Thurik, 2007). Data on educational attainment, operationalised as the gross enrolment rates for secondary and tertiary education, are taken from World Bank's data base EdStats. Gross enrolment rates in education are available for 22 OECD countries in the period 1972-2006 and for Germany in the period 1990-2006.

Taxes

Based on macro-economic theory, it is expected that an increase in the overall tax level leads to lower levels of private income and consumption. This may have a negative impact on economic growth. Conversely, a decrease in the overall tax level positively influences economic development. As an indicator for a country's tax level, we use total tax revenue as a percentage of GDP. This variable, which is available for all 23 OECD countries in the period 1972-2006, is taken from the OECD Revenue Statistics.

Service share

Wennekers et al. (2007, 2009) describe that the shift from the managed economy towards the entrepreneurial economy also involves the realisation of a service economy, in which small scale businesses dominate. This means that the share of services in an economy is related to the entrepreneurial structure (large versus small firms) and, consequently, might influence the business ownership rate at the economy-wide (macro) level. Indeed, setting up a business in the service sector (e.g. as compared to an enterprise in manufacturing) requires much lower investments and therefore leads to significantly higher business ownership rates at the sectoral level (Wennekers et al., 2007, 2009). As an indicator for a country's share of services in the economy, we use the share of services in terms of employment in total employment.[10] The OECD Labour Force Statistics (LFS) forms the main data source. Data is available for all 23 OECD countries in the period 1972-2006.

Social security benefits

As an indicator for the opportunity cost of self-employment, we use the variable social security benefits. As confirmed in the literature (e.g. Wennekers et al., 2007; Hessels, Van Stel, Brouwer and Wennekers, 2007), social security benefits negatively affects entrepreneurial activity since a generous social security system makes it less attractive for potential entrepreneurs to take risks for starting their own business – that is, the opportunity costs are higher. However, theoretically it is

[10] Following Wennekers et al. (2007), the following sectors are marked as service sector: Wholesale and retail trade, restaurants and hotels; Transport, storage and communication, Finance, insurance, real estate and business services; and Community, social and personal services.

also possible that social security benefits may act as safety net encouraging entrepreneurial activity. In fact, business owners might take the risk of starting a new firm if security is high in case of business failure. Social security benefits, operationalised as the unemployment gross replacement rate, are taken from the OECD Benefits and Wages Statistics. Data is available for 21 OECD countries in the period 1972-2006 and for Luxembourg and Iceland in the period 2001-2006.

3.2 Descriptive statistics

In this section, some descriptive statistics are provided for the business ownership rate and per capita income. Business ownership rates for all 23 highly developed countries in the period 1972-2007 are presented in Table 2. On average, the number of business owners has shown an upward trend during the time period considered, starting at a level of 30,086 in 1972 to 48,615 in 2007. The business ownership rate, i.e. the number of business owners as a share of the total labour force, was more or less stable between 1972 and 2007, slightly oscillating around 10-11%. Based on the business ownership rate combined with some other economic and non-economic factors, Wennekers et al. (2009) distinguish four main groups of OECD countries with Iceland, Japan and Luxembourg as special cases. More specifically, they differentiate Mediterranean countries, Scandinavian countries, Western European countries and Anglo-Saxon countries.

Mediterranean countries include Greece, Italy, Portugal and Spain and are characterised by relatively high business ownership rates in combination with a relatively low level of per capita income. As illustrated in Table 2, Italy (19.0%) and Greece (18.7%) reveal the highest rates of business ownership across all countries in the sample (averaged over time), and Portugal (13.6%) and Spain (12.0%) are placed fourth and fifth. As is explained in detail by Carree et al. (2002, p. 281) Italy even has a "special position" in the set of countries. It is characterized by a high rate of business ownership in combination with a near average value of GDP per capita. This finding was not in accordance with their expectation, because "countries with a high rate of business ownership are generally in a less advanced stage of economic development". This 'special' position can be explained by the structure of the Italian economy. Contrary to the other OECD countries, Italy consists of two different economies. Northern Italy is a well-developed economy, characterized by a high self-employment rate combined with a relatively high value of GDP per capita. Southern Italy is a less developed economy, characterized by a high level of self-employment, but combined with a low level of GDP per capita (in accordance with the general pattern).

The next group of countries, the Scandinavian countries, include Denmark, Finland, Norway and Sweden. With the lowest business ownership rates of all OECD countries, this group is at the other end of the entrepreneurship spectrum. Wennekers et al. (2009) explain how Scandinavian countries share several characteristics associated with lower business ownership rates, "including a high per capita income, high female labour participation rates, a low degree of income inequality, a large public sector, and a concentration of large business. In a certain sense, France could be considered part of this group of countries, with its system of centralised planning and control combined with strong public participation in large 'national champion' companies." (p. 22). Nevertheless, France also exhibits overlap in characteristics with the next group of countries.

The Western European countries, including Austria, Belgium, Germany, the Netherlands and Switzerland, have neither extraordinarily high nor low business ownership rates. Business ownership rates in these countries (averaged over time) range from 6.9% in Switzerland, followed by Germany and Austria (both 7.7%) to 9.2% in the Netherlands and even 11.3% in Belgium. However, self-employment exists primarily in the traditionally strong small business sector and new business creation is modest (Wennekers et al., 2009).

The final group is the Anglo-Saxon countries of Australia, Canada, Ireland, New Zealand, the United Kingdom and the United States. These countries have a relatively high level of economic development, related to both relatively high business ownership rates and new and young business activity. Several cultural and institutional characteristics might underlie this phenomenon, including high individualism, low social security expenditures, a low degree of employment protection, and low barriers to entry (OECD, 1999; Hofstede, 2001; Fonseca, Lopez-Garcia and Pissarides, 2001).

Table 2 Business ownership rates (%) in 23 OECD countries, 1972-2007.

	1972	1978	1984	1990	1996	2002	2007
Austria	9.3	7.7	6.5	7.2	7.4	8.7	9.4
Belgium	11.1	10.5	10.9	11.9	12.6	11.6	11.3
Denmark	8.2	7.9	6.6	6.3	6.4	6.7	6.9
Finland	6.6	5.9	6.6	8.2	8.0	7.9	8.5
France	11.3	10.3	9.8	9.8	8.8	8.1	8.7
Germany*	7.6	6.7	6.8	7.2	8.2	8.6	9.7
Greece	16.1	18.5	17.7	19.4	19.7	19.0	19.8
Ireland	7.7	8.2	8.9	10.9	11.2	11.4	11.6
Italy	16.2	16.5	18.7	19.9	20.8	20.7	21.0
Luxembourg	10.5	9.1	8.1	6.5	6.7	5.8	4.9
The Netherlands	9.7	8.4	7.8	8.2	9.8	10.3	12.0
Portugal	12.1	12.6	11.4	13.9	16.7	14.7	13.1
Spain	11.6	10.7	11.2	12.3	13.0	12.7	13.5
Sweden	7.4	6.8	7.2	6.9	8.1	8.1	8.8
United Kingdom	7.9	7.2	8.7	11.4	11.2	10.4	11.4
Iceland	9.6	8.6	7.9	9.4	11.2	10.6	10.8
Norway	9.7	8.7	8.7	7.7	7.1	6.5	8.5
Switzerland	6.3	6.4	6.5	6.9	7.7	7.4	6.8
USA	8.2	9.0	10.6	10.8	10.6	9.8	9.9
Japan	12.5	13.0	12.6	11.6	10.1	9.2	8.6
Canada	7.9	8.5	10.0	10.8	12.8	12.4	12.2
Australia	12.6	16.0	16.0	15.5	15.9	15.9	14.8
New Zealand	10.6	9.5	11.4	11.8	13.9	13.6	12.8
All countries	**10.0**	**9.9**	**10.0**	**10.6**	**11.2**	**10.9**	**11.1**
Total number of business owners (× 1,000)	**30,086**	**33,228**	**38,390**	**42,936**	**45,314**	**45,483**	**48,615**

Source: COMPENDIA 2007.1

**** Germany refers to West-Germany until 1991.***

4. Methodology

We will investigate the two-way relationship between entrepreneurship and economic performance using a wide range of internationally comparable variables measured on a yearly basis from 1972 until 2007, covering 23 OECD countries (primarily based on EIM's COMPENDIA). Because we state no prior assumptions on the endogeneity of entrepreneurship (measured by the business ownership rate) and economic performance (measured by per capita income), we use a Vector Error Correction Model (VECM)[11] – see Johansen (1988, 1994, 1995) – to unravel the relationship between entrepreneurship and economic performance. This approach allows us to investigate the genuine direction(s) of causality, as well as the possible existence of a long-run equilibrium relation between entrepreneurship and economic performance. Moreover, it enables us to account for the lag structure, to identify the path that describes the 'road' towards the long-run equilibrium relation (the short-run dynamics) as well as country- and/or time-effects. So contrary to other studies in this field of research, we investigate the relationship between entrepreneurship and economic per-

[11] Using the statistical program EViews (see www.eviews.com).

formance in one integrated framework. In order to do so, the research will be carried out by successively applying the following steps.

Step 1 – Test for stationarity: ADF Panel Unit Root test

We start our analysis by testing whether the economic variables are nonstationary[12] using the Augmented Dickey-Fuller (ADF) test (see Dickey and Fuller, 1979). All variables described in the previous section are tested for nonstationarity and in case a variable y turns out to be nonstationary, we apply the ADF test on Δy in order to investigate whether y is I(2)[13]. The test results are based on the test equation $\Delta y_t = \gamma + \rho y_{t-1} + \phi_1^* \Delta y_{t-1} + ... + \phi_{p-1}^* \Delta y_{t-(p-1)} + \delta t + \varepsilon_t$, where $\rho = -\phi_p(1) = \phi_1 + \phi_2 + \dots + \phi_p - 1$ and $\phi_j^* = -\sum_{i=j+1}^{p} \phi_i$. But because we have a panel dataset, we apply the ADF *Panel* Unit Root test instead of the usual ADF test. Panel unit root tests are similar (but not identical) to regular unit root tests carried out on a single time series. For the ADF panel unit root test, one tests the null hypothesis of a unit root (i.e. nonstationarity) against the alternative that some countries do not have a unit root. This can be carried out by country-wise estimating the test equation

$$\Delta y_{it} = \gamma_i + \rho_i y_{i,t-1} + \phi_{i,1}^* \Delta y_{i,t-1} + ... + \phi_{i,p-1}^* \Delta y_{i,t-(p-1)} + \delta_i t + \varepsilon_{i,t}, \quad (1)$$

where $\rho_i = \phi_{i1} + \phi_{i2} + \dots + \phi_{ip} - 1$ and ϕ_{ij}, j=1, …, p are the coefficients in the country-specific AR(p) model $y_{it} = \gamma_i + \phi_{i,1} y_{i,t-1} + \phi_{i,2} y_{i,t-2} + ... + \phi_{i,p} y_{i,t-p} + \delta_i t + \varepsilon_{it}$. Hence, the coefficients are allowed to vary freely across countries. The number of lags p incorporated in the test equations may also vary across countries and is determined automatically in EViews based on Schwarz Information Criterion (SIC). Furthermore, both a country-specific intercept and a country-specific linear trend are included in the test equation. Intercepts are included in all country-specific test equations, but as far as the inclusion of a trend is concerned, only if (the majority of) the country graphs of a certain variable indicate the presence of a clear upward or downward trend (based on own judgment), a trend will be included in any country-specific test equation.

After estimating the separate ADF regressions, one ADF Test Statistic measure for the whole series is calculated. This statistic summarizes all country-specific test results in an appropriate way. We make use of the ADF Z-statistic proposed by Choi (2001) which combines the p-values from the country-specific unit root tests to obtain one ADF measure. Let π_i be the p-value from the unit root test of country i, i=1,…,N. Then, under the null of a unit root for all N countries, the ADF Z-statistic is defined as

$$Z = \frac{1}{\sqrt{N}} \sum_{i=1}^{N} \Phi^{-1}(\pi_i) \rightarrow N(0,1), \quad (2)$$

where Φ^{-1} denotes the inverse of the standard normal cumulative distribution function.

ADF test results will be taken into account when constructing the Vector Error Correction Model (VECM).

[12] A time series is called stationary if its mean, variance and autocovariance remain constant over time; otherwise, the variable is nonstationary.

[13] A time series y_t is said to be integrated of order d (denoted as $y_t \sim I(d)$) if it has to be differenced d times in order to obtain stationarity, see Granger (1981).

Step 2 – Model specification

Vector Error Correction Model (VECM) with cointegration[14]

Assuming that (at least one of) the variables tested in step 1 are nonstationary, we continue with the second step in our analysis. This step regards the construction of a VECM to unravel the true relationship between entrepreneurship, economic performance and other relevant economic variables[15]. Both the direction of causality between economic performance and entrepreneurship and the long-run equilibrium relation follow from this VECM.

To start with, the m-dimensional Vector Autoregressive (VAR) model of order p is given by

$$(Y_t - \gamma - \delta t) = \Phi_1 (Y_{t-1} - \gamma - \delta(t-1)) + \ldots + \Phi_p (Y_{t-p} - \gamma - \delta(t-p)) + \Xi D_t + \varepsilon_t , \qquad (3)$$

where

- Y_t contains m relevant variables;
- Y_{t-j} its lagged values with corresponding mxm matrices of coefficients Φ_j for j=1,…,p;
- γ denotes an mx1 vector of intercepts;
- δ denotes an mx1 vector of deterministic drifts;
- D_t is a dx1 vector containing dummies and/or other nonstochastic variables, and Ξ is the corresponding mxd parameter matrix;
- the error terms ε_t are normally and independently distributed with mean zero and covariance matrix Ω, that is $\varepsilon_t \sim NID(0, \Omega)$.

From this VAR(p) model we can derive the reduced form Vector Error Correction Model (VECM), that is

$$\Delta Y_t = \mu_0 + \Pi (Y_{t-1} - \gamma - \delta t) + \sum_{j=1}^{p-1} \Gamma_j \Delta Y_{t-j} + \Xi D_t + \varepsilon_t , \qquad (4.A)$$

where

- μ_0 indicates that the individual time series contained in Y_t have trends (which follows from equation (3) if $\delta \neq 0$);
- $\Pi = \sum_{i=1}^{p} \Phi_i - I_m$;
- the parameter matrices $\Gamma_j = -\sum_{i=j+1}^{p} \Phi_i$, for j=1, …, p-1, represent the short-run dynamics (e.g. the relation between Δ *business ownership rate* and Δ *GDP per capita*) from which the direction of causality can be derived. We will use graphs, or more specifically Impulse Response Functions (IRFs), to provide more insight into this behaviour.

If it turns out that a certain co-movement exists between (some) variables stacked in Y_t (i.e. (some of) the variables in Y_t are cointegrated), one can assume that there exists at least one cointegrating relation. More specifically, one can speak of cointegration if the rank r of the matrix Π satisfies $0 < r < m$. Under this assumption, Π can be decomposed as $\Pi = \alpha\beta'$ such that the matrices α and β are mxr and have full rank r. Using this equality, one can rewrite equation (4.A) as

$$\Delta Y_t = \mu_0 + \alpha(\beta' Y_{t-1} - \mu_1 - \delta_1 t) + \sum_{j=1}^{p-1} \Gamma_j \Delta Y_{t-j} + \Xi D_t + \varepsilon_t , \qquad (4.B)$$

where

- $\beta' Y_{t-1}$ denote the long-run equilibrium relations (e.g. the relation between the business ownership rate and GDP per capita);
- α denote the corresponding adjustment parameters that describe the speed of adjustment towards the long-run equilibrium if the variables are out of equilibrium;

[14] See Heij et al. (2004), section 7.6; and Johansen (1995), section 2.1 and chapter 4.

[15] Consider two variables y_t and x_t that are nonstationary and can be made stationary by differencing – Δy_t and Δx_t are stationary. If there exists a linear combination of the form $y_t = \alpha + \beta x_t$, such that $y_t - \alpha - \beta x_t$ is stationary, then y_t and x_t are said to be cointegrated which suggests co-movements between the variables.

- the equilibrium relations may also contain a constant (if $\mu_1 \neq 0$) and a linear trend ($\delta_1 \neq 0$). The sum of μ_1 and $\delta_1 t$ indicate at which value the equilibrium relations attain their equilibrium. If both $\mu_1 \neq 0$ and $\delta_1 \neq 0$, the equilibrium relations are given by $(\beta' Y_{t-1} - \mu_1 - \delta_1 t) = 0$.

Thus, our modelling approach allows us to study both short- and long-run dynamics between the incorporated variables. This approach also helps us to get a better understanding of the different effects of business ownership and economic performance both at a country level and over time. The literature contains a wide range of papers using Vector Error Correction Models with cointegration, see for example Parker (2000) and Srinivasan and Bass (2000). These papers describe the advantages of the cointegration technique over time-series regression analyses and show the benefits of estimating long- and short-run dynamics in one integrated model. We will use EViews to estimate the VECM with cointegration.

Henceforth, equation (4.A) and (4.B) are referred to as equation (4), unless specified otherwise. For purposes that are explained below, the reduced form error correction model given by equation (4.B) is called model $H(r)$, following notation of Johansen (1995).

Table 3 Overview of five submodels obtained by imposing restrictions on the generalised reduced form VECM $\Delta Y_t = \mu_0 + \alpha(\beta' Y_{t-1} - \mu_1 - \delta_1 t) + \sum_{j=1}^{p-1} \Gamma_j \Delta Y_{t-j} + \Xi D_t + \varepsilon_t$.

	Imposed restrictions			
	Trend in data	Cointegrating relations		
(Sub)model	μ_0	μ_1	δ_1	Description
$H(r)$	**yes** ($\mu_0 \neq 0$)	**yes** ($\mu_1 \neq 0$)	**yes** ($\delta_1 \neq 0$)	*Linear trend in data*: intercept and trend in CE; intercept (no trend) in VAR.
$H^*(r)$	**yes** ($\mu_0 \neq 0$)	no ($\mu_1 = 0$)	**yes** ($\delta_1 \neq 0$)	*Linear trend in data*: trend (no intercept) in CE; intercept (no trend) in VAR.
$H_1(r)$	**yes** ($\mu_0 \neq 0$)	no ($\mu_1 = 0$)	no ($\delta_1 = 0$)	*Linear trend in data*: no intercept and trend in CE; intercept (no trend) in VAR.
$H_2(r)$	**yes** ($\mu_0 \neq 0$)	**yes** ($\mu_1 \neq 0$)	no ($\delta_1 = 0$)	*Linear trend in data*: intercept (no trend) in CE and VAR.
$H_1^*(r)$	no ($\mu_0 = 0$)	**yes** ($\mu_1 \neq 0$)	no ($\delta_1 = 0$)	*No trend in data*: intercept (no trend) in CE; no intercept in VAR.
$H_2^*(r)$	no ($\mu_0 = 0$)	no ($\mu_1 = 0$)	no ($\delta_1 = 0$)	*No trend in data*: no intercept or trend in CE or VAR.

Note: CE means Cointegrating Equation.

Model specification tests

The second step also concerns model specification tests for trends, intercepts, dummy variables, the lag structure, and so forth.[16] It is important to investigate whether a constant and/or a linear trend should be incorporated in the model as this is directly linked to the choice between model $H(r)$ and its submodels denoted by $H^*(r)$, $H_1(r)$, $H_2(r)$, $H_1^*(r)$, $H_2^*(r)$ that can be derived by imposing restrictions on the constants (μ_0 or μ_1) and/or the trend ($\delta_1 t$) in the general model $H(r)$ given in (4). See Table 3 for a complete overview of the submodels in terms of imposed parameters restrictions in model $H(r)$. The first submodel, denoted by $H^*(r)$, is appropriate when there exists a linear trend

[16] We refer to Franses and Van Dijk (in press), section 3.3 and 3.4; Heij et al. (2004), section 7.1.5 and 7.2.4; Johansen (1994); and Johansen (1995), section 2.3 and 5.7 for a detailed discussion regarding these specification tests.

in the variables that does not vanish in the cointegrating relations. If the trend cancels in the cointegrating relations the optimal model specification is either the second submodel, denoted by $H_1(r)$, or the third submodel, denoted by $H_2(r)$. The difference between these submodels is that $H_2(r)$ allows for an intercept in the cointegrating relation, while $H_1(r)$ does not. In case the data does not indicate a clear upward or downward trend, one can choose between submodel $H_1^*(r)$ and $H_2^*(r)$. The difference between these submodels is that $H_1^*(r)$ allows for an intercept in the cointegrating relations, while $H_2^*(r)$ does not contain any deterministic components at all.

Our aim is to investigate which of the submodels given in Table 3 best fits the data. Hereby, we take the cointegrating rank equal to the total number of variables, that is $r = m$. Once we find the best submodel using Likelihood Ratio (LR) tests, we determine the optimal lag length p (using LR tests or information criteria) and investigate whether the residuals are serially uncorrelated and white noise. To some extent we can make use of residual plots here. Findings from these plots might be confirmed by diagnostic test results.

Step 3 – Test for the number of cointegrating relations: Johansen Trace Test

Based on the achieved model specification, we can now test for the cointegration rank (i.e. the rank of the matrix Π). Let r denote the number of long-run relationships (i.e. the cointegration relations), then the variables in Y_t are cointegrated with r cointegration relations $\beta' Y_t$ if $0 < r < m$, where β contains r cointegration vectors in the model. We will perform the Johansen Trace Test to determine the number of cointegration relations.[17] It follows from the rank of the matrix Π how many variables are cointegrated and how many stochastic trends exist. If the matrix Π has rank $r = 0$ such that $\Pi = 0$, there are no cointegrated variables, but only m stochastic trends. In contrast, if the matrix Π has full rank $r = m$ it follows that none of the variables have a stochastic trend, but all have a deterministic trend which makes them trend stationary. Finally, if the rank r of the matrix Π is between 0 and m there is evidence for r cointegration relations and $(m - r)$ common stochastic trends.

A necessary condition for entrepreneurship to play a (direct) role in the economy is the existence of at least one cointegrating relation. To summarise, we will find one of the following three possibilities:

- $r = 0$, indicating that there is no genuine (long-run) relationship between entrepreneurship, economic development, and other economic variables in the model.
- $0 < r < m$, indicating that indeed one or more long-run relationships exist between the elements of Y_t.
- $r = m$, indicating that there exist as many relations as possible between economic development, entrepreneurship and other economic variables in the model, since all variables are then stationary by itself.

Step 4 – Tests on long-run parameters and adjustment parameters

If it turns out that there is at least one cointegrating relation (which corresponds to the second or third case in step 3), we can perform tests to find out to which extent the economic variables – specifically entrepreneurship – play a role in and adjust to the long-run equilibrium of the economy. To investigate which variables are important in the long-run equilibrium relation, tests on the long-

[17] We refer to Heij et al. (2004), section 7.6.3; and Johansen (1995), section 6.1, 11.1 and 11.2, and chapter 12 for a more detailed discussion of the Johansen Trace Test.

run parameters β are performed. The advantage of a VECM is that tests on the long-run equilibrium relationship take the presence of short-run deviations from the equilibrium into account.[18]

By performing exogeneity tests (i.e. tests on the adjustment parameters α in combination with the Granger Causality test) we can discover whether economic growth causes or is caused by entrepreneurship, or both. This result indicates whether entrepreneurship plays a direct role in the economy or not, in terms of being part of an economic equilibrium system. Loosely speaking, it follows from the α parameters whether a variable can be seen as right hand side (RHS) or left hand side (LHS) variable. Besides, the α parameters capture to which extent the variables adjust when the economy is shocked out of equilibrium, that is the error-correction behaviour. It is important to know which variables are weakly exogenous[19] since this indicates that these variables cannot easily converge back to the equilibrium via the other variables in the system. In this case, there may be an increased role for policy makers to stimulate these variables in order to restore the equilibrium.[20]

Step 5 – Short-run dynamics: Impulse Response Functions

In the final step of our research procedure, we will investigate how the endogenous variables in the system (business ownership and GDP per capita) respond to exogenous shocks, by making use of Impulse Response Functions (IRFs). These IRFs show, for example, how economic performance responds if an exogenous shock is given to the business ownership rate. The IRFs enable us to follow the development of the business ownership rate and GDP per capita over time, following an increase in business ownership. In describing the developments of the two variables over time, the IRFs take account of the full estimated system. Using the IRFs we also investigate whether the behaviour of the variables depends on the initial situation (i.e. the levels of business ownership and GDP per capita prior to the implementation of the shock). Does it matter how many business owners there already are before imposing a shock? Furthermore, we investigate how the system behaves for different sizes of the shocks. These exercises will give clear insights in the interrelation between entrepreneurship and economic performance.

5. Results

This section describes the results of the aforementioned methodological steps discussed. We start with the variable stationarity, followed by the model specification. Then we provide the test results on the number of cointegrating relations. Finally, the long-run equilibrium relation and short-run dynamics are discussed.

5.1 Variable stationarity

We start our analysis by testing whether the economic variables that are presented in the data section are nonstationary. The summarisd ADF Panel Unite Root test results are reported in Table 4. Using a 1% significance level for the ADF tests, this table reveals that only labour income share

[18] We refer to Johansen (1994); and Johansen (1995), section 5.3 and chapter 7 for the mathematical representations of the long-run parameter tests.

[19] Whether a variable is weakly exogenous or not depends on the significance of the α parameter corresponding to this variable. A variable is called weakly exogenous if its α parameter is not significantly different from zero, while a variable is called endogenous if its α parameter is significantly different from zero. The degree of endogeneity determines to which extent a variable is able to respond to deviations from the long-run equilibrium.

[20] We refer to Ericsson and Irons (1994), chapter 1; Granger (1969); Heij et al. (2004), section 7.6.2; Johansen (1994); and Johansen (1995), section 5.4, 5.6 8.1 and 8.2 for the mathematical representations of the exogeneity tests.

can be considered as stationary by itself, while the remaining variables presented need to be differenced once in order to obtain stationarity.[21]

Table 4 ADF Panel Unit Root test results (N=535).

Variable *y*	Test for nonstationarity of *y*			Test for nonstationarity of Δy		
	ADF Test Statistic		H_0 rejected?	ADF Test Statistic		H_0 rejected?
Business ownership rate	2.117	(0.983)	no	-9.131	(0.000)	yes
log(GDP per capita)	-1.789	(0.037)	no	-7.066	(0.000)	yes
log(employment per capita)	-2.111	(0.017)	no	-7.234	(0.000)	yes
log(real total net capital stock per capita)	1.856	(0.968)	no	-6.362	(0.000)	yes
log(total gross domestic expenditure on R&D per capita)	-1.823	(0.034)	no	-7.048	(0.000)	yes
Labour income share	-3.337	(0.000)	yes			
Gross enrolment rate for secondary education	2.353	(0.991)	no	-10.183	(0.000)	yes
Gross enrolment rate for tertiary education	2.885	(0.998)	no	-10.414	(0.000)	yes
Total tax revenue (% GDP)	-0.721	(0.236)	no	-12.142	(0.000)	yes
Service share	0.412	(0.660)	no	-11.022	(0.000)	yes
Social security benefits	1.070	(0.858)	no	-6.246	(0.000)	yes

Note: the p-values of the corresponding ADF Panel Unite Root test statistics, shown in brackets, are based on the test equation (1) with a constant and a trend.

These ADF Panel Unit Root test results will be taken into account when constructing the Vector Error Correction Model.

5.2 Model specification

Endogenous and exogenous variables

Since both entrepreneurship (measured by the business ownership rate) and economic performance (measured by *log*(GDP per capita)) are considered nonstationary, these variables will be included as potentially endogenous in the model, allowing them to be cointegrated. Additional variables included in the model, whether or not endogenous, were described in the data section. That is, three factors of production (to be precisely, *log*(employment per capita), *log*(capital stock per capita), and *log*(R&D expenditure per capita)), labour income share, enrolment rates in education, total tax revenue as percentage of GDP, the share of services in the economy, and social security benefits. These variables have repeatedly shown their value in empirical studies explaining national levels of entrepreneurship or economic performance. Their potential endogeneity is judged on the basis of economic theory as well as empirical testing. Note that potentially endogenous variables may still turn out to be (weakly or strongly) exogenous[22] in the model estimation. However, variables that are included as exogenous beforehand cannot become endogenous anymore. The advantage of including exogenous variables instead of (potentially) endogenous ones is that the number of model parameters to be estimated is smaller (and hence, the degrees of freedom is larger). A trial-and-error process revealed that only the business ownership rate and *log*(GDP per capita) were appropriate endogenous variables. We tested for other candidates (besides business ownership rate and

[21] The ADF tests use 535 observations corresponding to 21 countries for the period 1981-2006 minus 11 observations for Germany due to missing values for the tertiary education variable for 1981-1991. Compared to the 23 countries listed in Table 2, Iceland and Luxembourg are missing due to missing variables. When estimating the model, we will use 515 observations as one observation is lost for each country due to taking first differences.

[22] Granger *non*causality together with weak exogeneity results in strong exogeneity.

per capita income) for endogenous variables, but did not find another candidate since the corresponding α parameter is not significant for other variables.

In addition, we did a trial-and-error process for exogenous variables. Prior estimation revealed that enrolment rates in secondary education and social security benefits were not significant in the model. Hence, we do not include these variables. This leaves us with the following model specification.

Representation

Recall the general format of the reduced form VECM given in (4):

$$\Delta Y_t = \mu_0 + \Pi(Y_{t-1} - \gamma - \delta t) + \sum_{j=1}^{p-1} \Gamma_j \Delta Y_{t-j} + \Xi D_t + \varepsilon_t$$

$$= \mu_0 + \alpha(\beta' Y_{t-1} - \mu_1 - \delta_1 t) + \sum_{j=1}^{p-1} \Gamma_j \Delta Y_{t-j} + \Xi D_t + \varepsilon_t ,$$

Since tests revealed that the business ownership rate and *log*(GDP per capita) are the endogenous variables, these variables are included in the matrix Y_t. The other explanatory variables that are assumed to be relevant from an economic point of view are included as exogenous variables, represented by the matrix D_t. Hence, in our application we obtain:

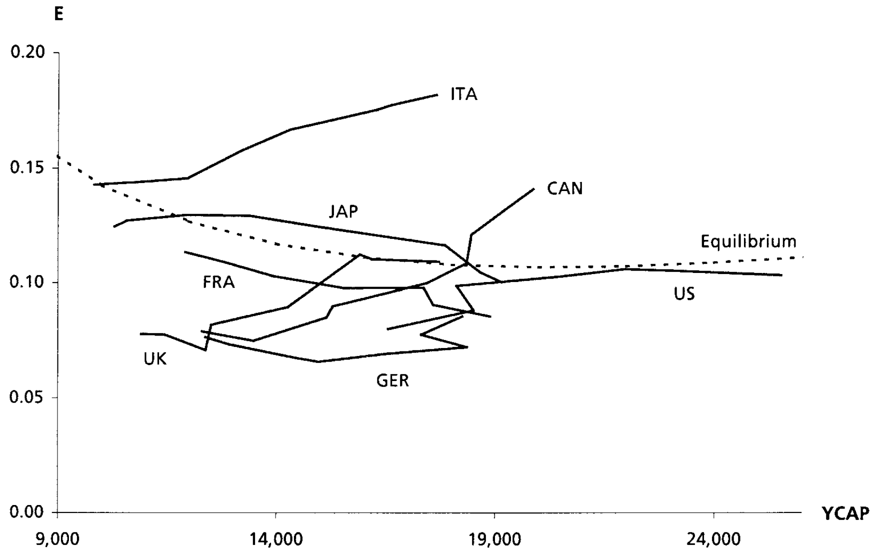
$$Y_t = \begin{bmatrix} \text{Business Ownership Rate (BOR)} \\ \log(\text{GDP per capita} / 1{,}000) \end{bmatrix} \text{ and } D_t = \begin{bmatrix} \Delta \log(\text{Employment per capita}) \\ \Delta \log(\text{Capital stock per capita}) \\ \Delta \log(\text{R \& D expenditure per capita}) \\ \Delta\text{Labour income share} \\ \text{Gross enrolment tertiary education} \\ \text{Total tax revenue (\% GDP)} \\ \text{Service share} \\ \text{Dummy for Italy} \end{bmatrix}.$$

All model variables are scaled in such a way that they can be interpreted as percentages.

As can be seen, D_t contains both exogenous, nonstochastic variables and a country dummy. Concerning the exogenous explanatory variables, note that the factors of production, i.e. *log*(employment per capita), *log*(capital stock per capita), and *log*(R&D expenditure per capita) are differenced once. In this respect, an increase of one unit represents an increase of one percent-point. In the equation explaining Δ*log*(GDP per capita), the sum of the estimated coefficients of the factors of production then indicates whether there is constant (sum equals 1), decreasing (sum smaller than 1) or increasing (sum larger than 1) returns to scale. Labour income share can be viewed as an inverse measure of profitability. Growth in the labour income share points at decreasing profitability which in turn may have a downward effect on the entrepreneurship rate (lower profitability makes entrepreneurship less attractive).

Besides the exogenous explanatory variables, the matrix D_t also includes a country dummy. As mentioned before, Italy deviates much from other countries in the dataset as it combines a high rate of business ownership with a near average value of per capita income (Carree et al., 2002). The deviating pattern of the actual business ownership rate in Italy is illustrated in Figure 3, taken from Carree et al. (2002): the curve for Italy lies above the equilibrium curve contrary to the other countries. It is not expected that the business ownership rate adjusts to the overall equilibrium, since Italy both has a relatively high business ownership rate compared to other countries, *and* the number of business owners seems to keep growing. In other words, Italy moves away from the equilibrium curve instead of in the direction of this curve. Since Italy does not seem to show error-correction behaviour, a dummy variable for Italian's economy is included in the VECM.

Figure 3 The actual and equilibrium rate of business ownership for G7-countries, 1972-1998.



Source: Carree, Van Stel, Thurik and Wennekers (2002), Figure 1, p. 283.

The variables included in D_t only affect Y_t in the short-run (thus ΔY_t). They do not affect the long-run equilibrium curve, at least not the shape of the long-run equilibrium relation. Changes in the exogenous variables may have an influence on the level of the long-run equilibrium relation however.

Deterministic components in the VECM

Under the assumption that there exists a cointegrating relation (i.e. that the business ownership rate and *log*(GDP per capita) are cointegrated), one can decompose Π as $\alpha\beta'$. From this we obtain the second equality in the VECM above. This will be used to test for the presence of deterministic components in the model.

Most variables included in the model show a (linear) trend, in particular the business ownership rate and *log*(GDP per capita), that is, Y_t, and the non-differenced variables in D_t. The trend in these variables is relevant for the presence of μ_0, μ_1 and δ_1 in the reduced form VECM in (4). Given the linear trend in the data, we can 'choose' an appropriate model from the set of candidates $\{H(r), H^*(r), H_1(r), H_2(r)\}$ that are described in Table 3. In other words, we set $\mu_0 \neq 0$ in the VECM and test for the significance of the intercept and trend in the cointegrating relation (i.e. μ_1 and δ_1). For this purpose, we start by estimating model $H(r)$, that is a VECM that incorporates both an intercept and a trend in the long-run equilibrium relation (i.e. $\mu_1 \neq 0$ and $\delta_1 \neq 0$). Hence, we assume that there exists a linear trend in the variables that does not vanish in the cointegrating relations. After carrying out some tests with respect to the lag length and the number of cointegrating relations, it turned out that the trend should be excluded from the long-run equilibrium relation (absolute t-value equals 0.588), that is $\delta_1 = 0$.

The optimal model specification for this application is therefore either $H_1(r)$ or $H_2(r)$. The difference between these models is the inclusion of an intercept in the long-run equilibrium relation or not. As explained at step 2 of the methodology, the intercept in the equilibrium relation indicates at which level the long-run equilibrium relation is located. Based on previous research in this area, we know that the relation between economic development (YCAP) and business ownership (E) does not cross the (0,0) point in the (YCAP, E) space (see Figure 3), and hence we include an intercept in the long-run equilibrium relation, that is $\mu_1 \neq 0$. This assumption is confirmed by the significance of the intercept in the final model, as we will see later.

Hence, the final model becomes model $H_2(r)$, where $\mu_0 \neq 0$, $\mu_1 \neq 0$ and $\delta_1 = 0$, such that is accounted for the linear trend in the data and the non-zero value at which the long-run relations attain their equilibrium.[23]

Lag length determination

Regarding the lag structure between entrepreneurship and economic performance, we need to incorporate several lags in the model. The lag length is partly based on the literature and partly on statistical tests. As shown in Figure 2, Fritsch and Mueller (2004) found that the effect of new business formation (as a measure of entrepreneurship) on employment change (as a measure of economic performance) changes over time. To account for these different phases, we include nine lags in the VECM[24], corresponding to the number of lags at which the third stage in Figure 2 has come to an end. More specifically, nine lags will be included for the variables ΔBOR and Δ*log*(GDP per capita). Note that nine lags in a VECM correspond to ten lags in a VAR model, such that the lag length p in model (4) is set equal to ten. Tests are carried out to investigate the significance of these lags on ΔY_t.

When performing tests on the lag length (see Table 5), it can be seen that only a few lags seem to contain significant information. The first lag is highly significant for both ΔBOR and Δ*log*(GDP per capita) separately, as well as for these variables jointly. The third lag is close to significant for the business ownership growth rate, while this holds for the fifth lag in relation to Δ*log*(GDP per capita). As becomes clear later, some lags of ΔBOR and/or Δ*log*(GDP per capita) do have a significant effect on ΔY_t which does not follow from the test statistics reported in Table 5. All nine lags will therefore be kept in the VECM, of which the results will be discussed later.

Table 5 Lag length determination (included observations: 515).

	ΔBOR			Δ*log*(GDP per capita / 1,000)			Joint: ΔY_t		
Lag	χ^2	df.	p-value	χ^2	df.	p-value	χ^2	df.	p-value
ΔY_{t-1}	36.20	2	(0.000)***	37.02	2	(0.000)***	67.73	4	(0.000)***
ΔY_{t-2}	1.78	2	(0.410)	2.36	2	(0.307)	4.68	4	(0.321)
ΔY_{t-3}	4.44	2	(0.109)	0.87	2	(0.648)	5.97	4	(0.201)
ΔY_{t-4}	1.96	2	(0.376)	1.85	2	(0.396)	3.95	4	(0.413)
ΔY_{t-5}	0.93	2	(0.629)	4.50	2	(0.106)	5.14	4	(0.273)
ΔY_{t-6}	2.02	2	(0.365)	1.76	2	(0.414)	3.42	4	(0.491)
ΔY_{t-7}	0.72	2	(0.698)	3.37	2	(0.185)	5.03	4	(0.285)
ΔY_{t-8}	2.11	2	(0.348)	5.24	2	(0.073)*	8.33	4	(0.080)*
ΔY_{t-9}	1.45	2	(0.485)	2.86	2	(0.239)	4.16	4	(0.385)

Note: the χ^2 test statistics for lag exclusion are based on the joint exclusion of the lags for ΔBOR Non-agriculture and for Δlog(GDP per capita / 1,000).

** significant at 10% level; ** significant at 5% level; *** significant at 1% level.*

Sample size

At first instance, we have data for 23 OECD countries in the period 1972-2007. Due to missing observations for some of the variables included in the model we are forced to delete a few countries and/or years from the sample. More specifically, the countries Luxembourg and Iceland are

[23] It should be noted that the intercept in the cointegrating relation (μ_1) is related to the intercept outside the cointegrating space (μ_0). Hence, μ_0 and μ_1 cannot be identified separately (meaning that one does not obtain separate standard errors).

[24] Contrary to Fritsch and Mueller (2004), Van Stel and Suddle (2008) and Fritsch (2008), we do not include Almon lag restrictions in our model since this is not possible in combination with a VECM with cointegration.

dropped from the sample[25] as well as the years 1972-1981 and 2007.[26] In addition, we exclude the years 1991 and 1992 for Germany, as there was a relatively large fall in the level of per capita income in 1991 as a result of the unification of East- and West-Germany. Furthermore, due to missing data for Germany for the variable gross enrolment in tertiary education, the years prior to 1990 are dropped for this country. Finally, the effective sample will be reduced as a result of the inclusion of lagged exogenous variables. The exogenous factors of production as well as the variable labour income share are differenced once. Since R&D expenditure per capita is not available prior to 1981, the sample size reduces with a total of 21 observations (corresponding to 21 countries). Note that the sample size is not further reduced as a result of the inclusion of nine lags in the VECM (thus ten lags in the VAR) – as discussed above. Since these lags are all available prior to 1981, no additional data reductions have to be applied for this.

This leaves us with an effective sample of 515 observations: 21 countries times 25 years (1981-2006 minus the year 1981 for the R&D lag), subtracting 10 observations for Germany corresponding to 1991/92 and corresponding to the missing years for the variable educational attainment (prior to 1990).

5.3 Number of cointegrating relations

Given the model specification of the Vector Error Correction Model, tests can be performed on the number of cointegrating relations, i.e. the Johansen Cointegration Test. The corresponding test statistics are given in Table 6. The first and second column of Table 6 show the number of stochastic trends and the corresponding number of cointegrating relations (under the null hypothesis). The third and fourth column respectively present the ordered eigenvalues of the matrix Π in the VECM, and the corresponding trace statistic (Johansen, 1995). The final two columns show the 5% critical value and the p-value.

It follows from Table 6 that the null hypothesis that r equals 0 is clearly rejected. On the contrary, the hypothesis that $r \leq 1$ is not rejected. This suggests that there exists one long-run equilibrium relation which means that entrepreneurship, as operationalised by the business ownership rate, and economic performance, as operationalised by per capita income, are indeed cointegrated.

Table 6 Test on the number of cointegrating relations.

m – r	r	Eigenvalue	Trace statistic	5 % critical value	p-value
2	0	0.076	40.799	15.495	(0.000)
1	1	0.000	0.004	3.841	(0.950)

Note: the p-values are MacKinnon-Haug-Michelis (1999) p-values. Included observations: 515.

5.4 Test for weak exogeneity and significance of variables in the long-run equilibrium

Given the existence of a long-run cointegration (equilibrium) relation, we can decompose the matrix Π as $\alpha\beta'$. The final parameter estimates of the VECM described in the section 'model specification', including the estimates of the cointegrating relations βY_{t-1} and the adjustment parameters α, are given in Table 7 and Table 8. Hereby, the long-run equilibrium relation is normalized on the business ownership rate in order to let the cointegrating vector β be identified. The estimates of β

[25] *Log* capital stock per capita is completely missing for Luxembourg, and *log* R&D expenditure per capita is largely missing for Luxembourg. Additionally, since not all countries in our dataset are of equal importance for determining the relationship between entrepreneurship and economic performance, no significant damage will be caused from deleting the smallest countries from the sample (i.e. Luxembourg and Iceland).

[26] *Log* R&D expenditure per capita is available only from 1981-2006. In addition, no data is available for the year 2007 for the variables *log* capital stock per capita, gross enrolment in tertiary education, total tax revenue as a percentage of GDP, and service share.

and α reported in Table 7 and Table 8 are based on the normalization $\beta' S_{11} \beta = I$, where S_{11} is defined in Johansen (1995).

From Table 7, it can be seen that there exists a significant and negative long-run relationship between the business ownership rate and the *log* of GDP per capita.[27] A graphical representation of this long-run equilibrium relation is given in Figure 4. This figure will be discussed in more detail later.

Table 7 Parameter estimates for the cointegrating coefficients β (normalized by $\beta' S_{11} \beta = I$).

Y_{t-1}	BOR_{t-1}	*log*(GDP per capita / 1,000)$_{t-1}$	constant (μ_0)
β	1.000	0.112	-42.002
Standard error	-	(0.014)	-
t-value	-	7.885	-

Note: Included observations: 515.

The parameters α (given in Table 8) capture not only the error-correction behaviour (i.e. the speed of adjustment towards the long-run equilibrium in case of disequilibrium), but also whether a variable is weakly exogenous or endogenous. In any given time period, economies can deviate from the long-run equilibrium as a result of exogenous (short-run) shocks. The adjustment parameters given by α describe how quickly (and in which direction) the variables in Y_t converge back to equilibrium. If a variable does not respond to deviations from the long-run equilibrium, then it is called weakly exogenous. This corresponds to an adjustment parameter that is not significantly different from zero. If a variable adjusts back to equilibrium, then it is called endogenous, corresponding to an α parameter being significantly different from zero.

It follows from Table 8 that both the business ownership rate and the *log* of GDP per capita are endogenous variables, since the corresponding adjustment parameters are highly significant. In case the relationship between entrepreneurship and economic performance in a certain economy is above the equilibrium curve, the general tendency is that both the business ownership rate and (the log of) GDP per capita will decrease in order to restore the equilibrium. The opposite holds for economies in which the business ownership rate and/or level of per capita income are below the equilibrium value. As we will show later, other factors are also at play in the restoring mechanism. Note that the speed of adjustment is relatively slow as can be seen from the low parameter estimates (Table 8), in particular for the business ownership rate.

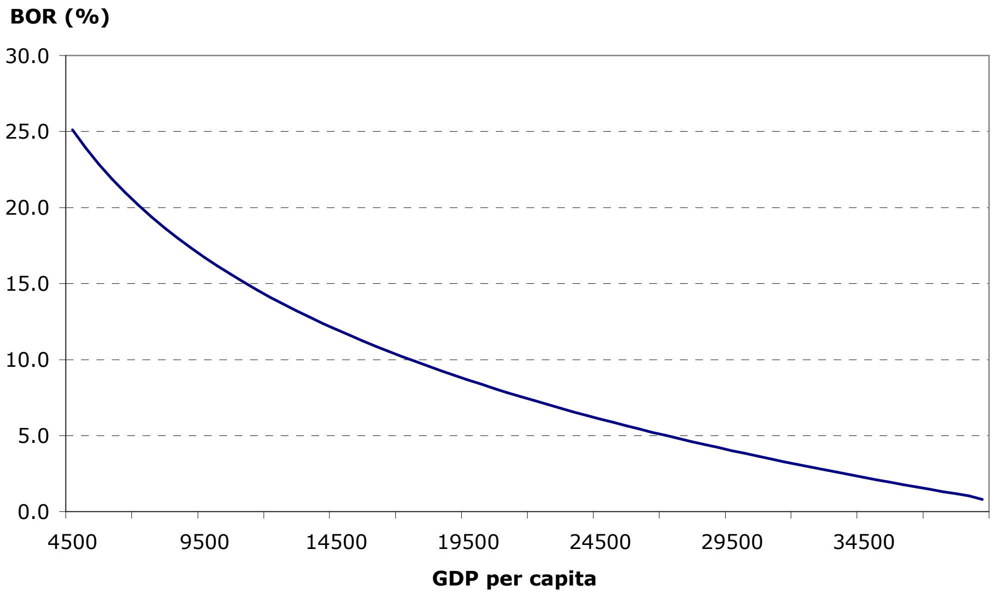
Table 8 Parameter estimates for the adjustment coefficients α (normalized by β'S11$\beta = I$).

ΔY_t	α	Standard error	t-value
ΔBOR	-0.041	(0.007)	-6.218
Δ*log*(GDP per capita / 1,000)	-0.075	(0.029)	-2.576

Note: Included observations: 515.

[27] In general, the cointegrating relations $\beta' Y_t = 0$ can be written as $y_1 = -(\beta_{i2}/\beta_{i1})y_2 - (\beta_{i3}/\beta_{i1})y_3 - \ldots - (\beta_{im}/\beta_{i1})y_m$ with y_1 the variable that is normalized on and the remaining *m* variables on the right hand side.

Figure 4 The long-run equilibrium relation between GDP per capita and the business ownership rate.



Note: The estimated curve is given by BOR = 42.002 – 0.112 log(GDP per capita / 1,000).

5.5 Short-run dynamics

5.5.1 Impulse Response Functions

The parameter estimates regarding the short-run dynamics between entrepreneurship, economic performance and the exogenous explanatory variables are reported in Table 11. Focusing on the effects of lags of ΔY_t on both ΔBOR and Δlog(GDP per capita / 1,000), that is the effect of $\sum_{j=1}^{9}\Gamma_j \Delta Y_{t-j}$ on ΔY_t, it can be seen from Table 11 that these effects change over time. When interpreting the total (net) effect of each lag on the current situation in terms of signs and sizes one cannot interpret the estimated coefficients directly, because a certain lag (say the second lag) does not only have a direct effect on the current value (as given in Table 11), but the second lag also affects the current value via the first lag. Hence, the parameters corresponding to a certain lag do not represent the total effect on ΔY_t. They only indicate the direct effect, without taking the intermediate (indirect) effects into account. In order to visualise the 'complete' lag structure, Impulse Response Functions (IRFs) provide valuable insights. An Impulse Response Functions illustrates the development of an endogenous variable in response to some external change (the impulse). Typically, an external shock has a relatively strong initial impact on the variable under consideration but this effect dies out after a certain period of time. In response, the variable considered is shocked out of equilibrium (assuming that the system was in equilibrium prior to the external shock) and gradually converges to a new steady state (i.e. a new point on the equilibrium curve) as the impact of the external shock dies out.

Focusing on the relation between entrepreneurship and economic performance, the IRFs show that the convergence pattern depends to a large extent on the 'position' of the economy at the time of the external shock. More precisely, when for instance the actual business ownership rate (BOR) is below the equilibrium BOR (indicated by BOR*) and BOR increased as a result of the external shock, then in most cases the economy will converge to a new place on the equilibrium curve – see Figure 4 – which is to the right of the original place. This corresponds to a higher level of per capita income (i.e. economic growth). On the other hand, when the actual business ownership rate is above BOR*, then a further increase in BOR (due to an exogenous shock) will result in a new place on the equilibrium curve to the left of the original place in the (GDP per capita; BOR) space. Hence, per capita income is then lower, corresponding to negative economic growth.

To summarise, by and large, below the curve, stimulating BOR results in higher levels of per capita income. These results are in line with the equilibrium relation also functioning as an optimum (Carree et al., 2002, 2007). In other words, the impact of entrepreneurship depends on how many business owners there already are.

Simulations

To illustrate this in more detail, we will manually add shocks to the current state of the economy as well as vary with the starting situation. The results are shown in Table 9. To start with, let us assume that the equilibrium rate of the business ownership rate equals 11%. According to the long-run equilibrium curve depicted in Figure 4, the corresponding equilibrium value of GDP per capita (YCAP*) then equals 15,826.92 in millions of purchasing power parities (PPP) per international dollar at 1990 prices. Suppose that the economy is suddenly shocked out of equilibrium due to an external shock of 0.1 percent-point such that BOR becomes 11.1% while GDP per capita still equals its equilibrium value. In order to restore the equilibrium the restoring mechanism (expressed by the α parameters presented in Table 8) is put into operation. Both the business ownership rate and GDP per capita start to adjust in such a way that the economy converges to a new equilibrium. In fact, as can be seen in Table 9, given that the economy was in equilibrium (BOR*=11; YCAP*=15,826.92) the economy converges to a new equilibrium up and to the left of the original situation. In the new equilibrium the business ownership slightly increased to 11.03% (cell is coloured green in Table 9) while per capita income slightly decreased to 15,791.23 in millions of PPP per 1990 US$ (cell is coloured dark orange in Table 9).

Adding shocks when the system is out of equilibrium

But what if the economy was not in equilibrium prior to the external shock? Then there are two possibilities (under the assumption that per capita income still takes its equilibrium value corresponding to BOR*=11): the economy is below equilibrium if BOR < BOR*, or the economy is above equilibrium if BOR > BOR*. Varying with deviations from the equilibrium business ownership rate of 6, 3.5, 2, 1, 0.5, 0.4, 0.3, 0.2 and 0.1 percent-points, Table 9 shows the new steady state for each starting point as a result of an external shock of 0.1 percent-point. For example, suppose that the business ownership rate was 6 percent-points below the equilibrium BOR* of 11% (that is, BOR=5). Then an impulse of 0.1 percent-point – initially pushing BOR to 5.1 – creates a multiplier effect driving the economy towards the equilibrium curve. Once the effect caused by the impulse died out, the economy has converged to a new steady state up and to the right of the starting situation: the business ownership rate increased from 5% to 10.30% and GDP per capita increased with 6.5% from 15,826.92 to 16,851.98. Therefore, both cells are coloured green in Table 9.

Similarly, the new steady state is presented for other starting points below and above equilibrium. An interesting finding is that the economy actually seems to converge back to the original equilibrium (BOR*=11; YCAP*=15,826.92) when the business ownership rate is 0.2 percent-points below BOR* (that is, BOR=10.8) and gets a shock of 0.1 percent-point. The adjustment process then drives the business ownership rate to 11% and per capita income (close) to YCAP*. A general pattern that can be derived from Table 9 is that, by and large, an external shock of 0.1 percent-point to an economy located vertically below BOR* of 11% moves the economy up and to the right of the starting situation (as can be seen from the green cells in Table 9). On the other hand, a shock of 0.1 percent-point to an economy located vertically above BOR* of 11% pushed the economy down and to the left of the starting situation (as can be seen from the dark orange cells in Table 9). Hence, when the actual business ownership rate is below the equilibrium, stimulating entrepreneurship is beneficial, while encouraging entrepreneurship when the number of business owners is already above equilibrium leads to a penalty in the sense that the level of per capita income is lower compared to the starting situation.

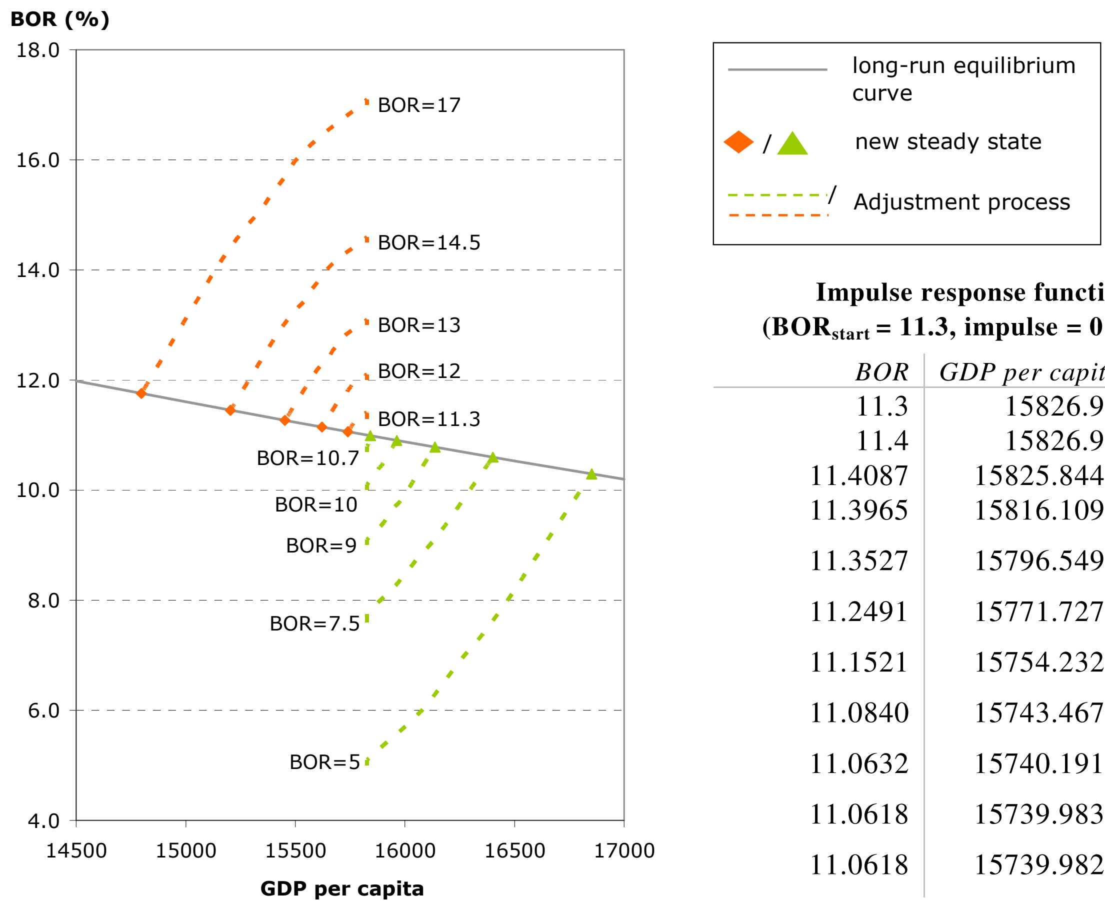
Table 9 Responses of the Business Ownership Rate (BOR) and GDP per capita (YCAP) from different starting points as a result of an external shock with size 0.1, 0.5 or 1.0.

		Size of impulse					
		0.1		**0.5**		**1.0**	
Below equilibrium	**5**	BOR:	10.30	BOR:	10.40	BOR:	10.52
		YCAP	16851.98	YCAP	16700.50	YCAP	16513.07
	7.5	BOR:	10.60	BOR:	10.70	BOR:	10.83
		YCAP	16401.61	YCAP	16254.18	YCAP	16071.75
	9	BOR:	10.78	BOR:	10.88	BOR:	11.01
		YCAP	16137.18	YCAP	15992.13	YCAP	15812.64
	10	BOR:	10.90	BOR:	11.01	BOR:	11.13
		YCAP	15963.27	YCAP	15819.78	YCAP	15642.23
	10.5	BOR:	10.96	BOR:	11.07	BOR:	11.19
		YCAP	15877.02	YCAP	15734.30	YCAP	15557.71
	10.6	BOR:	10.98	BOR:	11.08	BOR:	11.20
		YCAP	15859.82	YCAP	15717.26	YCAP	15540.86
	10.7	BOR:	10.99	BOR:	11.09	BOR:	11.22
		YCAP	15842.65	YCAP	15700.24	YCAP	15524.03
	10.8	BOR:	11.00	BOR:	11.10	BOR:	11.23
		YCAP	15825.49	YCAP	15683.24	YCAP	15507.22
	10.9	BOR:	11.01	BOR:	11.11	BOR:	11.24
		YCAP	15808.35	YCAP	15666.25	YCAP	15490.43
Equilibrium	**BOR* = 11**	BOR:	11.03	BOR:	11.13	BOR:	11.25
		YCAP	15791.23	YCAP	15649.29	YCAP	15473.65
Above equilibrium	**11.1**	BOR:	11.04	BOR:	11.14	BOR:	11.27
		YCAP	15774.13	YCAP	15632.34	YCAP	15456.89
	11.2	BOR:	11.05	BOR:	11.15	BOR:	11.28
		YCAP	15757.05	YCAP	15615.41	YCAP	15440.15
	11.3	BOR:	11.06	BOR:	11.16	BOR:	11.29
		YCAP	15739.98	YCAP	15598.50	YCAP	15423.43
	11.4	BOR:	11.07	BOR:	11.18	BOR:	11.30
		YCAP	15722.94	YCAP	15581.61	YCAP	15406.73
	11.5	BOR:	11.09	BOR:	11.19	BOR:	11.31
		YCAP	15705.91	YCAP	15564.73	YCAP	15390.04
	12	BOR:	11.15	BOR:	11.25	BOR:	11.38
		YCAP	15621.05	YCAP	15480.63	YCAP	15306.89
	13	BOR:	11.27	BOR:	11.37	BOR:	11.50
		YCAP	15452.70	YCAP	15313.80	YCAP	15141.92
	14.5	BOR:	11.45	BOR:	11.55	BOR:	11.68
		YCAP	15203.57	YCAP	15066.91	YCAP	14897.81
	17	BOR:	11.76	BOR:	11.86	BOR:	11.98
		YCAP	14797.25	YCAP	14664.24	YCAP	14499.66

Note: In equilibrium, BOR = 11 and GDP per capita* = 15,826.92. Given this value of GDP per capita, BOR can be below equilibrium (e.g. 6; 3.5; 2; 1; 0.5; 0.4; 0.3; 0.2 or 0.1 percent-points below BOR*), in equilibrium, or above equilibrium (e.g. . 6; 3.5; 2; 1; 0.5; 0.4; 0.3; 0.2 or 0.1 percent-points above BOR*). Green cells refer to an increase of the corresponding variable w.r.t. the starting situation, while dark orange cells refer to a decrease w.r.t. the starting situation.*

A graphical representation of this adjustment process is presented in Figure 5. For a selection of starting values of BOR along the vertical line of GDP per capita corresponding to BOR* = 11% the adjustment process is visualised. More precisely, Figure 5 shows the responses starting values of BOR that are 6, 3.5, 2, 1 or 0.3 percent-points below or above BOR*. Basically, the economy always converges back towards the long-run equilibrium relation. If the economic situation is initially below equilibrium, both the business ownership rate and per capita income directly increase and push the economy upwards towards the equilibrium curve. If the economic situation is initially above equilibrium however, directly after the shock the business ownership rate starts to increase a little before actually adjusting downwards in order to restore equilibrium. To illustrate this, see the development in the business ownership rate (and GDP per capita) presented at the bottom right of Figure 5. This effect becomes stronger when a larger external shock is given to the business ownership rate.

Figure 5 The adjustment process towards the long-run equilibrium relation as a response to an impulse of 0.1 percent-point in the business ownership rate.



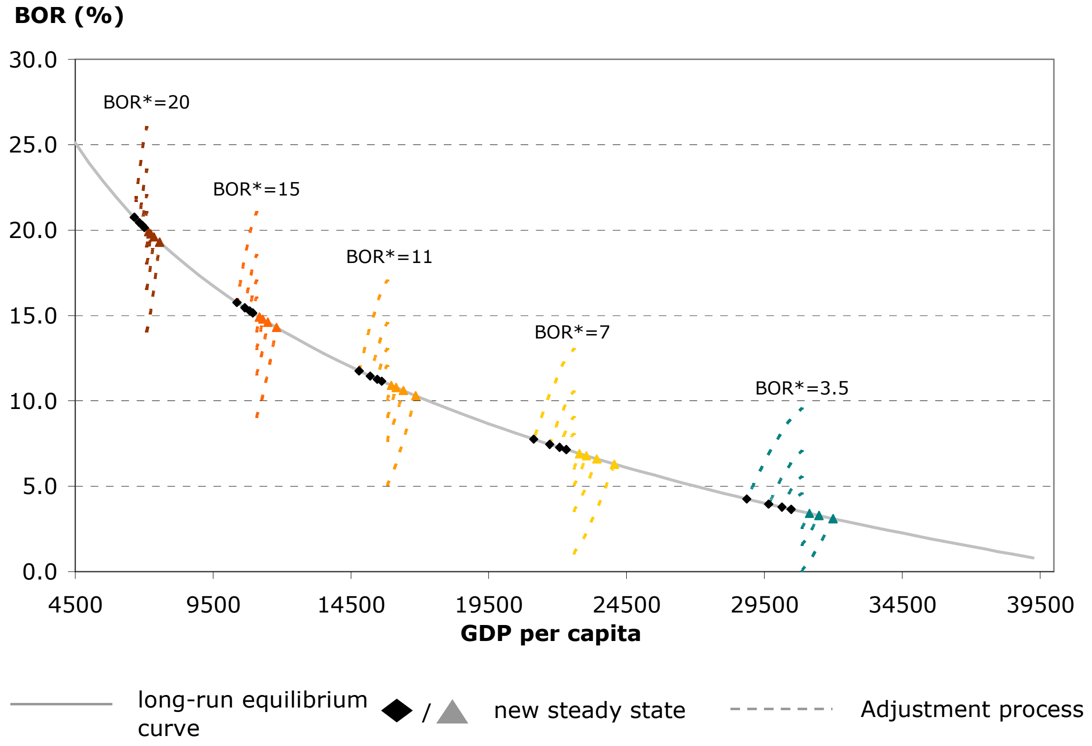
Impulse response function
(BOR_{start} = 11.3, impulse = 0.1)

BOR	*GDP per capita*
11.3	15826.92
11.4	15826.92
11.4087	15825.8444
11.3965	15816.1099
11.3527	15796.5499
11.2491	15771.7278
11.1521	15754.2322
11.0840	15743.4673
11.0632	15740.1911
11.0618	15739.9833
11.0618	15739.9826

Note: In equilibrium, BOR = 11 and GDP per capita = 15,826.92. Given this value of GDP per capita, BOR is 6, 3.5, 2, 1 or 0.3 percent-points below or above BOR*. The different starting values of BOR are all along the vertical line of GDP per capita corresponding to BOR* = 11%.*

So far, we have assumed that the equilibrium situation was given by a business ownership rate of 11% (BOR*) and that the corresponding equilibrium level of per capita income was 15,826.92 (YCAP*). When taking other values for BOR* – more to the left or more to the right at the equilibrium relation depicted in Figure 4 – we obtain the adjustment processes depicted in Figure 6. It follows that the adjustment process is similar along the long-run equilibrium curve. Because the curve is steeper at lower levels of per capita income while the equilibrium relation is flatter where levels of per capita income are higher, the adjustment processes seem to be different though.

Figure 6 The adjustment process towards the long-run equilibrium relation as a response to an impulse of 0.1 percent-point in the business ownership rate.

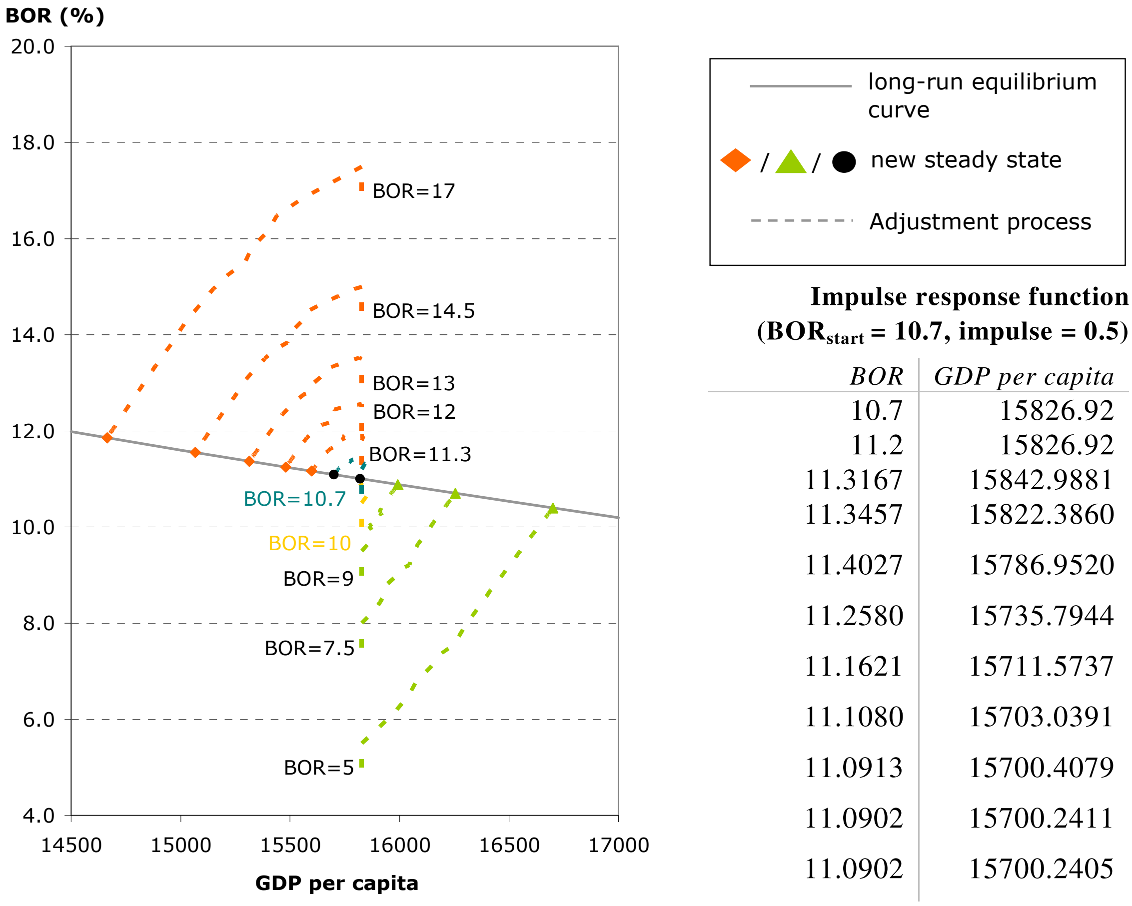


Note: In equilibrium, BOR = x where x=20, 15, 11, 7 or 3.5, and GDP per capita* equals the value corresponding to BOR*=x. Given this value of GDP per capita, BOR is 6, 3.5, 2 or 1 percent-points below or above BOR*. The different starting values of BOR are all along the vertical line of GDP per capita corresponding to BOR* = x%.*

Size of the shock

To what extent does the adjustment process change when larger shocks are given to the business ownership rate? Up till now we have investigated the adjustment process for different equilibrium values of the business ownership rate (ranging from 3.5% to 20%) and for various starting values given a particular equilibrium situation (ranging from 6 percent-point below to 6 percent-point above BOR*) as a result of an impulse of 0.1 percent-point to the starting value of the business ownership rate. Larger shocks will now be given to the business ownership rate using a similar procedure as explained above. Starting again with BOR* being equal to 11%, the results are shown in Table 9. This shows that the adjustment process becomes different when larger external shocks are given to the business ownership rate. Whereas both the business ownership rate and GDP per capita increase due to an impulse of 0.1 percent-point to a business ownership rate that is below equilibrium, this does not always hold anymore when the impulse is larger. As far as can be derived from Table 9 it seems that an impulse of 0.1 percent-point to the business ownership rate is still beneficial for both BOR and per capita income if the initial business ownership rate is only 0.3 percent-point below BOR* (that is, BOR=10.7). In case an impulse of 0.5 percent-point is given to a below equilibrium business ownership rate, the level of GDP per capita already declines when the initial business ownership rate is 1 percent-point below BOR* (that is, BOR=10). The penalty term becomes larger if an even larger impulse is given to the business ownership rate. This suggests that stimulating entrepreneurship should not happen too enthusiastic. If governments want to stimulate entrepreneurship, it is recommended to do it gradually, i.e. to give a few small shocks to the business ownership rate rather than one large impulse.

Figure 7 The adjustment process towards the long-run equilibrium relation as a response to an impulse of 0.5 percent-point in the business ownership rate.



Impulse response function
(BOR_{start} = 10.7, impulse = 0.5)

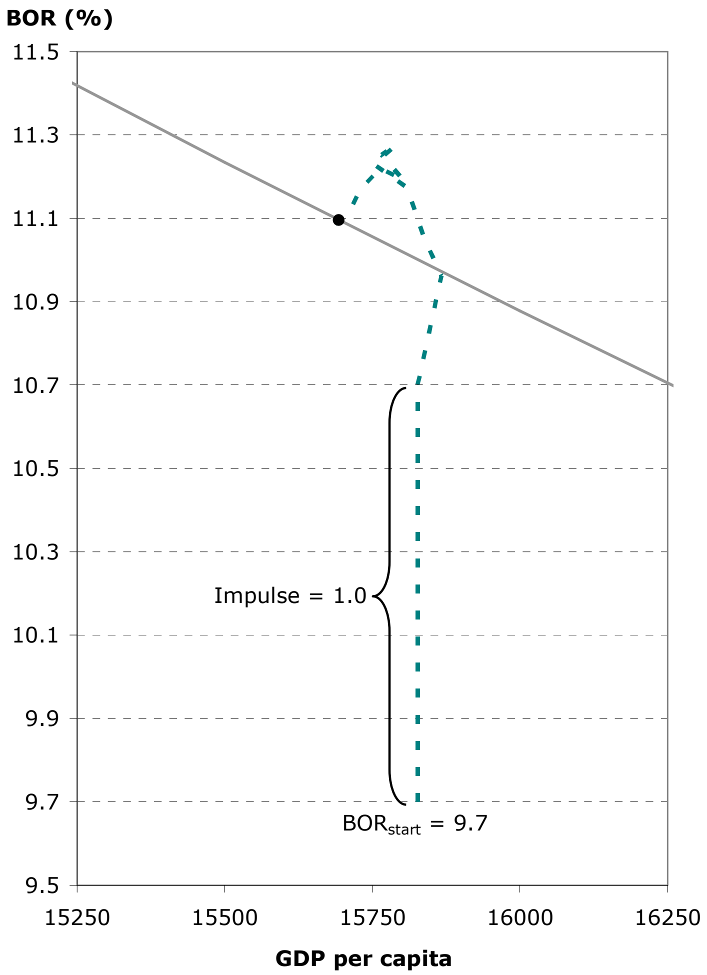
BOR	*GDP per capita*
10.7	15826.92
11.2	15826.92
11.3167	15842.9881
11.3457	15822.3860
11.4027	15786.9520
11.2580	15735.7944
11.1621	15711.5737
11.1080	15703.0391
11.0913	15700.4079
11.0902	15700.2411
11.0902	15700.2405

Note: In equilibrium, BOR = 11 and GDP per capita = 15,826.92. Given this value of GDP per capita, BOR is 6, 3.5, 2, 1 or 0.3 percent-points below or above BOR*. The different starting values of BOR are all along the vertical line of GDP per capita corresponding to BOR* = 11%.*

This is related to overshooting (see, e.g., Burke and Van Stel, 2009). Overshooting occurs when a below-equilibrium business ownership rate gets a large external shock such that it overshoots its equilibrium value at the expense of per capita income. In other words, whereas a country's economy was initially below the equilibrium curve, the impulse caused an increase in the business ownership rate in such a way that it shoots through its equilibrium value and finally converges to a new steady state up and to the left of the starting situation. Hence, at a point where the business ownership rate is higher – but above the equilibrium value – while the level of per capita income has become lower (associated with negative economic growth).

This phenomenon is illustrated in Figure 8. In this case, the equilibrium is again supposed to be given by BOR* being equal to 11% such that the corresponding equilibrium value of per capita income is given by 15,826.92 (YCAP*). Suppose that the business ownership rate is 1.3 percent-point below equilibrium (i.e., BOR_{start}=9.7). Then an impulse of 1.0 percent-point to the business ownership rate pushes BOR immediately to 10.7%. As a result of this shock the economic adjustment process is put into operation and starts to converge in the direction of the long-run equilibrium relation. However, since the external shock of 1.0 percent-point relative to the starting value of the business ownership rate was too large, the economy shoots through the equilibrium curve and the business ownership rate ends up above the equilibrium. In order to restore equilibrium, both the business ownership rate and per capita income need to adjust downwards. In the new steady state (indicated by a black dot in Figure 8), the business ownership rate has increased with respect to its initial value of 9.7%, but at the expense of GDP per capita which decreased compared to the starting situation. When taking a closer look into Table 9, it follows that there are more cases of overshooting. In fact, when the business ownership rate increased to a value above the equilibrium business ownership rate of 11% (BOR*) – the cell is coloured green – at the expense of GDP per capita – the cell is coloured dark orange – the economy has overshoot. In addition, the larger the impulse given to the business ownership rate, the higher the probability of overshooting.

Figure 8 Overshooting as a response to an impulse of 1.0 percent-point in the business ownership rate.



Note: In equilibrium, BOR = 11 and GDP per capita = 15,826.92. Given this value of GDP per capita, BOR is assumed to be 1.3 percent-points below BOR*.*

This also follows from Table 10, which shows the responses of the business ownership rate and GDP per capita as a result of external shocks with sizes ranging from 0.1 to 1.5 percent-point, using different starting points for BOR located below the equilibrium business ownership rate (BOR*=11). As follows from the increasing number of dark orange cells per column, the larger the size of the impulse the more often the economy overshoots. The external shock is then too large in such a way that it creates a particularly strong multiplier effect driving the economy through its equilibrium. As a consequence, the economy has to restore this overshooting process by adjusting the business ownership rate and per capita income downwards. On balance, a country then has a higher business ownership rate but paid a penalty in terms of decreased per capita income.

The adjustment process towards the long-run equilibrium curve, as represented by Impulse Response Functions, is derived from the short-run dynamics of the estimated Vector Error Correction Model (see Table 11). This involves both lagged influences of endogenous variables and influences of exogenous variables.

Table 10 Responses of the Business Ownership Rate (BOR) and GDP per capita (YCAP) from different starting points as a result of an external shock with sizes ranging from 0.1 to 1.5.

			Size of impulse										
			0.1	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**	**1**	**1.5**
Below equilibrium	**5**	BOR:	10.30	10.32	10.35	10.37	10.40	10.42	10.45	10.47	10.50	10.52	10.65
		YCAP	16851.98	16813.98	16776.07	16738.24	16700.50	16662.85	16625.27	16587.79	16550.39	16513.07	16327.74
	6	BOR:	10.42	10.44	10.47	10.49	10.52	10.54	10.57	10.59	10.62	10.65	10.77
		YCAP	16670.37	16632.78	16595.27	16557.86	16520.52	16483.27	16446.10	16409.02	16372.02	16335.10	16151.77
	7	BOR:	10.54	10.56	10.59	10.61	10.64	10.67	10.69	10.72	10.74	10.77	10.89
		YCAP	16490.71	16453.53	16416.43	16379.41	16342.48	16305.63	16268.86	16232.18	16195.58	16159.06	15977.70
	7.5	BOR:	10.60	10.62	10.65	10.68	10.70	10.73	10.75	10.78	10.80	10.83	10.95
		YCAP	16401.61	16364.62	16327.73	16290.91	16254.18	16217.53	16180.96	16144.47	16108.07	16071.75	15891.37
	8	BOR:	10.66	10.69	10.71	10.74	10.76	10.79	10.81	10.84	10.86	10.89	11.02
		YCAP	16312.99	16276.20	16239.50	16202.89	16166.35	16129.90	16093.53	16057.24	16021.04	15984.91	15805.51
	8.5	BOR:	10.72	10.75	10.77	10.80	10.82	10.85	10.87	10.90	10.92	10.95	11.08
		YCAP	16224.85	16188.26	16151.76	16115.34	16079.00	16042.75	16006.58	15970.48	15934.47	15898.54	15720.11
	9	BOR:	10.78	10.81	10.83	10.86	10.88	10.91	10.93	10.96	10.98	11.01	11.14
		YCAP	16137.18	16100.79	16064.49	16028.27	15992.13	15956.07	15920.09	15884.19	15848.38	15812.64	15635.17
	9.1	BOR:	10.79	10.82	10.84	10.87	10.90	10.92	10.95	10.97	11.00	11.02	11.15
		YCAP	16119.70	16083.36	16047.09	16010.91	15974.81	15938.79	15902.85	15866.99	15831.21	15795.52	15618.24
	9.2	BOR:	10.81	10.83	10.86	10.88	10.91	10.93	10.96	10.98	11.01	11.03	11.16
		YCAP	16102.25	16065.94	16029.71	15993.57	15957.51	15921.53	15885.63	15849.81	15814.07	15778.41	15601.32
	9.3	BOR:	10.82	10.84	10.87	10.89	10.92	10.95	10.97	11.00	11.02	11.05	11.17
		YCAP	16084.81	16048.54	16012.35	15976.25	15940.23	15904.28	15868.42	15832.64	15796.94	15761.32	15584.43
	9.4	BOR:	10.83	10.86	10.88	10.91	10.93	10.96	10.98	11.01	11.03	11.06	11.19
		YCAP	16067.39	16031.16	15995.01	15958.95	15922.96	15887.06	15851.24	15815.50	15779.83	15744.25	15567.55
	9.5	BOR:	10.84	10.87	10.89	10.92	10.94	10.97	10.99	11.02	11.05	11.07	11.20
		YCAP	16049.99	16013.80	15977.69	15941.66	15905.72	15869.85	15834.07	15798.37	15762.75	15727.20	15550.69
	9.6	BOR:	10.86	10.88	10.91	10.93	10.96	10.98	11.01	11.03	11.06	11.08	11.21
		YCAP	16032.61	15996.46	15960.39	15924.40	15888.49	15852.67	15816.92	15781.26	15745.67	15710.17	15533.85
	9.7	BOR:	10.87	10.89	10.92	10.94	10.97	10.99	11.02	11.04	11.07	11.10	11.22
		YCAP	16015.24	15979.13	15943.10	15907.15	15871.29	15835.50	15799.79	15764.17	15728.62	15693.16	15517.03
	9.8	BOR:	10.88	10.90	10.93	10.96	10.98	11.01	11.03	11.06	11.08	11.11	11.23
		YCAP	15997.90	15961.83	15925.84	15889.93	15854.10	15818.35	15782.68	15747.10	15711.59	15676.16	15500.22
	9.9	BOR:	10.89	10.92	10.94	10.97	10.99	11.02	11.04	11.07	11.09	11.12	11.25
		YCAP	15980.58	15944.54	15908.59	15872.72	15836.93	15801.22	15765.59	15730.04	15694.57	15659.19	15483.44
	10	BOR:	10.90	10.93	10.95	10.98	11.01	11.03	11.06	11.08	11.11	11.13	11.26
		YCAP	15963.27	15927.27	15891.36	15855.53	15819.78	15784.11	15748.52	15713.01	15677.58	15642.23	15466.67
	10.1	BOR:	10.92	10.94	10.97	10.99	11.02	11.04	11.07	11.09	11.12	11.14	11.27
		YCAP	15945.98	15910.03	15874.15	15838.36	15802.65	15767.01	15731.46	15695.99	15660.60	15625.29	15449.92
	10.2	BOR:	10.93	10.95	10.98	11.00	11.03	11.05	11.08	11.11	11.13	11.16	11.28
		YCAP	15928.71	15892.80	15856.96	15821.21	15785.53	15749.94	15714.43	15678.99	15643.64	15608.37	15433.19
	10.3	BOR:	10.94	10.97	10.99	11.02	11.04	11.07	11.09	11.12	11.14	11.17	11.29
		YCAP	15911.46	15875.58	15839.79	15804.07	15768.44	15732.88	15697.41	15662.01	15626.70	15591.46	15416.47
	10.4	BOR:	10.95	10.98	11.00	11.03	11.05	11.08	11.10	11.13	11.16	11.18	11.31
		YCAP	15894.23	15858.39	15822.63	15786.96	15751.36	15715.84	15680.41	15645.05	15609.77	15574.58	15399.78
	10.5	BOR:	10.96	10.99	11.02	11.04	11.07	11.09	11.12	11.14	11.17	11.19	11.32
		YCAP	15877.02	15841.22	15805.50	15769.86	15734.30	15698.82	15663.43	15628.11	15592.87	15557.71	15383.10
	10.6	BOR:	10.98	11.00	11.03	11.05	11.08	11.10	11.13	11.15	11.18	11.20	11.33
		YCAP	15859.82	15824.06	15788.38	15752.78	15717.26	15681.82	15646.46	15611.18	15575.98	15540.86	15366.44
	10.7	BOR:	10.99	11.01	11.04	11.06	11.09	11.12	11.14	11.17	11.19	11.22	11.34
		YCAP	15842.65	15806.92	15771.28	15735.72	15700.24	15664.84	15629.52	15594.28	15559.11	15524.03	15349.80
	10.8	BOR:	11.00	11.03	11.05	11.08	11.10	11.13	11.15	11.18	11.20	11.23	11.36
		YCAP	15825.49	15789.81	15754.20	15718.68	15683.24	15647.87	15612.59	15577.39	15542.26	15507.22	15333.18
	10.9	BOR:	11.01	11.04	11.06	11.09	11.11	11.14	11.17	11.19	11.22	11.24	11.37
		YCAP	15808.35	15772.71	15737.14	15701.66	15666.25	15630.93	15595.68	15560.52	15525.43	15490.43	15316.57
Equilibrium	**BOR* = 11**	BOR:	11.03	11.05	11.08	11.10	11.13	11.15	11.18	11.20	11.23	11.25	11.38
		YCAP	15791.23	15755.63	15720.10	15684.65	15649.29	15614.00	15578.79	15543.67	15508.62	15473.65	15299.98

Note: In equilibrium, BOR = 11 and GDP per capita* = 15,826.92. Starting values located vertically below BOR* of 11%. Green cells refer to an increase of the corresponding variable w.r.t. the starting situation, while dark orange cells refer to a decrease w.r.t. the starting situation.*

Table 11 Short-run parameter estimates of the estimated VECM.

		ΔBOR			Δ*log*(GDP per capita / 1,000)		
Short-run dynamics		Coeff.	SE	t-value	Coeff.	SE	t-value
	$\sum_{j=1}^{9}\Gamma_j \Delta Y_{t-j}$						
Lags of ΔBOR	t – 1	0.250***	(0.045)	5.589	0.233	(0.199)	1.172
	t – 2	0.024	(0.046)	0.518	-0.313	(0.204)	-1.534
	t – 3	0.097**	(0.046)	2.104	-0.069	(0.205)	-0.337
	t – 4	0.005	(0.046)	0.115	-0.276	(0.205)	-1.346
	t – 5	0.027	(0.046)	0.591	0.433**	(0.204)	2.119
	t – 6	-0.049	(0.046)	-1.071	-0.269	(0.205)	-1.309
	t – 7	-0.037	(0.046)	-0.820	0.372*	(0.203)	1.832
	t – 8	0.055	(0.046)	1.210	-0.384*	(0.203)	-1.892
	t – 9	-0.053	(0.044)	-1.120	-0.098	(0.198)	-0.497
Lags of Δ*log*(GDP per capita / 1,000)	t – 1	0.013	(0.009)	1.405	0.234***	(0.041)	5.741
	t – 2	-0.008	(0.008)	-1.230	0.002	(0.034)	0.074
	t – 3	-0.001	(0.007)	-0.093	-0.026	(0.032)	-0.832
	t – 4	0.080	(0.007)	1.374	0.011	(0.032)	0.348
	t – 5	-0.006	(0.007)	-0.822	-0.005*	(0.031)	-0.168
	t – 6	-0.005	(0.007)	-0.809	0.011	(0.030)	0.367
	t – 7	0.002	(0.006)	0.292	-0.008	(0.027)	-0.278
	t – 8	0.004	(0.006)	0.695	0.039	(0.027)	1.451
	t – 9	0.001	(0.006)	0.250	0.041*	(0.024)	1.659
	Constant (μ_1)	-0.285*	(0.144)	-1.971	-1.785***	(0.642)	-2.778
	ΞD_t						
Exogenous variables	Δ*log*(employment per capita)	-0.589	(0.989)	-0.595	51.751***	(4.400)	11.763
	Δ*log*(real total net capital stock per capita)	-1.061	(1.119)	-0.949	18.272***	(4.979)	3.670
	Δ*log*(total gross domestic expenditure on R&D per capita)	-0.644*	(0.327)	-1.971	9.885***	(1.453)	6.801
	ΔLabour income share	-0.004	(0.001)	-0.379	-0.313***	(0.043)	-7.331
	Gross enrolment rate for tertiary education	0.004***	(0.001)	3.537	0.009**	(0.005)	2.006
	Total tax revenue (% GDP)	-0.002	(0.002)	-0.817	0.022**	(0.010)	2.107
	Service share	0.004***	(0.001)	2.962	0.018***	(0.006)	2.975
	Dummy for Italy	0.489***	(0.095)	5.158	0.626	(0.422)	1.484
		Model statistics					
	R^2	0.201			0.571		
	Adjusted R^2	0.157			0.547		
	Log-likelihood	-85.286			-854.108		

Note: all variables are scaled in such a way that they can be interpreted as percentages. Included observations: 515.

** significant at 10% level; ** significant at 5% level; *** significant at 1% level.*

5.5.2 Exogenous variables

Concerning the exogenous variables, most of them have plausible coefficients (see Table 11). The traditional input factors of production – employment, physical capital and R&D – are positive and strongly significant in the equation of economic growth. With an estimated coefficient of 51.8 employment, or more precisely Δlog(employment per capita), can be marked as the most important input factor in the production function. The estimated coefficient for physical capital, or more precisely Δlog(real total net capital stock per capita), equals 18.3 which therefore also contributes significantly to economic growth. The final production function input factor is also significant. The estimated coefficient for innovation, or more precisely Δlog(total gross domestic expenditure on R&D per capita), equals 9.9 and is therefore the smallest among all three input factor. The joint effect of the three factors of production on economic growth is about 80 (the sum of the corresponding estimated coefficients) implying that there are almost constant returns to scale (which is associated with an aggregate of 100).

The differenced variable labour income share has a significantly negative effect on economic growth and is insignificant for entrepreneurship (net entry). Since labour income share can be seen as an inverse measure for profitability, growth in the labour income share points at decreasing profitability which is therefore expected to have a negative impact on entrepreneurship. Although the sign of Δlabour income share is negative, this variable is not significant for ΔBOR. The negative impact on economic growth might suggest that struggling firms (i.e. firms with decreasing profits) postpone investments.

Consistent with the existing literature, tertiary education positively affects entrepreneurship, or more precisely ΔBOR, in higher developed countries. In addition, human capital contributes significantly to economic growth in the sense that a higher educated population stimulates economic growth.

As far as total tax revenue as a percentage of GDP is concerned, this variable seems to have a significantly positive impact on economic growth. Perhaps in countries where tax incomes are high, governments spend more money, thereby stimulating the economy.

A country's share of services in the economy positively affects entrepreneurial activity as well as economic growth. In higher developed countries the service sector has grown rapidly starting in the 1970s and 80s (Wennekers et al, 2009). The growing service sector was one of the contributing factors to the shift from the managed economy towards the entrepreneurial economy (Wennekers and Thurik, 1999; Wennekers et al., 2007, 2009). As opposed to setting up a new business in manufacturing for example, it requires relatively modest investments to set up an enterprise in the service sector with its smaller scale and lower entry barriers. According to Table 11, countries with larger services sectors also seem to enjoy higher economic growth rates.

Finally, we included a dummy for Italy as exogenous variable in the model, since Italy deviates from the overall pattern in the sense that this country combines a high business ownership rate with a near average level of per capita income. In fact, Italy both has a relatively high business ownership rate compared to other countries, *and* the number of business owners keeps growing. So Italy rather moves away from instead of in the direction of the equilibrium curve. In order to account for this deviating pattern, a dummy variable is included for Italy. As can be seen from the parameter estimates presented in Table 11, the dummy for Italy is strongly significant in the relation for ΔBOR. The positive sign indeed confirms that, relative to the other countries, the business ownership rate in Italy is growing considerably in the period under consideration.

6. Conclusions

We examine the two-way relationship between entrepreneurship and economic performance, using a harmonized data set covering 21 OECD countries in the period 1981-2006. While the relation between entrepreneurship and economic performance has been investigated extensively, most papers in this research field suffer from one or more methodological flaws, so that the important question: "does entrepreneurship cause economic performance?" can still not be answered up till the present day. In this paper we investigate the relationship in an integrated framework, accounting for the direction of causality, the lag structure, the short-run dynamics and the long-run equilibrium relation.

More specifically, we estimate a Vector Error Correction Model (VECM) with cointegration which imposes no prior assumptions on the endogeneity of entrepreneurship (business ownership) and economic performance (GDP growth). The VECM with cointegration allows us to unravel the genuine relationship between entrepreneurship and economic performance. We find evidence for the existence of a long-run equilibrium relation between the level of business ownership and per capita income. We also find evidence that increases in business ownership actually cause economic growth. However, the effect depends on the number of business owners already present in the economy, i.e. we find decreasing marginal returns to entrepreneurship. We also find that the effect depends on the size of the shock (i.e. the increase in entrepreneurship), where too big shocks may lead to negative effects on GDP due to 'overshooting'. To avoid 'overshooting' entrepreneurship should only be stimulated gradually, if at all.

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