Time series and panel data analysis of GEDI and growth performance indicators

Niels Bosma, Jeroen Content, Mark Sanders and Erik Stam

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1. Executive Summary

In this paper we look into the hypothesis that institutions drive high quality entrepreneurship that in turn promotes innovative and inclusive growth. We start our analysis by estimating baseline growth models for 25 EU countries over the period 2006-2014. We compare our results to those of growth model specifications in the tradition of Islam (1995) and then estimate these models with different dependent variables to capture dimensions of economic growth. We also include various measures of entrepreneurial activity in these growth regressions and control for and interact these with institutional variables that we show to have a direct positive effect on our entrepreneurship variables. Regulation of credit, labour and business positively affects (high quality) entrepreneurship, while the size of the government is negatively linked to entrepreneurship. For those institutions that are shown to promote entrepreneurship we apply a 3SLS estimation method to account for endogeneity following Bjornskov and Foss (2016) and Aparicio-Audretsch-Urbano (2016). We find a positive link between entrepreneurship and GDP growth. These effects are only reinforced after controlling for institutional characteristics that are linked to entrepreneurship in the existing body of literature. We discuss various possible explanations for our results and offer implications for institutional reform agendas aimed at stimulating entrepreneurship.

2. Institutions, Entrepreneurship and Inclusive Growth

2.1 Introduction

The FIRES-project and the Entrepreneurial Society (Audretsch, 2007) revolve around the assumption that institutions determine the allocation of talent, finance and labour to entrepreneurial venturing that eventually results in inclusive and innovative economic growth and social development. But this assumption is not (yet) part of the mainstream in economic thinking on growth and development. The late William Baumol used the famous words "The prince of Denmark has been expunged from the discussion of Hamlet" to describe the remarkable neglect of entrepreneurship in the academic research on economic growth (Baumol, 1968). In response to his challenge, many have since tried to come up with evidence to support the claim that entrepreneurship spurs economic development, but with mixed results and limited success (Minniti, 2016). Entrepreneurship still does not play a substantial role in the economic models discussed in mainstream economics journals or standard economics textbooks.

While the notion that entrepreneurship matters to economic progress resonates with academics and policy makers alike, strong empirical support is lacking. Bjornskov & Foss (2016) concluded, in a recent overview on the link between entrepreneurship and growth, that the literature has so far aimed at explaining differences in levels (typically cross-sectional approaches to GDP per capita and productivity levels) rather than growth rates. Evidence on the former seems supportive, but suffers a lot from endogeneity issues. The evidence on the latter is much more scant and mixed. This lack of clear-cut empirical results can be tied back to on the one hand, the complexity of the relationship, that may play out differently in different contexts and with different and complex lags. Bjornskov & Foss (2016) for example argue in their review of the literature that current performance is the result of past institutions when institutions and policies may both moderate and mediate the effects of entrepreneurship on growth and performance.[1] At the same time, the literature to date resists a clear and uniform definition of what entrepreneurship is and consequently how to measure it. This resulted in a lack of reliable, long time series of data that is comparable across countries. In this report, we use the data collected in earlier deliverables (D4.1 and D4.2) to dig into the complex interaction of institutional specificities and entrepreneurial activity. The focus in this report will be on the national level and time dimension. Moreover, in this report we zoom in on growth.

A more thorough and complex assessment of the interrelationship between entrepreneurship and the contextual (institutional) environment is required to make inferences on the impact of entrepreneurship on (different types of) performance. In an ideal academic setup, we would like to model variation of economic

[1] In fact, this observation was also made by Harry Leibenstein in the very same journal issue as Baumol's paper (Leibenstein, 1968).

growth across nations, over time and distinguish between different types of entrepreneurship to retrieve 'genuine' effects of entrepreneurship on socio-economic progress. Moreover, we would control for institutional effects as well as human capital, financial capital and knowledge as traditional inputs of the production function.

The approach in this report addresses most of the elements mentioned above. We consider variations in nations and investigate the impact of a variety of types of entrepreneurship over time. We model growth in economic output as well as levels, and consider the national institutions that shape the types of entrepreneurship that are observed in the country. A rigorous analysis of the relation between inputs (including institutional characteristics), outputs (types of entrepreneurship) and outcomes (economic growth) for 25 European Union countries yields some support for the positive link between entrepreneurship and economic development. Contrary to what might be expected, the more general measures of early-stage entrepreneurship appear to be the best predictors of annual national economic growth. Our model finds institutions related to business regulations (including labour regulations) and to nurturing cultures addressing awareness and self-efficacy of entrepreneurship to be seen as the best drivers of this type of productive entrepreneurship. In addition, size of the government affects economic growth via entrepreneurship, witness the results from our models. However, the debate on inclusive growth comes into play here, as diminishing government spending (and of course in particular the reduction of amenities for the poor that are associated with cuts in government spending) may also increase inequality and hence discourage *inclusive* growth (Roine et al. 2009). As there is no consensus on how to measure the latter consistently across countries and over time, we keep the focus in our analysis on GDP growth but will discuss this complication where appropriate. The remainder of this section presents our theoretical background in a literature review. Building on that we develop our empirical strategy in section 3 and present our results in section 4. Section 5 concludes.

2.2 Theoretical background and Literature Review

In our effort to unpack the role of entrepreneurship in economic and social progress, we adopt a basic scheme that puts entrepreneurship in a centre stage between institutional characteristics, traditional input factors and economic and social progress. The field of institutional economics, with seminal contributions from North (1990), Scott (1995) and Williamson (2000), contents that formal rules (constitutions, laws and regulations) and informal rules (norms, habits, social practices) play a key role for economic development as they shape societies' economic behaviour. Studies by e.g. Demirgüç-Kunt & Levine (2004) and Acemoglu et al (2005) support this view. In this report, we try to capture one particular mechanism from the 'institutional base' to its impact on economic growth: that of entrepreneurial behaviour. To what extent does entrepreneurship affect economic growth, how is this enabled by institutional settings and to what extent does entrepreneurship moderate the impact of labour and capital on economic growth?

2.2.1 Institutions and entrepreneurial behaviour

National and supranational institutional settings do not only establish the rules of the game; they also help determine the local 'plays' of the game, to use Williamson's terminology (Williamson, 2000). As such, the institutional context provides the incentive structure for the entrepreneurially talented. Baumol (1990) has thoroughly described how sets of rules, including formal and informal ones, can lead to vastly different types of entrepreneurial behaviour. In turn, the observed entrepreneurial behaviour that emerges from an institutional context can have vastly different impacts on economic growth. This implies there is a complex and empirically hard to disentangle interrelationship between the institutional framework conditions in which entrepreneurs operate and the actions they take to build their ventures. This problem is compounded by the fact that both "entrepreneurship" and "institutions" are empirically rather fuzzy and multidimensional concepts.

Before we proceed, it is therefore important to be more precise what we consider (not) to be "entrepreneurship". Arguably, the management literature has had the richest debate when it comes to defining entrepreneurship. We adopt Shane and Venkataraman's (2000) view that entrepreneurship is a process characterized by recognizing, evaluating and exploiting opportunities to create new value, either for the individual, the organization or society. Moreover, we do not see this as a linear process; aligning with Alvarez & Barney (2007) for example, it is perfectly conceivable that new opportunities are only recognized, or even created, by starting to exploit initial ideas. Entrepreneurs may or may not be ambitious in terms of growth expectations (Stam et al. 2012) or successful in that respect. In addition, as Shane and Venkataraman (2000) also note, individuals can pursue entrepreneurial activities as employees in (large) public or private organizations. They do not need to be self-employed and being self-employed does not make one an entrepreneur. Entrepreneurship refers to the behaviour, not a labour market status or contractual arrangement (cf. Wennekers & Thurik 1999).

The problem is of course that behaviour is hard to measure consistently across national and institutional borders. Observing the outcomes of entrepreneurial activity risks creating a tautology (e.g. those observed to introduce innovations are innovators, so their presence correlates highly with innovations being introduced). Observing entrepreneurs by personal characteristics or labour market status risks introducing very high levels of measurement error (e.g. opening a coffee shop is considered more entrepreneurial than starting Facebook while in college). The best, most consistent measures we have of entrepreneurial activity are therefore obtained in representative adult population surveys, where respondents are simply asked if they are involved in performing a set of well-defined (entrepreneurial) activities. Such measures are systematically collected for almost two decades now in the Global Entrepreneurship Monitor (GEM). Before, self-employment and entry rates have been used but these are restricted in the sense that they refer to occupation rather than entrepreneurial behaviour (as defined above) and do not consider entrepreneurial activities that occur before the 'event' of a start-up, entering the registration database. The GEM data offer a larger variety of entrepreneurship, reflecting the process of entrepreneurship. At the same time, its limitation is that it uses

self-reported data. Also, one should bear in mind that national rates obtained from GEM are based on a sample of the adult population, and hence go together with statistical upper and lower bounds. In our empirical exercise, we adopt some of the GEM measures and combine pre-startup and post-startup phases and different levels of growth expectations. We also include the (more recent) GEM-measures of entrepreneurial employee activity. For "institutions" we take a more pragmatic approach. There we simply follow the literature and first distinguish between formal and informal institutions.

Formal institutions and entrepreneurial behaviour

Formal institutions that have already been linked to entrepreneurial behaviour include the size of the government (Bjornskov & Foss 2008, Aidis et al. 2012). This size is shown to have a negative effect on entrepreneurship. The proposed reasons include job opportunities in the public sector that put downward pressure on the propensity of people to become entrepreneurs. But also the laws and regulations associated with 'big' governments can be linked to entitlements for inhabitants that supposedly make them more hesitant to take risks. For example, unemployment benefits and employment protection may discourage a group of individuals, including some with entrepreneurial talents, to engage in the risky business of starting a firm or trying out new projects on own initiative in their firm. Another formal institutional determinant zooms in more specifically on the regulatory burdens or stimuli for entrepreneurs (DeClercq et al. 2010, Levie and Autio, 2011). Making it 'easy to do business' may facilitate the transition from an evaluation stage to the exploitation stage. Arguably, this may also attract more people who do not have the capabilities to contribute directly or indirectly to economic growth. Business regulations may also deter or facilitate the hiring of new personnel, making it easier for talented people who are able to grow a new business or initiative to do so.

Financial systems employed in a country, as well as the predictability of these systems, is also important for entrepreneurs (Bjornskov & Foss 2008). This applies to both formal structures, such as the presence of market-based or bank-based financial systems (Demirgüç-Kunt & Levine 1999; Levine 2002) and informal structures, such as the relative number of informal investors that may help the large group of 'bricoleurs' among the entrepreneurs in society (Ho & Wong 2007). Especially in the age of modern crowdfunding, the participation of informal investors may increase, and complete funding for more aspiring entrepreneurs in the very initial stage. This may provide for a more effective filter to the large pool of entrepreneurs with good and bad business ideas.

Informal institutions and entrepreneurial behaviour

Attitudes and cultural beliefs are, certainly since Baumol's (1990) study and Hofstede's work on cultural indicators (Hostede 2003), increasingly studied as important determinants for economic growth (Glaeser et al. 2002; Sobel 2002). In this, it can be questioned to what extent informal institutions impact growth directly, or if it requires entrepreneurs to appreciate the informal institutional context (bearing in mind the existing formal

rules of the game, see above), develop their entrepreneurial ventures based on this institutional context and as such contribute to economic development.

Tabellini 2008, Gorodnichenko & Roland (2016), amongst others, come up with different but related cultural and attitudinal components of informal institutions that also matter for entrepreneurship (see e.g. Freytag & Thurik 2010). The main informal institutions refer to attitudes towards risk taking and individualism (Hechevarria and Reynolds 2009; Pinilos & Reyes 2011), associational activity (DeClercq et al. 2010, Danis et al. 2011) and socially supportive cultures (Stephan & Uhlaner 2010) or social capital and trust (Dakhli & DeClercq 2004). Based on Putnam's introduction of social capital theory, stating that "trust, norms and networks can improve the efficiency of society by facilitating coordinated actions" (Putnam, 1993), trust is also associated with productive entrepreneurship.

Table 1 Table 1 Institutional determinants of entrepreneurship, based on GEM-based studies

Determinant	Type of eship	Authors
Formal Institutions: Government size & regulation		
Size of Government	(opportunity) TEA	Bjornskov & Foss 2008
Regulatory Burdens	TEA	De Clercq et al 2010
Labour market regulations	TEA	Van Stel et al. 2007
Social Security	Ambitious TEA	Hessels et al. 2008
Regulatory Burdens, moderated by Rule of Law	Ambitious TEA	Levie & Autio 2011
Rigid Working Time regulation	Opportunity TEA	Stephen et al. 2009
Regulatory business costs	Opportunity TEA	Ho & Wong 2007
Financial institutions		
Sound money (consistency monetary policy)	(opportunity) TEA	Bjornskov & Foss 2008
Financial support	Growth oriented TEA	Bowen & Declerq 2008
Informal investments	Varied TEA	Ho & Wong 2007
Informal institutions: culture, norms & networks		
Associational activity	TEA	De Clercq et al 2010
Associational activity	TEA	Danis et al. 2011
Normative Burdens		De Clercq et al 2010
Socially Supportive Culture	TEA varied	Stephan & Uhlaner 2010
Social Networks	TEA	Danis et al. 2011
Trust	TEA	Nissan et al. 2012
Individualism	TEA	Pinilos & Reyes 2011
Education		
Education support	Growth oriented TEA	Bowen & Declerq 2008
Education, mediated by opportunity perception	Varied	Levie & Autio 2008
Cognitive Institutional Burdens	TEA	De Clercq et al 2010
Other controls		
Unemployment	Varied	Koellinger & Minniti 2009

Note to FIRES reviewers: final version will include more recent contributions

2.2.2 Entrepreneurship and growth

From a neoclassical economics perspective entrepreneurs make changes in sectoral structure (structural change) and shift the production possibilities frontier out by introducing novel input-output combinations (technical change). As such, they drive economic growth. Noseleit (2009) argues that the importance of structural change for economic growth became more apparent due the rise of endogenous growth theory, stressing technology-driven input changes (Romer 1990). In this neoclassical framing, incumbent firms are unable to use their existing resources efficiently in preparation for future economic structures. The resource based view (Barney 1991) supports this argument from a management perspective. Incumbent firms may develop competitive advantages due to their distinct firm resources. However, these advantages may be temporal and if the environment changes, the danger of a 'lock-in effects' are looming (Afuah, 2000). New entrepreneurial activities are better equipped to move towards a new, though still uncertain, future. This is closely related to the process of creative destruction, introduced by Schumpeter (1942) and developed into economic modelling by Aghion & Howitt (1992). They already argued the incumbent firms should not be expected to innovate and thereby cannibalize on their existing profit flows and it therefore contents that new entrepreneurial activities represent the 'fuel' for economic development, moving the production frontier out.

The Austrian economics school of thought takes a somewhat different perspective. They view entrepreneurs as individuals who spot opportunities based on the institutional context and act on these opportunities. Rather than moving the production frontier forward, they see entrepreneurs as individual agents who are alert to new opportunities and move the economic state towards an equilibrium, even though the economy will never reach such a state (Kirzner 1973, 1997). Dew et al. (2004) pointed out how individuals, based on their prior experiences and expertise, may see different opportunities in very similar contexts based on Hayek's work on information asymmetry (Hayek, 2010). Baumol's (1990) view of the role of entrepreneurs also builds on this notion but is more focused on the role of institutions, as he proposes that institutions and policies affect the productivity of entrepreneurial activity (rather than the number of entrepreneurs).

Empirical evidence on the link between entrepreneurship and economic growth produces mixed findings and is certainly not well-embedded in the mainstream economics literature (Bjornskov & Foss, 2016). Moreover, we can expect a selection bias as studies reporting a positive and significant impact may be more prone to publication than papers discussing non-significant effects. Table 2 provides a non-exhaustive overview of recent studies that have assessed the relationship between entrepreneurship and economic growth at the national level. With Bjornskov & Foss, we conclude the evidence on development levels is positive, but is likely to be driven by unresolved endogeneity issues, whereas the effects on growth are much more scanty and mixed.

Table 2 The impact of entrepreneurship on economic growth: evidence from empirical cross-national studies from 2010 onwards

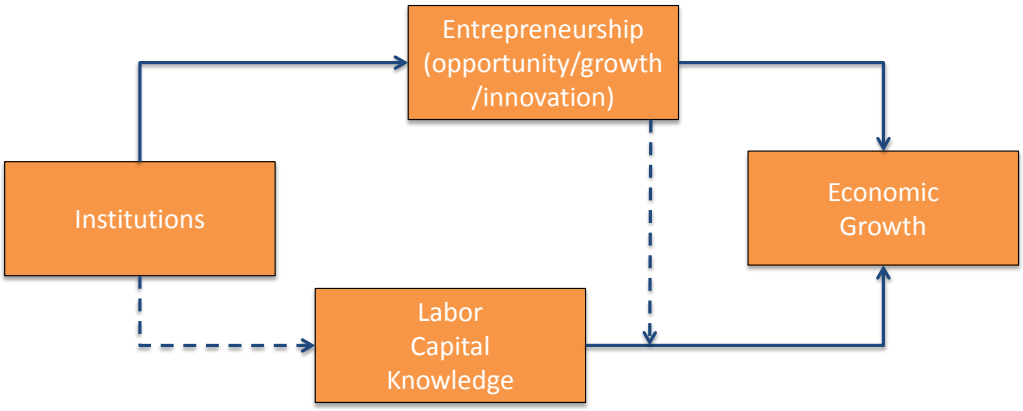
	Theoretical underpinning	Dependent variable	Type of entrepreneurship	Model	Main significant results	Remarks
Aparicio – Urbano – Audretsch (2016)	Institutional economics	Productivity levels	TEA, opportunity TEA, necessity TEA	Cobb-Douglas, Panel IV estimation, 3SLS	All eship indicators positive, in particular OECD;	Gross Fixed Captial formation important control (but not for OECD)
Bjornskov & Foss (2013)	Neoclassical economics, Austrian perspective?					
Braunerhjel,m et al. (2010)	Endogenous growth theory & Schupetarian	Δlog GDP per capita	Non-agricultural self-employment	Extended Romer production function, GLS Panel & OLS	Entrepreneurship positive for growth	
Castano-Martinez et al. (2015)	Schumpetarian	GDP per capita, Gross National Income per capita	TEA, Opportunity-TEA	Structural Equation Modeling (cross-sectional)	Investments in R&D, education linked to entrepreneurship, this is in turn linked to economic performance	Cross sectional model of 13 EU countries
Erken et al (2016)	Schumpetarian		Ratio between actual business ownership rate and 'standardized' business ownership rate [1)]	Regressing on TFP – IV approach - Proper controls for knowledge & HC		Standardized business ownership rate: 'equilibrium rate' based on U-shape pattern, determined by Carree et al. 2007
Hessels and Van Stel (2011)	Endogenous growth theory	GDP per capita growth	TEA, export-driven TEA	Panel data estimation, fixed effects	Entrepreneurship and export-driven entrepreneurship positive	
Lafuente et al. (2016)				Data envelopment analysis		
Prieger et al. (2016)	Neoclassical economics	GDP per capita growth (ln)	TEA (versus optimal TEA)	Growth Penalty Model, differenced OLS	TEA positive growth penalty occurs in developing economies	Penalties assumed where TEA rates differ from optimum
Urbano _ Aparicio (2016)	Institutional economics	Ln GDP per capita	TEA, opportunity TEA, necessity TEA	Panel estimation, fixed effects	All eship indicators positive, in particular OECD;	Gross Fixed Captial formation important control (but not for OECD)

Note: studies ordered by author names

2.3 Summary

Figure 1 provides a simplified synthesis of the arguments made above, integrating lines of thought from neoclassical economics, institutional economics (including the Austrian perspective) and management. Institutions impact economic growth via the traditional inputs labour, capital and knowledge. However, these relationships neglect the role of entrepreneurs. By explicitly accounting for their role in a growth equation, we may get clearer indications as to (i) to what extent entrepreneurship contributes to economic growth; (ii) to what extent is this impact contingent on institutional settings and (iii) how does acknowledging for the impact of entrepreneurship change the effect of the traditional inputs? These questions can only be answered while addressing the relationships in conjunction.

Figure 1 Institutions, entrepreneurship and economic growth. A simplified framework



3. Methodology & Data

Our methodology can be divided up in four different steps. First, we specify and estimate our growth equation, for which we follow Islam (1995), and try to reproduce his findings. Secondly, we account for the effect of different types of entrepreneurship by including indicators into our model directly. In this way, we test to what extent different types of entrepreneurship – assumed to affect the way in which production factors are converted into output – are drivers of economic growth. The third step is to estimate the effect of formal and informal institutions on entrepreneurship. The assumed logic being that institutions enable and constrain (productive) entrepreneurship in society. Our final step is then to incorporate into a single estimation the effect of entrepreneurship on growth and the effect of institutions on entrepreneurship in order to account for the endogenous character of entrepreneurship and its institutional context.

We take the relationship in the lower side of Figure 1 as our starting point in building our model. Here we adopt the model proposed by Islam (1995), who augments the seminal Mankiw-Romer-Weil (MRW; 1992)

model by taking into account dynamic effects in a panel data setting. GDP per capita in country *i* and year *t* is denoted by $y_{it.}$ The model in conventional panel data notation is given by

Equation (1)

$$y_{it} = \gamma y_{it-1} + \beta_1 s_{it} + \beta_2 (n + g + \delta)_{it} + \eta_t + \mu_i + \nu_{it}$$

where y_{it} is log GDP per capita in country i and year t, s_{it} represents gross fixed capital formation, n and g equal growth of labor and capital, and δ the depreciation rate. η_t represents regional fixed-effects, μ_i represents time-fixed effects, and ν_{it} is the error term. For the second step of our procedure we add different types of entrepreneurship, which are directly inserted into our model as

Equation (2)

$$y_{it} = \gamma y_{it-1} + \beta_1 s_{it} + \beta_2 (n + g + \delta)_{it} + \beta_3 ent_{it}^{j} + \eta_t + \mu_i + \nu_{it}$$

where ent_{it}^{j} denotes entrepreneurship indicator j country i and year t. This model, however, does not yet acknowledge the endogenous character of entrepreneurship and its contingence on the institutional context. As is clear from equation (3), ignoring this potential endogeneity could result in a bias for coefficients in equation (2). That is, when entrepreneurial activity is positively correlated with institutional quality, it will be hard to disentangle these effects. Hence the next step is to model, in the vein of Aparicio et al. (2016) but aligning closely with the Islam (1995) model, a system of two equations where entrepreneurial activity mediates the impact of a particular set of institutions (notably those that are expected to impact entrepreneurship) on economic growth, controlling for the impact of the traditional input factors (see equation 3, where institutions are captured in $Formal_{it}^{k}$ and $Informal_{it}^{l}$, along with control variables X_{it}^{m}). Additionally, we augment our model by allowing for moderating effects between entrepreneurial activity and other input factors such as human capital and investment (equation 4).

Equation (3)

(3a): $y_{it} = \gamma y_{it-1} + \beta_1 s_{it} + \beta_2 (n + g + \delta)_{it} + \beta_3 ent_{it}^{j} + \eta_t + \mu_i + \nu_{it}$

(3b): $ent_{it}^{j} = \propto \sum_{k=1}^{K} \propto^{k} Formal_{it}^{k} + \sum_{l=1}^{L} \propto^{l} Informal_{it}^{l} + \sum_{m=1}^{M} \propto^{m} X_{it}^{m} + \varphi_i + \omega_{it}$

Equation (4)

(4a): $y_{it} = \gamma y_{it-1} + \beta_1 s_{it} + \beta_2 (n + g + \delta)_{it} + \beta_3 ent_{it}^{j} + \theta ent_{it}^{j} * s_{it} + \vartheta\, ent_{it}^{j} * n + \eta_t + \mu_i + \nu_{it}$

(4b): $ent_{it}^{j} = \propto \sum_{k=1}^{K} \propto^{k} Formal_{it}^{k} + \sum_{l=1}^{L} \propto^{l} Informal_{it}^{l} + \sum_{m=1}^{M} \propto^{m} X_{it}^{m} + \varphi_i + \omega_{it}$

We restrict our regressions to 25 of the EU28 countries, for which we have entrepreneurship data available for the years 2003-2014[2]. This time frame is not as extensive as used by others in economic growth modeling. For this reason, we use annual data rather than five-year-averages as in Islam (1995). This implies, however, that more of the variation in GDP growth is related to the business cycle. Given the fact that our period includes the financial crisis of 2007-2011 that affected most European member states substantially, this should be considered when interpreting the results. The financial crisis can be expected to obscure the hypothesised relationship between entrepreneurship and growth. That is, as demand side economic shocks drive economic growth, the relationship between these variables on the supply side, is harder to discern. This would bias our results against finding support for the hypothesis and as such implies our test is conservative. Alternatively, one could interpret our test a test of the hypothesis that entrepreneurship helps moderate and absorb negative demand side shocks (as opposed to creating long term growth). Either way we feel the data can tell us useful things. We restrict ourselves to the EU countries as they offer a variety in economic development as well as in institutional settings (see Dilli & Elert 2016), while they are at the same time under a coherent 'umbrella' of institutions. Moreover, these countries would mostly qualify as 'innovation driven' and entrepreneurship in these countries is most likely to be of the opportunity driven type. This is useful as, aligning with our argumentation in the previous section, the nexus of institutions, entrepreneurship and growth may work out very differently in case institutional settings are vastly different and/or the types of entrepreneurship are very different.

We take data on economic growth and capital formation from the Penn World Table (PWT) (Feenstra et al., 2015). The dependent variable, y_{it}, is defined as the logarithm of expenditure-side real GDP per capita in Purchasing Power Parities (PPP). Like Islam (1995) we include a one-year lag of the dependent variable. Alternatively, we regress on labour productivity, defined as the logarithm of real GDP divided by the number of employed inhabitants in a country. For the value of *s,* we take the logarithm of the share of gross capital formation. As our measure of *n,* we calculate the annual population growth rate. Following MRW, we set $(g + \delta)$ to be equal to 0.05 and assume this value to be the same for all countries and years in our sample. Finally, as our proxy for human capital we include the logarithm of the human capital index drawn from the PWT. This indicator is based on the average years of schooling (Barro & Lee 2010) and assumed returns to education, hence an attempt to measure 'productive' human capital.

We include *j*=4 alternative indicators for entrepreneurship ent_{it}^{j}. Data have been obtained from the Global Entrepreneurship Monitor (GEM), the largest cross-national data collection effort in the world. GEM collects data based on surveys to representative samples of the adult population, adopting harmonized procedures. More information about GEM's methodology can be found in Reynolds et al. (2005) and Bosma (2013). The first indicator ent^{1} is the most-used one, denoting the prevalence rate of individuals who are actively involved in starting up a business, being either in the pre-start-up phase (having taken concrete steps to get the business

[2] Omitted EU-28 countries: Bulgaria, Cyprus, Malta.

started) or at most 42 months after the business started to generate income. This indicator is called Total early-stage Entrepreneurial Activity (TEA). It is important to note that this indicator is not an index – it includes all entrepreneurial activities (including informal ones) and it is not contended that higher TEA rates should always be associated with higher rates economic development or growth. Indicators ent^2 and ent^3 nuance TEA in terms of motivation (opportunity-motivated rather than necessity-motivated) for engaging in entrepreneurship and in ambitious entrepreneurship (growth expectations), respectively. Indicator ent^4, finally, denotes the rate of entrepreneurial employee activity: the prevalence rate of individuals who, as an employee, are actively involved in developing new products and services. This entrepreneurship indicator is however only available for a very limited number of years. This is because the EEA measure was introduced only in 2011 and adopted systematically in GEM since 2013.

One might argue that treating drivers of economic growth as rather isolated forces is against the systemic nature of economic growth, for which a large number of institutions and production factors need to be in place and in sync (Stam 2015; Acs et al. 2017). The influence of institutions and entrepreneurship can be dealt with in many ways: one way is to combine institutions and entrepreneurship into an interdependent system of complementarities as applied in the global Entrepreneurship Index (GEI) (Acs, Autio and Szerb 2014; Acs et al. 2017). A second way is to treat institutions as enabling and constraining entrepreneurship, which then subsequently drives economic growth, with entrepreneurship thus mediating the effect of institutions on economic growth (Aparicio et al 2016). A third way is to see institutions as a means to affect the allocation of entrepreneurial activity within a society over unproductive and productive economic activities (Baumol 1990), with the latter type of activities driving economic growth.

In this report we build on traditional economic growth models (Mankiw, Romer and Weil 1992; Islam 1995), and add entrepreneurship as an explanatory factor, but with also taking into account institutions as a formative element, in the same way as recent empirical studies (Aparicio et al 2016), and comparing this to the approach in which institutions are combined with entrepreneurship as drivers of economic growth (Acs et al. 2014; Acs et al 2017). In the third and fourth step, indicators measuring relevant formal institutions, informal institutions, and control variables, most of them also elements in the Global Entrepreneurship Index, will also be included into the estimation.

Our measures of formal institutions are taken from the Fraser Institute Economic Freedom project: https://www.fraserinstitute.org/economic-freedom/map. The index published in Economic Freedom of the World measures the degree to which the policies and institutions of countries are supportive of economic freedom. The cornerstones of economic freedom are personal choice, voluntary exchange, freedom to enter markets and compete, and security of the person and privately owned property. All variables come from third party sources, such as the International Country Risk Guide, the Global Competitiveness Report, and the World Bank's Doing Business project. We take three specific measures from this source, 'size of government', 'regulation of credit, labour, and business', and 'access to sound money'. Highers score for low government

presence (size of government) indicate “small general government consumption”, “small transfer sector”, “few government enterprises”, and “low marginal tax rates and high income thresholds”. Higher score for ‘regulation of credit, labour, and business’ indicate “high percentage of deposits held in privately owned banks”, “low foreign bank license denial rate”, “private sector’s share of credit is close to the base-year-maximum”, “interest rates is determined primarily by market forces and the real rates is positive”, “low impact of minimum wage”, “no price controls or marketing boards”, and “starting a new business is generally easy”. Higher score for ‘access to sound money’ indicate “low annual money growth”, “low or no variation in the annual rate of inflation”, “low inflation rate”, and “foreign currency bank accounts are permissible without restrictions”. The scores are obtained from various sources, based on an objective assessment of existing rules and regulations in the different areas mentioned above. The scores can range between 0 and 10.

Information on informal institutions that are also included in GEI were taken from the GEM. We include the following three measures of informal institutions: ‘fear of failure’ when it comes to start a business, ‘perceived knowledge and skills’ to start a business, and ‘entrepreneurship as a good career choice’. We measure fear of failure as the percentage of population perceiving good opportunities who indicate that fear of failure would prevent them from setting up a business. The perception of people’s capabilities is captured by measuring the percentage of the population who believe they have the required skills and knowledge to start a business[3]. Entrepreneurship as a good career choice is include as the percentage of the population who believe that entrepreneurship is considered as a good career choice in their country. Finally, we control for unemployment by including the rate of unemployment as percentage of total labour force. Descriptive statistics of variables that enter equation 3a are shown in Table 3[4]. Correlations between independent variables are generally low and multicollinarity issues are not present. Perhaps most interesting is that the EEA indicator appears to have the strongest correlations with the three performance indicators (1-3), and all with a positive sign.

[3] It should be acknowledged that this measure may encompass different elements: it may reflect (subjective) skills, the difficulty of starting a business (minimum capabilities needed) in a given context and even the awareness of the difficulty or easiness of starting a business. In some contexts it may also reflect ‘overconfidence’ on the aggregate level.

[4] Here, variables 2 (GDP per capita growth) and 3 (labour productivity) represent alternative measures of economic performance. Models explaining these performance measures have been analysed as a check for robustness (se Appendix I)

Table 3 Descriptive Statistics Growth Equation

	Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8	9
1 ln (GDP pc)	10.36	0.32	9.52	11.46									
2 Δln (GDP pc)	0.00	0.00	-0.01	0.02	-0.29								
3 ln Productivity	11.17	0.25	10.38	11.74	0.94	-0.31							
4 ln Capital form.	-1.40	0.19	-1.94	-0.93	0.11	0.26	0.03						
5 ln Popgr	0.00	0.01	-0.04	0.01	0.27	-0.21	0.31	0.03					
6 ln Human cap.	1.15	0.10	0.8	1.32	0.24	0.00	0.15	-0.22	-0.03				
7 ln TEA	1.78	0.38	0.34	2.66	-0.14	0.17	-0.15	-0.15	-0.25	0.06			
8 ln TEA-opp	1.49	0.38	-0.21	2.43	0.06	0.12	0.01	-0.06	-0.18	0.09	0.93		
9 ln TEA-jobgr	2.94	0.51	0.24	3.88	-0.12	0.19	-0.13	0.01	-0.17	0.29	0.21	0.21	
10 ln EEA	1.54	0.58	-0.27	2.78	0.46	0.24	0.34	0.46	0.07	0.38	-0.11	0.12	0.21

Descriptive statistics of the variables that enter equation 3b (Table 4) also suggest no particular dangers of multicollinearity. We observe that the variables expressing formal institutions (regulation of credit, labour and business and low size of the government) and informal institutions relevant to entrepreneurship (perceived startup skills, fear of failure, entrepreneurship as a good career choice) are positively associated with – in particular – the more generic measures of entrepreneurship denoting (opportunity-motivated) early-stage entrepreneurial activity.

Table 4 Descriptive Statistics Entrepreneurship Equation

		Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8	9	10	11
1	ln TEA	1.78	0.38	0.34	2.66											
2	ln TEA-opp	1.49	0.38	-0.21	2.43	0.93										
3	ln TEA-jobgr	2.94	0.51	0.24	3.88	0.21	0.21									
4	Ln EEA	1.54	0.58	-0.27	2.78	-0.11	0.12	0.21								
5	Regulation	7.24	0.61	5.47	8.6	0.06	0.19	0.27	0.55							
6	Low gov size	5.06	0.95	2.84	7.42	0.32	0.24	0.13	-0.26	-0.09						
7	Sound money	9.42	0.41	7.78	9.86	0.00	0.12	-0.17	-0.09	0.19	-0.08					
8	ln fear failure	3.69	0.23	2.98	4.28	0.29	0.17	-0.10	-0.72	-0.31	0.38	0.13				
9	ln startup skill	3.72	0.21	2.68	4.11	0.44	0.41	0.13	-0.21	-0.10	0.22	-0.06	0.19			
10	ln career choice	4.06	0.19	3.45	4.45	0.18	0.14	-0.13	-0.11	-0.18	0.13	-0.09	0.17	0.22		
11	ln unempl.	2.1	0.44	0.74	3.3	0.15	-0.01	-0.11	-0.60	-0.39	0.21	-0.11	0.52	0.14	0.00	
12	ln Human cap.	1.15	0.1	0.8	1.32	0.06	0.09	0.29	0.38	0.36	-0.13	-0.05	-0.11	-0.04	-0.37	-0.26

4. Results

Given our data availability, adopting annual data between 2004-2014 for 25 EU countries, we first reproduce the panel data structure model introduced by Islam (1995). Bearing in mind the different time frame and set of countries, the estimates shown in Table 5 in Model 1 compare rather well with those reported in Table IV (22 OECD countries, five time periods) of Islam's paper. The estimated coefficient of the lagged dependent variable equals 0.72 (0.59 in Islam 1995) and is significantly different from one, suggesting convergence – all else being equal. The share of gross capital formation is also positively linked to economic growth: a one percent increase in this share is associated with 0.16 percent increase in GDP per capita (0.12 in Islam 1995). The effect of population growth is, as in Islam 1995, not significant. For human capital, we take a different variable, based on years of schooling (Barro-Lee 2013) and assumed returns, and find a strong positive effect on economic growth.

Adding different types of entrepreneurship to the equation in Models 2a-2d, we observe that the more generic indicators of early-stage entrepreneurship (TEA and opportunity-motivated TEA), add more to the equation than ambitious (TEA with job growth expectation) and EEA (intrapreneurship)[5]. However, we should add that in Model 2d, we are forced to use a smaller sample due to limited data availability. Based on the results in Table 5, a few observations can be made. First and foremost, we do find evidence for entrepreneurial activity to impact GDP growth in EU countries, over and above the impact of the traditional input factors. This is in congruence with some other recent work like Aparicio et al. (2016) and Erken et al. (2016). The estimated size of the effect appears to be limited on first inspection but seems roughly in line with expectations: a ten-percent increase in a country's TEA rate (which is realistic given the within-country variation) would, based on the results in Model 28, result in a 0.18 percent increase in GDP per capita. This is statistically significant, but a rather limited effect on the economy at large.

A second observation is that the variance of GDP growth in EU countries explained by entrepreneurship overrides a modest part of the impact ascribed to human capital in Model 1. Other input factors seem far less affected. Thus, we may tentatively conclude that the impact of entrepreneurship on growth mostly links to the human capital. Seeing entrepreneurship as a specific type of human capital has a long legacy in economics, going back to Marshall (1920) and Schultz (1975). Still, as shown in Figure 1 our model is not complete at this stage: entrepreneurship is treated as an independent variable, while the literature described in the previous section clearly suggests it is not. We have not yet incorporated the institutional settings that provide an incentive structure for entrepreneurship. We do this in two steps: we first explain the country variation in entrepreneurship, by regressing our four indicators of entrepreneurship on the most widely reported institutional determinants. Second, we integrate the growth equation and the entrepreneurship equation in a three-stage least squares setting.

[5] A likelihood ratio test confirms this: Models 2a and 2b produce a significantly better model fit in comparison to Model 1

Table 5 Estimation results. Dependent variable: GDP per capita in purchasing power parities (PPP), in logarithm

	Model 1	Model 2a	Model 2b	Model 2c	Model 2d
Lagged GDP per capita (ln)	0.72 (11.11)**	0.70 (10.07)**	0.71 (10.12)**	0.70 (11.25)**	0.63 (5.78)**
Share of gross capital formation (ln)	0.16 (9.23)**	0.16 (8.31)**	0.16 (8.43)**	0.17 (9.79)**	0.08 (1.38)
Population growth (ln)	-0.37 (0.32)	-0.76 (0.73)	-1.01 (0.97)	-0.06 (0.05)	-2.82 (0.59)
Human capital Index (ln)	0.84 (3.76)**	0.78 (3.35)**	0.78 (3.35)**	0.88 (3.93)**	1.75 (1.64)
TEA rate (ln)		0.018 (2.43)*			
Opportunity motivated TEA (ln)			0.018 (2.76)*		
Growth expectation TEA (ln)				0.011 (1.35)	
Intrapreneurship (ln)					0.017 (1.70)
Constant	2.15 (4.51)**	2.38 (4.54)**	2.37 (4.53)**	2.29 (5.21)**	1.87 (2.04)+
F statistic	236.2	193.5	195.8	237.2	40.5
Adjusted R-squared	0.888	0.890	0.891	0.889	0.851
N	210	210	210	210	56

+ $p<0.1$; * $p<0.05$; ** $p<0.01$; T-values in parentheses

As a prelude to the simultaneous equation modelling in equation 3, Table 6 presents the results of a linear model explaining national rates of entrepreneurship (i.e. equation 3b only). We include year dummies in order to account for business cycle effects that are likely to dominate effects caused by changes in institutions. Thus, the variance explained by institutions can mainly be attributed to differences across countries. We find that general policies reflected lower 'sizes' of the government tend to go together with more entrepreneurial activity. The effect of the latter, however, is not significant for entrepreneurial employee activity. This makes sense, as larger presence of the government in economic activities, and the safety nets associated with it, are not expected to discourage entrepreneurial employee activity (EEA) per se. As expected we do see that EEA, like the other types of entrepreneurship, benefit from business friendly regulations with respect to getting credit and hiring and firing of employees.

Table 6 Determinants of different types of entrepreneurship: evidence from 25 EU countries, 2003-2014

	TEA	Opportunity-motivated TEA	Growth-expectation TEA	Entrepreneurial Employee Activity
Formal Institutions				
Regulation of Credit, Labor and Business (current)	0.17 (2.80)*	0.20 (3.00)**	0.27 (3.06)**	0.40 (2.40)*
Low size of Government: Expenditures, Taxes and Enterprises (current)	0.11 (4.22)**	0.10 (2.98)**	0.11 (2.65)*	-0.10 (1.25)
Access to Sound Money (current)	-0.02 (0.18)	0.05 (0.43)	-0.43 (4.42)**	-0.13 (0.75)
Informal institutions				
Fear of failure (self-perception)	0.01 (0.04)	-0.08 (0.59)	-0.39 (1.84)+	-1.49 (4.06)**
Startup skills (self-perception)	0.73 (5.64)**	0.78 (6.21)**	0.16 (0.62)	0.80 (1.27)
Entrepreneurship believed to be a good career choice	0.29 (1.70)	0.20 (1.21)	-0.10 (0.46)	-0.21 (0.36)
Controls				
Unemployment rate (ln)	0.03 (0.30)	-0.09 (0.91)	0.08 (0.80)	-0.37 (1.56)
Human Capital (ln)	0.17 (0.55)	-0.09 (0.36)	0.99 (1.30)	-0.05 (0.07)
Year dummies (base year is 2003)				
2004.year	0.04 (0.39)	0.01 (0.10)	-0.40 (2.71)*	
2005.year	0.10 (1.07)	0.04 (0.40)	-0.36 (2.19)*	
2006.year	0.13 (1.15)	0.09 (0.75)	-0.23 (1.73)+	
2007.year	0.08 (0.84)	0.03 (0.26)	-0.23 (1.71)+	
2008.year	0.23 (1.86)+	0.21 (1.47)	-0.28 (2.10)*	
2009.year	0.19 (1.68)	0.12 (0.90)	-0.29 (2.03)+	
2010.year	0.10 (0.87)	0.08 (0.57)	-0.15 (0.97)	
2011.year	0.36 (3.38)**	0.32 (2.40)*	0.08 (0.49)	
2012.year	0.44 (3.59)**	0.43 (3.05)**	-0.06 (0.38)	0.10 (0.83)
2013.year	0.46 (4.16)**	0.43 (3.13)**	-0.12 (0.93)	0.15 (1.93)+
2014.year	0.47 (4.34)**	0.42 (3.24)**	-0.01 (0.09)	-0.16 (1.73)+
Constant	-4.35 (2.82)**	-4.30 (3.32)**	4.58 (1.98)+	4.77 (2.00)+
F statistic	24.0	72.5	32.4	17.0
Adjusted R-squared	0.507	0.448	0.330	0.650
N	208.000	208.000	207.000	55.000

+ $p<0.1$; * $p<0.05$; ** $p<0.01$; T-values between parentheses

Perceiving to have skills and knowledge to start a business resonates well with observed (opportunity motivated) entrepreneurship rates. Apparently self-efficacy is an important element of national informal institutional settings. Fear of failure when it comes to start a business is negatively linked to both growth-expectation TEA and to EEA. Apparently, this fear of failure also expresses fear of failure linked to developing new initiatives as an employee and hence seems to go beyond the risk-reward assessment of starting an own business. Access to sound money is not significant, except for the model explaining growth-expectation entrepreneurship. Whereas a positive sign was expected (higher levels of access and more stability are hypothesized to induce more entrepreneurship), a negative relationship was found.

Taking into account the effect of institutional structures, TEA rates have been structurally higher since 2011. Further analysis should demonstrate if this is due to a (post) economic crisis effect, or for example to a higher presence of Eastern European EU countries in the sample (and not fully reflected by the institutional variables). The variance explained is within the acceptable range given results from other studies summarized in Table 1, even though we should acknowledge that an important part of the variance remains unexplained. Various other variables have been included in alternative specifications. These did not appear to increase the model fit and/or resulted in multicollinearity issues[6].

Given that Models 2a and 2b yielded the best model fits in the panel structure specification (equation 2) in Table 5, and the explained variance in the models explaining different types of entrepreneurship is highest for the TEA measure, we opt to include this measure in our model explaining entrepreneurship and economic growth simultaneously. Table 7 shows that while the effects of lagged GDP and financial capital (share of gross capital formation) are very similar to those in Table 5, accounting for institutional determinants of TEA changes the picture for the influence of both entrepreneurship and human capital. Entrepreneurship now fully drives the nexus of entrepreneurship, human capital and growth. This is also reflected in the estimated size of the impact of entrepreneurship on growth, that has increased substantially. Model 3c introduces informal institutions and demonstrates the importance of cultures that express high levels of perceived skills to start a business. Taking this model we also tested for a moderation effect: however, Models 4a and 4b do not provide support for the notion that the *combination* of human capital and entrepreneurship is particularly good for growth (over and above the main effects).

[6] Measures that entered the regression included corruption, associational activity, trust and informal investments. Including these measures either led to insignificant results, multicollinearity issues, and/or a significant loss in the number of observations. The variables included in the final model were chosen based on alignment with the literature and yielding an acceptable number of observations in our country-year data structure.

Table 7 Institutions, entrepreneurship and growth: results of the simultaneous equation model

Growth equation	Model 3a	Model 3b	Model 3c	Model 4a	Model 4b
Lagged GDP per capita (ln)	0.72	0.67	0.66	0.65	0.66
	(12.31)**	(12.62)**	(16.18)**	(15.22)**	(16.90)**
Share of gross capital formation (ln)	0.10	0.09	0.14	0.14	0.14
	(2.91)**	(3.62)**	(5.09)**	(5.18)**	(5.18)**
Population growth (ln)	-1.41	-1.56	-0.99	-1.05	-0.96
	(1.06)	(1.55)	(0.99)	(0.99)	(0.99)
Human Capital Index (ln)	-0.13	-0.19	0.28	0.29	0.29
	(0.55)	(0.96)	(1.14)	(1.20)	(1.20)
Entrepreneurship (TEA, ln)	0.21	0.20	0.11	0.12	0.11
	(3.17)**	(6.67)**	(5.03)**	(4.76)**	(5.06)**
Entrepreneurship * Share of gross capital formation				0.03	
				(0.84)	
Entrepreneurship * Human Capital					-0.09
					(0.84)
Constant	3.04	3.50	3.58	3.63	3.60
	(5.10)**	(6.38)**	(8.70)**	(8.28)**	(9.13)**
Entrepreneurship equation					
Control variables					
Unemployment	-0.15	-0.09	-0.08	-0.08	-0.08
	(3.22)**	(1.80)+	(1.19)	(1.19)	(1.20)
Human Capital	-0.13	-0.09	-0.05	-0.06	-0.04
	(0.35)	(0.32)	(0.18)	(0.19)	(0.13)
Formal Institutions					
Regulation of Credit, Labor and Business		0.09	0.14	0.14	0.14
		(3.98)**	(5.57)**	(5.63)**	(5.11)**
Low size of Government		0.13	0.15	0.15	0.15
		(5.11)**	(6.45)**	(6.31)**	(6.35)**
Access to Sound Money		0.01	-0.01	-0.01	-0.01
		(0.37)	(0.22)	(0.17)	(0.20)
Informal Institutions					
Fear of failure			-0.02	-0.02	-0.02
			(0.25)	(0.28)	(0.26)
Perceived startup skills			0.48	0.47	0.47
			(3.84)**	(3.79)**	(3.96)**
National belief: entrepreneurship good career choice			0.13	0.13	0.13
			(1.06)	(0.98)	(1.06)
Constant	0.43	-0.98	-4.06	-4.05	-4.01
	(3.54)**	(2.96)**	(4.33)**	(4.42)**	(4.41)**
Model parameters					
ln(σ1)	-2.62	-2.74	-3.19	-3.18	-3.19
	(8.31)**	(19.41)**	(32.75)**	(31.10)**	(34.01)**
ln(σ2)	-1.06	-1.17	-1.26	-1.26	-1.26
	(15.22)**	(18.39)**	(20.86)**	(21.08)**	(21.03)**
Atan(ρ)	-1.97	-1.90	-1.43	-1.45	-1.43
	(5.69)**	(12.45)**	(7.26)**	(6.94)**	(7.76)**
N	251	251	230	230	230

+ $p<0.1$; * $p<0.05$; ** $p<0.01$; T-values between parentheses. Year dummies included in the entrepreneurship equation, country dummies included in the growth equation. Variables included in the interaction terms in models 4a and 4b have been mean-centred at zero.

We also tested for the significance of the mediation effects represented by the institutional settings impacting economic growth through entrepreneurship. For both the two formal institutions and the perceived skills among the population we found the effect to be statistically significant ($p<.05$). Improving each of these institutional components by ten percent is estimated to lead to an increase in GDP per capita (via entrepreneurship) with 1.1 percent (in the case of regulation of credit and labor component) and 0.8 percent (in the case of the size of the government). However, one should bear in mind that changing these formal institutions by ten percent is a very ambitious goal that usually requires multiple years of consistent and serious commitments towards improving the institutional structure[7]. In addition, in particular as regards the size of the government, the policy debate should be broader than just narrowing down on stimulating economic growth. Size of government may also affect income inequality, for example; smaller government spending is associated with a rise of the top 10% share of income (Roine et al 2009)[8].

As regards the informal institutions, we estimated the mediation effects for the single significant variable in the entrepreneurship equation: the degree to which individuals perceive to have the skills to start a business. This variable arguably includes two dimensions; awareness of what entrepreneurship entails and self-efficacy. Increasing this rate by 10 per cent (which is a realistic assumption given observed variation within countries) would increase GDP per capita with 0.5 percent via entrepreneurship. Thus, nurturing a culture of entrepreneurship that stimulates awareness and perceived capabilities can have effects on GDP per capita. Even though debating how this may be achieved is beyond the goal of this paper, one discussion that is taking place is whether or not to integrate knowledge on, and examples of, entrepreneurship better in primary schools (mostly aged 8-12), where individual ambitions can still be influenced (Stam et al. 2012). This is certainly not a direct implication we can take from our analysis, at the same time our results seem to be in congruence with this notion. Taking all results in consideration, this report has identified a combination of formal and informal institutional settings that impacts GDP per capita, via an entrepreneurial mechanism

[7] Indicators range from 0 to 10, however we observe limited variation in the indicators over time: absolute averages of changes in a five-years period equals to 0.33 for the regulation variable, with a maximum of 1.75. The average value of this indicator equals 7.2. Hence in a five-years period the average (absolute) change equals 4.5%.

[8] An additional panel data regression for the countries and years in our sample confirms this: government size increases inequality indicators defined by Gini coefficients (retrieved from the World Development indicators) and shares in GDP of the top 10%, while GDP growth does not.

5. Conclusion

In this paper we have looked into the hypothesis that institutions drive high quality entrepreneurship that in turn promotes economic growth. In order to do so, we first augmented the well-established model of Islam (1995) and included various measures of entrepreneurial activity in the panel regressions he suggested. We then proceeded by adding an equation accounting for the effect of institutions on entrepreneurial activity. We showed for a sample of 25 EU countries, covering 2003-2014, that combined regulation of credit, labour and business positively affects (high quality) entrepreneurship, while the size of the government is negatively linked to entrepreneurship. Moreover, nurturing a culture of entrepreneurship that stimulates awareness and perceived capabilities was found to be conducive to entrepreneurial activity. We also found a positive link between entrepreneurship and GDP per capita, also after controlling for the abovementioned institutional effects on entrepreneurial activity.

In fact, by explicitly taking institutional effects into account, the variation in national economic growth explained by entrepreneurship increased (at the cost of the variation in national economic growth explained by human capital). In terms of directions for policy, this combination of findings potentially signals that education should not only be directed towards cognitive skills about 'what we know' (which is merely reflected in the indicator of human capital), but also towards appreciating the unknown and about recognizing (business) opportunities and challenges, as well as teaching approaches to evaluate and exploit such opportunities and challenges. Greater attention to such soft and hard skills, possibly starting from primary education during the ages of 8-12 where ambitions can still be influenced, would raise the awareness and appreciation of individuals' own skills and knowledge required for (ambitious) entrepreneurship. This, paired with regulations around credit, labour and business that are 'friendly' for entrepreneurs – yet at the same time fair to all other stakeholders – seems to be a mix that could optimize continuous experimenting, leading to renewal of economic activities and in the end increase per capita income.. Given our results, increasing the perceived skills by 10 percent could result in growth of GDP per capita of 0.5 percent and relaxing the regulations around credit, labor and business by 10 percent could result in additional growth of 1.1 percent. Thus, we identify a combination of formal and informal institutional settings that impacts GDP per capita, via more and better entrepreneurship.

As regards the size of the government and its impact on growth via entrepreneurship, the policy debate should be broader than just narrowing down on stimulating economic growth. Size of government may also affect income inequality, and we provide some evidence that this may indeed be the case. As always, policy makers should look at the broader impact of potential interventions.

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Appendix I Growth model adopting alternative growth measures

Table I.1 Dependent variable: annual GDP per capita growth, panel data fixed effects

	lngdppcgr	lngdppcgr	lngdppcgr	lngdppcgr	lngdppcgr
lncsh_i	0.01	0.01	0.01	0.01	0.01
	(5.37)**	(5.21)**	(5.19)**	(5.45)**	(0.76)
lnpopgr	-0.29	-0.30	-0.32	-0.29	-1.09
	(1.83)+	(1.96)+	(2.04)+	(1.86)+	(1.96)+
lnhc	-0.01	-0.02	-0.02	-0.01	-0.02
	(1.88)+	(1.63)	(1.73)+	(2.00)+	(0.37)
lntea		0.00			
		(0.58)			
lntea_opp			0.00		
			(0.89)		
lntea_hjg				0.00	
				(0.08)	
lneea					0.00
					(0.36)
Constant	0.03	0.036	0.037	0.036	0.027
	(4.39)**	(3.97)**	(3.93)**	(4.71)**	(0.56)
F statistic	14.1	13.7	11.8	17.1	1.6
Adjusted R-squared	0.211	0.209	0.211	0.211	0.114
N	251.000	251.000	251.000	250.000	63.000

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

Table I.2 Dependent variable: annual productivity levels, panel data fixed effects

	lnproductivity	lnproductivity	lnproductivity	lnproductivity	lnproductivity
lncsh_i	0.03	0.02	0.02	0.03	-0.09
	(0.41)	(0.42)	(0.40)	(0.44)	(1.06)
lnpopgr	-4.83	-5.91	-6.34	-4.45	-0.45
	(1.23)	(1.52)	(1.71)	(1.12)	(0.07)
lnhc	3.14	2.94	2.96	3.07	4.32
	(8.07)**	(7.58)**	(7.54)**	(8.66)**	(3.61)**
lntea		0.05			
		(2.09)*			
lntea_opp			0.04		
			(1.80)+		
lntea_hjg				0.03	
				(2.86)**	
lneea					0.04
					(2.67)*
Constant	7.60	7.740	7.739	7.593	5.863
	(15.98)**	(16.98)**	(16.76)**	(17.10)**	(4.32)**
F statistic	29.6	21.4	21.6	27.0	29.6
Adjusted R-squared	0.685	0.705	0.701	0.693	0.724
N	251.000	251.000	251.000	250.000	63.000

Productivity is measured as ln (expenditure side real GDP in PPP / employment-persons).

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

Note: Even though these results support the findings in Aparicio et al. (2016), introducing the lagged dependent variable renders the estimates to entrepreneurship to be insignificant:

Table I.3 Dependent variable: annual productivity levels, panel data fixed effects – including lagged dependent variable

	lnproductivity	lnproductivity	lnproductivity	lnproductivity	lnproductivity
L.lnproductivity	0.76	0.75	0.75	0.76	0.64
	(22.65)**	(21.81)**	(22.61)**	(24.45)**	(4.13)**
lncsh_i	0.06	0.06	0.06	0.06	-0.01
	(5.78)**	(5.53)**	(5.50)**	(5.76)**	(0.14)
lnpopgr	-3.41	-3.73	-3.86	-3.41	-5.91
	(5.34)**	(5.42)**	(5.37)**	(5.37)**	(1.04)
lnhc	0.77	0.75	0.75	0.78	0.50
	(5.81)**	(5.28)**	(5.20)**	(5.82)**	(0.32)
lntea		0.009			
		(1.41)			
lntea_opp			0.009		
			(1.37)		
lntea_hjg				0.001	
				(0.16)	
lneea					0.012
					(0.94)
Constant	1.91	2.06	2.06	1.92	3.37
	(7.16)**	(7.15)**	(7.35)**	(8.09)**	(3.77)**
F statistic	672.8	545.4	553.8	716.1	78.6
Adjusted R-squared	0.917	0.917	0.917	0.916	0.810
N	210.000	210.000	210.000	210.000	56.000

Productivity is measured as ln (expenditure side real GDP in PPP / employment-persons).

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