Effectual Upshots on Firm Performance: A determinative perspective of Business Model Innovation

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[Abstract]

This paper analyzes the relationship between business model innovation and firm performance in terms of both cost and profit efficiency. Unlike previous studies, the present analysis is carried out within a stochastic frontier framework, while we use a suitable econometric model to solve for possible endogeneity issues. The empirical framework is applied to an industry-wide sample of UK firms during the period 2002-2009. The paper, firstly, documents a positive correlation between business innovation and cost and profit efficiency. Secondly, we investigate the effect of individual, organizational and country level characteristics on business model innovation. Using dynamic frameworks, the empirical analysis reveals that business model innovation is affected by the size of the company and the human capital. The board structure plays a crucial role as well as the presence of foreign owners, by contrast to increased ownership concentration which seems to exert a negative influence. Moreover, we find that GDP enhance business innovation. Finally, we identify a positive impact of certain industries on innovation, based on individual investments on R&D.

JEL Classification: O32; O31; G32; L25; L21.
Keywords: Business Model Innovation; R&D; Performance; Efficiency.

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1. Introduction

In the era of business evolution many researchers have placed great emphasis on the contribution of business model innovations to an organization's overall performance outcomes. Business model innovations are simply redefinitions of what an existing product, service or process is and how it is provided (and marketed) to customers (Marcedis, 1997; 1998; 2006). More specifically, such models translate the intrinsic value of an innovative concept into a commercial good by securing economic value not only for the launch firm itself but also for the ultimate users, the stakeholders and the partners. Indeed, the existing research body leads to a consensus that organizations with the ability to effectively manage business model innovation portfolios (already developed or that planned to be lunched) gain a better claim to superior innovativeness, superior effectiveness and efficiency as well as superior customer responsiveness.

Focusing on the business model itself, which allows an organization to maximise its businesses, it is posited out that for such a model to be effective an organization should undertake specific innovative actions. That is to say, business models should be conducted under specific market conditions (to penetrate new segments), to take place within the constraints of limited time (to gain the first-mover advantage) and in a coordinated sequence of actions (to avoid imitations by the competitors). Although the organization's ability to gain access to and offer attractive innovative business models often promises organizational success (as it has found to improve firm performance), the organizational antecedents able to business model innovation have rarely considered and investigated. A plausible explanation could be the tendency by many researchers to focus on the antecedents of the business model itself (e.g. the design as it has been offered by Amit and Zott, 2002a; 2002b), combined with the rationale to offer a sufficient rigorous analysis on a direct relationship between the two variables that of business model innovation and performance.

Without underestimating the existing work on business model innovation, but aiming to expand it one step further, three spectrums of factors are taken into consideration: the individual, the organizational and the country level factors. Closely related to these elaborating spectrums of factors is the rationale behind many researches which indicates that, in general terms, organizational characteristics influence business innovation.

The aforementioned elements sum up the complexity of the concept of business model innovation by also indicating that its effectiveness is the outcome of different factors related to

either the external or internal organizational environment. Additionally, it is worth mentioning that business model innovation as a type of innovation (along with the product, service or process innovation) can be launched by innovative performers which operate in any conventional factor.

As we learn more about the dynamics of business evolution, three interrelated characteristics are receiving increasing attention, namely business model innovation, performance and organizational characteristics. Yet, researchers have not examined empirically whether and how individual, organizational and country level characteristics, such as human capital, board structure, risk variables and ownership interact with business innovation in shaping firm performance. The empirical analysis is carried in a large dataset of UK listed firms over the period 2002-2009. Also, to account for the fact that static econometric frameworks may be insufficient to capture the dynamics of the business model innovation, we apply a dynamic framework.

Despite this renowned interest in the role of business model innovation and its influence on firm performance, the empirical studies have not embraced the large literature on the measurement of performance using stochastic frontier methods. The main reasoning is that frontier measures use statistical techniques that remove the effects of differences in prices and other exogenous market factors affecting the standard performance ratios and, therefore, they are capable of characterizing the underlying production relationship (e.g., Bauer et al., 1998; Fried et al., 1993).

Two final distinguishing characteristics of this study are worth noting. First, advances in Stochastic Frontier Analysis (SFA), which is the method used in the present paper, allow controlling for a number of firm-level and industry determinants of efficiency. In addition, we augment the usual stochastic frontier methods to account for the possible endogeneity between firm performance and business model innovation. By employing the Stochastic Frontier Analysis and particularly the model of Battesse and Coelli (1995) we investigate cost and profit efficiency and the influence of business model innovation . This allows the estimation of firm-specific deviations from cost and profit optima, so-called inefficiency. In other words, in contrast to previous literature we model business model innovation as cost and profit efficiency determinants rather than direct cost and profit determinants. This is important since profitability and profit efficiency measure different dimensions of performance. For instance, even a relatively profitable firm may still not have realized its full potential compared to peers given observed production

plan choices and profits. Recent theories of business model innovation assert that firms especially engage in 'strategic' or 'profit-maximizing' innovations. Basically, the argument is that both costs and revenues are affected by engaging in business innovations. Costs will increase because the changes of production processes require money. However, innovation is also expected to have a positive impact on earnings too.

The key objective of our paper is to solve two issues. First estimate the determinants of business model innovation. Second whether innovative behavior influences performance. To this extent, as it has already been aforementioned a Stochastic Frontier Analysis which investigates both cost efficiency and profit efficiency is applied. Therefore, this study is the first to analyze cost and profit efficiency for a prolonged period of time on an industry-wide basis. We also include a set of industry dummies as to account for systematic cost differences that are not due to the innovative attitude of firms.

The rest of the paper is organized as follows. The following section demarcates the general framework of the business model innovation considered. Section 3 presents the empirical model and discusses the data sources. Section 4 discusses the empirical results and Section 5 concludes the paper.

2. Business Model Innovation (a brief literature review)

Even if the field of innovation is very broad and densely populated, a sufficient definition in order to conceptualize the different types of innovation and to describe the different aspects of their operation is hardly possible for scholars to give. Damanpour (1991) in attempting to address the issue in question argues that "…*innovation is an adoption of an internally generated or purchased device, system, policy, program, process, product, or service that is new to the adopting organization*" (Damanpour, 1991:556). Such a definition posits the multi-faceted nature of business innovation (Cooper, 1998) which includes the development of new ways of doing business, i.e. by developing products effectively and economically (product innovation), developing and applying new methods of delivering services (service innovation), encouraging revolutionary or breakthrough improvement (process innovations), or even adapting new ways of managing strategic business resources (managerial innovation) (Davenport et al., 2004)

In this study, the case of innovation to be examined is that of business model innovation which rests in the business model itself (not in the product, service or process). Business model

innovations are not new discoveries. Rather, they are simply redefinitions of what an existing product, service or process is and how it is provided (and marketed) to customers (Marcedis, 1997; 1998; 2006). In other words, such a model addresses the issue of how the inherent value of an innovative concept can be commercialized by creating economic value for all of the interested parties (i.e. the ultimate user, firm, stakeholders and partners).

Despite the range and depth of ongoing research, few studies to date have concentrated on business model innovation *per se*. In addition, such work has essentially taken the form of small-scale analyses. Nevertheless, the concept-related evidence provided is quite meaningful and useful for further analysis of business model innovation (Weill and Vitale, 2001). Moreover, most of the earlier work on business model innovation has considered it tantamount to information technology, focusing also on e-commerce (Jang et al, 2002; Porter, 2001; Tapscott et al, 2000).

Specifically, in his two-dimensional analysis of business model innovation (functional integration and the degree of innovation), Timmers (1998) uses the e-commerce area to test the hypotheses of the study, finally concluding in eleven different Internet business model innovations. Similarly, Tapscott et al (2000), as well as Weill and Vitale (2001), taking the e-business model as a case study, describe relationships between suppliers, distributors, or customers and the major benefits to participants.

Several scholars in an attempt to differentiate their work on innovation from prior research, distanced themselves from the information technology domain and applied their studies to other areas such as logistics firms (Chapman et al., 2002) or compared business model innovation cases in different regions (Neely et al, 2001). Additionally, Zott and Amit's (2002a, 2002b) multilevel analysis linked the value that the business design themes create (for the stakeholder) to the value that the firm gains testing their research hypotheses on relatively recently established entrepreneurial firms. The same researchers examined empirically similar relationships submitting equivalent applications to emerging public growth firms (Zott and Amit, 2002b).

Another important issue to be mentioned is that of the business model innovation's typologies and taxonomies as categorized by several scholars on this topic aiming at a more methodical examination of innovations of that kind (Galbraith and Schendel, 1983; Garcia and Calantone, 2002; Miller and Friesen, 1978). Amongst the most comprehensive business model

innovation's typologies is that of Weill et al (2004) which differentiates the companies' business innovations in terms of what the business does and how the business makes money out of it.

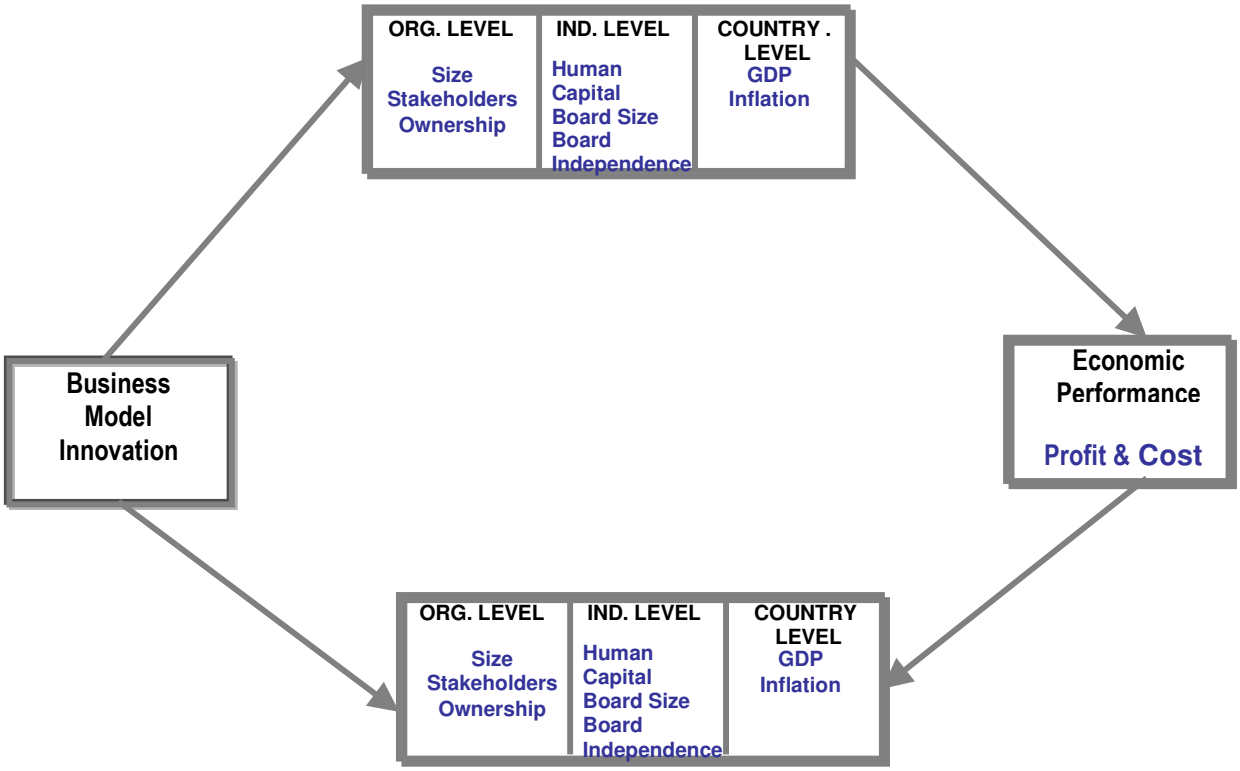
When examining studies of business model innovation, it could be argued that there is a general agreement directly related to the way that an organization makes profit. Whether it is perceived as "*a far cry from creating economic value*" (Porter, 2001) or merely "*a story about the business*" (Magretta, 2002), the most important requirement for organizations in their search for increased performance (based on its innovation projects) is to see business model innovation for what it is: an indicator of well managed and exploited internal capabilities, which further reflects the effect of the latent value of knowledge on the performance of the organization.

3. The conceptual model

According to the existing literature on business model innovation a numerous of studies (either conceptual or empirical) has considered business model innovation in the context of firm performance (e.g. Filson, 2004; Rajgopal et al., 2003; Zott and Amit, 2006). Many independent variables are taken into consideration as a separate component of business model innovation (such as the design of an entrepreneurial firm business model examined by Zott and Amit (2006) or as a spectrum of components which together consist the notion of business model innovation (such as R&D expenses). Either considering the one-dimensional or the multidimensional approach of the conceptualization of business model innovation, its effect on firm performance outcomes has intrigued many researchers. Building on, but also exceeding the existing work which investigates the effect of business model innovation, the role of potential mediators is also examined. More specifically, looking for missing variables we estimated that both the internal and the external environment in which an organization operates has to be taken into consideration. With regard to the internal environment individual and organizational level variables have been defined whilst the external environment has been illustrated through the definition of country level variables.

Additionally, our research model is grounded on two assumptions: (i) the business model innovation which is offered by the innovative organizations cause a direct and positive effect on their performance, thus the direct and positive link between business model innovation and performance is examined. (ii) the aforementioned direct and positive relationship (bidirectional

linkage) can be mediated by other variables (individual, organizational and country level variables) thus supposing an indirect effect on firm performance outcomes.



3.1 Research Hypothesis

3.1.1 Business model innovation and performance

Business model innovations which are innovative drivers for an organization concerning the business model itself (not the product, service or the process which they offer) are dealing with the way in which the hidden, latent or innate value of an innovative idea, concept or context is commercialised thus creating economic value for all the interest parties, i.e. the end users, the organization itself and the strategic partners (in the case of strategic alliances) (Marcedes, 1997; 1998; 2006). A successful business model may alter the existing economic status of a particular sector since it is hardly possible for competitors to imitate (Barney, 1991; Davenport et al, 1996; Jantunen, 2005; Merx-Chermin and Nijhof, 2005; Sharkie, 2003) or to reproduce it. This is owed mainly to the big imitation cost as well as the luck of the particular knowledge (either codified or non-codified) or know-how the reproduction of which requires.

Hence, organizations which are characterized as innovative performers, in terms of making profits based on the differentiation of their offered products, services or process, manifest high levels of business model innovation capability; that is to say, they are able to turn innovative ideas into economic returns by implementing successful business model innovation projects (e.g. Magretta, 2002; Marcedis, 2006; Zott and Amit, 2002; 2006). In other words, such an innovative movement offers competitive advantage to organizations which are able to frequently introduce new models by also gaining the first mover advantage in the market place and simultaneous entry into multinational markets. Additionally, they have the ability to be competitive in terms of price as they avoid imitations by the competitors. Drawing on the existing research on the effective innovation offerings it is assumed that organizations which are able to develop business model innovations have a direct positive effect on firm performance outcomes. Thus we, firstly, hypothesize that

Hypothesis 1: *Business Model Innovation will have a direct and positive effect on firm performance*.

A common element in the literature is that firm performance is proxied by simple accounting ratios that have been proved limited measures of firm performance. This seems odd because most performance studies have reached consensus that frontier efficiency measures are superior for most regulatory and other purposes to the standard financial ratios from accounting statements, which are commonly employed by regulators, managers and industry consultants to assess performance. The main reasoning is that frontier measures use statistical techniques that remove the effects of differences in prices and other exogenous market factors affecting the standard performance ratios and, therefore, they are capable of characterizing the underlying production relationship (e.g., Bauer et al., 1998; Fried et al., 1993). In contrast, measures such as the return on assets (ROA) or Tobin's Q do not originate from standard economic theory.

In the context of present analysis, the above consideration has at least three implications that justify analyzing the impact of business model innovation on firm performance within a frontier efficiency framework. First, financial ratios such as the return on assets (ROA) and the return on equity (ROE) suffer from the well-known conceptual shortcomings relating to the evaluation of inventories and depreciation (Destefanis and Sena, 2007; Fisher and McGowan,

1983; Pi and Timme, 1993). These ratios under-represent a firm's value because of the so-called investment myopia problem (that is, when executives overextend the useful life of their assets and delay needed new investments). If executives indulge in myopic behavior, longer-term investment decreases and frontier efficiency is capable of capturing this effect, since inventories and depreciation are accounted for in the production relationship. Moreover, a drawback to ROA is its reliance on accounting earnings and book value of assets. Accounting earnings may not reflect economic earnings and the book value of assets may not reflect market values for a variety of reasons (Pi and Timme, 1993). The above arguments imply that a study of the relationship between business model innovation and firm performance within a Stochastic Frontier framework is worthwhile.

To provide a comprehensive analysis of firm efficiency we estimate both cost and profit efficiency, using the aforementioned stochastic frontier analysis (SFA). More specifically, we build on the model put forth by Battese and Coelli (1995), as their framework permits the simultaneous estimation of the profit or cost frontier with the equations including the determinants of efficiency.

Efficiency measures are success indicators, by which the performance of individual firms can be evaluated. Overall, inefficiency implies that resources are wasted, either because firms are producing less than the feasible level of output from the resources employed, or because they are using relatively costly combinations of resources to produce a particular mix of products or services.

Cost efficiency is defined as the deviation of a firm's actual cost from the best-practice in the industry. Thus, the cost efficiency ratio measures the proportion of cost or resources that are used efficiently by the company. The general Battese and Coelli (1995) model specifies a cost frontier with the following properties:

$$\ln TC_{it} = f(W_{it}, Y_{it}) + v_{it} + u_{it} \qquad (1)$$

where TC_{it} denotes observed operating and financial cost for firm i at year t (in logarithmic terms), W_{it} is a vector of input prices and Y_{it} is a vector of outputs of the firm. The error term is distinguished in two components: v_{it} corresponds to the random fluctuations, is assumed to follow a symmetric normal distribution around the frontier ($v_{it} \sim iidN(0, \sigma_v^2)$) and captures a phenomenon beyond the control of management; u_{it}, accounts for the firm's inefficiency, which

can be controlled by management and is assumed to follow a truncated normal distribution of the form $u_{it} \sim N(m_{it}, \sigma_u^2)$.[1]

For the estimation of the cost function, we follow the literature (see e.g., Lensink et al. 2007) in using the following translog specification:[2,3]

$$\ln(TC_{it}) = a_0 + \sum_i a_i \ln W_{it} + \sum_j \beta_j \ln Y_{jt} + 1/2 \sum_i \sum_m a_{im} \ln W_{it} \ln W_{mt} + 1/2 \sum_j \sum_k \beta_{jk} \ln Y_{jt} \ln Y_{kt} + \\ + \sum_i \sum_j \delta_{ij} \ln W_{it} \ln Y_{jt} + \lambda D + \kappa T + \kappa' T^2 + v_{it} + u_{it} \quad (2)$$

Note that in the above specification we include a time trend (T) in the estimation of the frontier. Since a translog function is a second order approximation, a squared term of the trend is also included.

Contrary to the concept of cost efficiency, profit efficiency captures both the cost and revenue dimension of firm operation and therefore accounts for inefficiency originating both in the input and output side (Berger et al., 1993). In other words, profit efficiency is a broader and thus more reliable measure of firm performance that identifies how close a firm is to producing the maximum possible profit, given a particular level of input and output prices (Berger and Humphrey, 1997). The profit function of a firm takes the following general form:

$$\Pi_{it} = f(W_{it}, Y_{it}) + v'_{it} + u'_{it} \quad (3)$$

where Π_{it} is total profit of firm i in period t, and the error terms (inefficiency and remainder disturbance) follow the same assumptions as above. Note that we employ an alternative profit function in which each firm maximizes profits given output quantities, rather than taking output prices as exogenous (Berger and Humphrey, 1997).[4]

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[1] The SFA approach assumes that the inefficiency component of the error term is positive; that is, higher firm inefficiency is associated with higher cost.

[2] The standard symmetry restrictions are imposed, i.e., $a_{im} = a_{mi}; \beta_{jk} = \beta_{kj}$ (see also Berger and Mester, 1997).

[3] This specification results in a better fit of the frontier than e.g., the Cobb–Douglass form (Kumbhakar and Lovell, 2000).

[4] In most cases the alternative profit function has provided qualitatively similar results with a standard profit function; however, the alternative profit function can be employed when output price data is missing. Alternative efficiency is measured by how close a firm comes to earning maximum profits given its output levels rather than its output prices. That is, the alternative profit function employs the same dependent variable as the standard profit function and the same exogenous variables as the cost function. Thus, instead of counting deviations from optimal output as inefficiency, as in the standard profit function, variable output is held constant as in the cost function, while output prices are free to vary and affect profits (Berger and Mester, 1997). For further discussion on this issue, see Berger and Humphrey (1997), Berger and Mester (1997) and references therein.

Similarly to the case of the cost function, we specify a translog profit function of the following form:

$$\ln(\Pi_{it}+\theta+1)=a_0+\sum_i a_i \ln W_{it}+\sum_j \beta_j \ln Y_{jt}+1/2\sum_i\sum_m a_{im}\ln W_{it}\ln W_{mt}+1/2\sum_j\sum_k \beta_{jk}\ln Y_{jt}\ln Y_{kt}+$$
$$+\sum_i\sum_j \delta_{ij}\ln W_{it}\ln Y_{jt}+\lambda D+\kappa T+\kappa' T^2+v_{it}-u_{it} \quad (4)$$

Notice that, consistent with the profit efficiency literature (see e.g., Berger and Mester, 1997), we add a constant θ[5] to the profits of all firms to avoid having observations with negative net profits that would render estimation unfeasible.

In both the cost and profit efficiency models, the mean of the inefficiency term *m* is modeled as a linear function of a set of explanatory variables:

$$m_{it}=\xi_i Z_{it}+w_{it} \quad (5)$$

where w_{it} is assumed to be truncated normally distributed, with zero mean and variance σ_u^2, ξ is a vector of coefficients to be estimated, and *Z* is a vector of firm-specific and country-level factors that affect efficiency, including the proxy for the business model innovation.

There are arguments to suggest that business model innovation is endogenously determined by firm performance while economic modelling shows that the level of profitability may explain variation in innovation across firms. The usual problems of joint endogeneity could cause problems in the estimation of results. For instance, firm performance is both a result of the influence of business innovation and itself a factor that potentially influences the choice of subsequent innovative strategy. Overall, business model innovation may have an impact on firm performance and as well firm performance may influence business innovation. A causal relationship between business model innovation and firm performance when the former is assessed as exogenous should be approached with cautiousness. Therefore, besides using a stochastic frontier approach to proxy firm performance, we also opt for augmenting the estimation technique to account for the aforementioned potential endogeneity. In order to deal with the endogeneity problem we follow the proposition of Bhargava (1991), who suggests separating the Z-variables into a class of exogenous variables and a class of endogenous variables. In this framework, a third equation is estimated simultaneously with Eqs. (2 or 4) and

[5] θ indicates the absolute value of the minimum profit over all firms in the sample.

(5), which involves regressing the endogenous variable on the exogenous variables. The system can be estimated using full information maximum likelihood, under the assumption of normal standard errors.[6] Naturally, the endogenous variables in this study include the business innovation variable.

The first problem encountered in evaluating firm efficiency is the definition and measurement of output. Accordingly, we specify net sales as output; and two inputs, personnel expenses and total other expenses. The two input prices are constructed by dividing (i) personnel expenses by total assets and (ii) overheads by total fixed assets. In order to guarantee linear homogeneity we scale total costs and inputs prices by the price of labor. The elements *Z* of main interest in the present study are the measures of business model innovation. We also use as *Z* firm-level controls for capitalization and liquidity risk, so as to capture the potential interrelationship between business innovation with these basic firm characteristics. Capitalization is measured by the ratio of equity to total assets and liquidity risk by the ratio of liquid assets to total assets. Poor liquidity and low levels of capital are the two major causes of business failure. We employ country-specific controls, which include GDP per capita as a proxy for differences in the level of economic development and inflation as a proxy for the differing monetary conditions across countries.

3.1.2 The Determinants of Business Model Innovation

Apart from the direct and positive effect that the development of a business model innovation causes on the performance of an organization we estimate that there are factors which may mediate the aforementioned relationship. As we have already mentioned these factors consist of three different spectrums (individual, organizational and country level) each includes a number of different variables.

Individual Level Variables: Based on the existing literature on innovation the link between the individual level factors and innovation is firstly justified in terms of an individual's ability to create new innovative ideas which, in turn, are successfully implemented in practice (Farr and Ford, 1990). Under the same rationale, the concept of knowledge workers could also support the argument that an individual's cognitive background is fond to be one of the main antecedents for

[6] Luckily, normality is identified using a Jarque-Bera test. If normality was not identified a three-stage least squares estimator would have been the consistent method. For a thorough see Bhargava (1991).

organizational innovation. Other scholars (e.g. Dillon, 1982) have worked on individual perceptions proposed that those employed at innovative organization should realise the need for change as well as its successful implementation in an organization's daily routine and tasks. Therefore, they contribute to the generation of innovative projects. In order to expand this prior work, we link the individual factors with the business model innovation using the variables of human capital (proxied by the number of employees) and board structure (board size and board composition) estimating that each mediates the bidirectional linkage between the business model innovation and performance. Boards with many directors would be able to assign more people to supervise and advise managers' decisions, thus reducing managers' discretionary power or at least making it easier to detect managers' opportunistic behavior and increasing strategic capabilities to complement that of the CEO. In particular, board composition captured by the percentage of non-executive directors that have been nominated may have a positive bearing on the quality of corporate decision-making and strategy by (a) bringing new perspectives from other businesses, (b) constructively challenging and enriching company strategies and introducing significant sources of management experience and expertise, and (c) advancing the company's reputation and assisting in the creation of business affiliations (OECD, 2004, at pp. 64-65; UK FRC Combined Code, 2008, at p. 5).[7]

More specifically we hypothesize that:

Hypothesis 2a: *Human Capital will have a positive impact on the development of business model innovation.*

Hypothesis 2b: *Board size will have a positive impact on the development of business model innovation.*

Hypothesis 2c: *Board composition will have a positive impact on the development of business model innovation.*

Organizational Level Variables: The impact of organizational level factors on innovations has broadly approached in terms of inter-organizational collaborative arrangements (Doz and Hamel, 1998; Powell et al, 1996). Many scholars support that innovative organizations should access

[7] On the advisory role of non-executive, independent directors see, inter alia, Daily and Schwenk (1996), Johnson et al. (1996), Lawler et al. (2002), Fich (2005).

value-creating sources outside their boundaries (Gulati et al, 2000). However, the organizational characteristics (such as organizational structure, organizational size and organizational resource slack) have been investigated by many researchers as identified factors able to affect the innovative actions of an organization (Damanpour, 1988; 1991; Kim, 1980; Kimberly and Evanisko, 1981). Without underestimating the existing work on innovation but aiming at expanding this work one step further we propose that the firm size and ownership structure mediates the direct and positive effect of the creation of business model innovation and the firm performance. We employ the logarithm of total assets (*SIZE*) to capture the effect of firm size. This variable controls for cost differences as well as product and risk diversification according to the size of the firm. Moreover, the effectiveness of a firm's innovation system may be enhanced by a number of internal and external mechanisms such as the presence of large shareholders and a well-functioning ownership structure. Two different measures of ownership structure that reveal important information have been used: the percentage of independence and the percentage of foreign ownership. Concentrated ownership can affect the governance of the firm since it provides the largest shareholders with too much discretionary power over using firm resources in ways that serve their own interest at the expense of other shareholders. Second, the identity of owners is also likely to influence the performance of firms. Foreign investors require high information disclosure standards and, for reputational concerns, maintain a strict control of managers' actions (Dyck, 2001). However, domestic firms have the general advantage of better information about their country's economy, language, laws and politics (Lensink et al., 2008). A foreign firm's technological edge is strong enough to overcome any informational disadvantage. One potential advantage for foreign firms is that their organizations may be able to diversify and absorb risks across nations and regions of the world. These may include managerial expertise and experience, a well-developed business plan, superior access to capital, ability to make larger loans, a seasoned labor force, market power over suppliers, superior managerial expertise/experience, access to capital, use of hard-information technologies, and ability to diversify risk. Turning to potential disadvantages for foreign firms, these institutions are sometimes located at significant distances from their organization headquarters. This may be associated with organizational diseconomies to operating or monitoring from a distance, although some evidence suggests that this disadvantage may be falling over time with technological

progress. Differences in language, culture, economic development, and so forth may increase the costs of management, impede the flow of information, or reduce efficiency in other ways.

Hypothesis 3a: *The firm size will have a positive impact on the development of business model innovation.*

Hypothesis 3b: *Foreign ownership will have a positive impact on the development of business model innovation.*

Hypothesis 3c: *Ownership independence will have a positive impact on the development of business model innovation.*

Country Level Variables: An enormous body of the previous work on innovation offers estimation that the external environment of an organization affects its innovative actions. To capture the effect of the macroeconomic environment we use GDP growth *(GDP)* and inflation *(INF)*. GDP per capita serves as a general indicator of economic development by reflecting differences in technology, the mix of firm opportunities and any aspects of regulations omitted from the regression. Also, an increase in GDP per capita could be expected to increase firm's income as a result of more spending. High inflation rates are generally associated with reduced consumption. However, high inflation may also be viewed as a proxy for poor macroeconomic performance and stability, which makes the accurate assessment of credit and market risks more difficult. The effect of inflation depends on whether firm's operating expenses increase at a rate faster than the inflation. Therefore, a positive or a negative relationship between inflation and performance depends on whether the first is predictable or not.

Hypothesis 4a: *Economic development measured by the GDP per capita will have a positive impact on the development of business model innovation.*

Hypothesis 4b: *Inflation will have ambiguous impact on the development of business model innovation.*

This empirical model involves the estimation of the following dynamic specification which includes a lagged dependent variable[8] among the regressors and/or treats some explanatory variables as predetermined.[9]:

$$BI_{it} = c + \alpha\, BI_{it-1} + \beta_1 HC_{it} + \beta_2 BC_{it} + \beta_3 BS_{it} + \beta_4 FO_{it} + \beta_5 OI_{it} + \beta_6 SIZE_{it} + \beta_7 GDP_t + \beta_8 INF_t + \beta_9 D_{year} + \delta D_{IND} + \varepsilon_{it} \quad (6)$$

where business innovation BI_{it} of the firm i at year t is written as a function of time-dependent human capital variable, *HC*; a vector of individual-level variables reflecting board size *BS* and board composition *BC* of each firm; variables that reflect the ownership structure of the market, *FO* and *OI*; firm size, *SIZE*; macroeconomic conditions, *GDP* and *INF*; and the error term *u*. D_{IND} is a set of industry dummies, and D_{year} are the yearly dummy variables. A value of α between 0 and 1 implies that the business model innovation persists, but it will eventually return to its normal (average) level. A value close to 0 means that the industry is characterized by high speed of adjustment, while a value of α close to 1 implies very slow adjustment.

3.1.3 Data

Having defined the methodological approach to be followed, we focus on the selection of variables. We construct a balanced sample of 557 listed firms operating in UK over the period 2002-2009. All data were manually collected from Fame Database and annual reports. The availability of panel data permits us to check the response processes over time and to identify how the changing characteristics affect firm efficiency and business innovation. We proxy business model innovation by the Research and Development (R&D) expenses. Then, we control for the effect firm-specific variables may have on business innovation. Thus, we introduce in the analysis a number of firm-specific factors as independent variables to examine the effects these may have, simultaneously with the board structure, on business innovation.

Following the corporate governance literature (e.g., Yermack, 1996), we define board size as the natural logarithm of the number of directors. Turning our attention to the board composition measure, we use the ratio of non-executive directors over the total number of

[8] The validity of the instruments applied is tested with the Sargan test.
[9] As regards Eq. (6), we use the system GMM estimator proposed by Blundell and Bond (1998).

directors. A common and generally acceptable denominator could be traced in the EU Commission Recommendation 2005/162/EC, defining an 'executive director' as any member of the board who is engaged in the daily management of the company, and a 'non-executive director' as any member of the board of a company other than an executive director.[10] All variables are expressed in natural logarithms to improve the regression's goodness of fit and to reduce possible simultaneity bias.

Ownership Independence *OI* variable takes numeric values between 1 and 4, defined according to the notation levels of the Independence Indicator, using a linear transformation. (A=1- No shareholder with more than 25% of direct or total ownership ="Independent companies"; B=2- No shareholder recorded with more than 50% of direct, indirect or total ownership, one or more shareholders recorded with more than 25% of direct or total ownership; C=3- No shareholder recorded with more than 50% of direct ownership, one shareholder recorded with more than 50% of total ownership = indirectly majority owned; One shareholder recorded with more than 50% of direct ownership = directly majority owned). Leverage (capital adequacy) is proxied by the ratio of equity to assets and serves as an indicator for the risk of insolvency and the market value of assets. Liquidity risk is proxied by the liquid to total assets ratio. Liquidity risk is the variation in net income and market value of equity caused by a firm's difficulty in obtaining cash at reasonable cost from the sale of assets. Data for the

[10] In UK, the board of directors sets the company's strategic aims, ensures that the necessary financial and human resources are in place for the company to meet its objectives and reviews management performance. As part of their role as members of a unitary board, non-executive directors constructively challenge and help develop proposals on business strategy. Non-executive directors scrutinise the performance of management in meeting agreed goals and objectives and monitor the reporting of performance. They should also satisfy themselves on the integrity of financial information and that financial controls and systems of risk management are robust and defensible. Non-executive directors are responsible for determining appropriate levels of remuneration of executive directors and have a prime role in appointing, and where necessary removing, executive directors, and in succession planning (UK Combined Code on Corporate Governance, par. A1). In UK, with the exception for smaller companies (i.e., those that are below the FTSE 350 throughout the year immediately prior to the reporting year) at least half the Board, excluding the chairman, should comprise non-executive directors determined by the board to be independent. A smaller company should have at least two independent non-executive directors. In deciding whether a director is independent, the Board should take into account whether the director: (a) has been an employee of the company or group within the last five years, (b) has, or has had within the last three years, a material business relationship with the company either directly, or as a partner, shareholder, director or senior employee of a body that has such a relationship with the company, (c) has received or receives additional remuneration from the company apart from a director's fee, participates in the company's share option or a performance-related pay scheme, or is a member of the company's pension scheme, (d) has close family ties with any of the company's advisers, directors or senior employees, (e) holds cross-directorships or has significant links with other directors through involvement in other companies or bodies, (f) represents a significant shareholder, (g) has served on the board for more than nine years from the date of their first election (UK Combined Code on Corporate Governance, par. A.3.1).

macroeconomic variables are collected from the World Bank's World Development Indicators. The data are reviewed for reporting errors and other inconsistencies.

Table 1 provides descriptive statistics for all the potential correlates of firm efficiency as well as the determinants of business model innovation.

[Insert Table 1 here]

4. Estimation and results

Given the considerations of the theoretical and empirical literature described above, we estimate the effect of (i) business innovation on cost and profit efficiency and (ii) the determinants of business model innovation. In this way, we would be able to identify a chain of causality, the first link being the influence on firm performance in terms of either profit or cost efficiency, and the last link being the magnitude of parameters that influence the business innovation process.

[Insert Table 2 here]

The findings of the first specifications are reported in Table 2. The estimated values for the cost and profit efficiency are fairly reasonable. On average, cost efficiency obtains a mean value of 86% and profit efficiency stands at 79%.[11] All coefficients for inputs and outputs have the expected signs and are significant at the 5% significance level. It should be noted, however, that because of the amount of interaction terms, and higher order terms included in the frontier it is hard to give any interpretation.

The coefficient estimate of the price of physical capital is positive and statistically significant at 1 per cent level of significance, insinuating that 1 per cent increase will raise total cost. Moreover, the coefficient of the price of labor is also positive and statistically significant at the 1 percent level, suggesting that an increase in personnel expenses will raise total cost. With respect to the elasticity of total cost to the output, the estimated coefficient is positive and statistically significant. The higher order terms of input prices as well as their interactions with each other are almost always positive and significant at a level of 5%. It seems, however, as if in general, higher prices or higher output generate higher total costs. The results also show that most variables in which a time trend has been included are not significant.

[11] Due to space considerations we do not report detailed efficiency results. However, these results are available on request. For expositional brevity we report results on inefficiency (not efficiency).

A first hint regarding the good fit of our equations is obtained from the findings on the effect of control variables on cost and profit efficiency. In particular, our results show that GDP per capita has a positive impact on cost efficiency, implying that an increase in GDP lowers total costs. This appears intuitive considering that in more prosperous conditions firms have better access to new technologies or they can offer services of better quality. This suggests that total cost depends on the economic development insinuating that the dynamism of the industry is closely related to the developments in productivity growth of the whole economy. There is a positive and significant relationship between the level of economic development as measured by the GDP per capita and profit efficiency, implying that firms when income is higher are more efficient in terms of generating stronger cash flows and higher profits. The inflation rate is found to be negatively correlated with profit and cost inefficiency, suggesting that high inflation is not necessarily associated with large scale inefficiencies.

The capital ratio is negatively correlated with cost inefficiency, but it appears insignificant in the case of profit efficiency. The latter result is consistent with the literature advocating that higher capital increases revenues and thus counterbalances the increased costs. The negative coefficient of liquid assets suggests that higher percentage of liquid assets is associated with less funding expenses which in turn is associated with higher cost efficiency values. In the case of profit inefficiency, we observe a positive and statistically significant relationship with the liquidity ratio at 1 per cent level of significance, suggesting that while liquid assets reduce firm's liquidity risk, they are more decrease profits. The LR-tests indicate that efficiency has a significant impact on the model.[12]

Turning to the main focus of our study, our findings seem to be more favorably inclined towards the strand of literature suggesting a positive correlation between business model innovation and performance (measured in terms of both cost and profit efficiency). Organizations which implement successful innovative business models achieve superior innovative performance. The latter could be conceptualized in various terms. Firstly, we can support that effective business models enable organizations to achieve the first mover advantage either in the national or in the global market meaning that they turn innovative ideas (which are hardly imitated by their competitors) into economic returns before their competitors (e.g. Magretta, 2002; Marcedis, 2006; Zott and Amit, 2002; 2006). Additionally, innovative organizations cab

[12] Details about the LR-test statistic are given in Coelli et al. (1998).

effectively deal with the rapid changes happened in their external environment thus achieving a meaningful increase in their performance. More specifically, the launching of successful innovative business models is a premise on the part of innovative performers that are able to effective perform in a dynamic external environment where technological development is rapid and product life-cycle is quite often short. Consequently, an organization's ability for prompt action before its competitors is crucial for success requiring new structures which enable small flexible business model to survive (Jantunen, 2005).

An additional active role of innovative business models is played not only by their direct launch but also by the prompt acquisition, effective implementation and assimilation of new know-how into inovative organizational activities. Organizations should not only form inovative projects aimed at obtaining an instant increase in their performance but they should gain sustainable competitive advantage. The later could happen by maximizing their business in new sectors in which they do not previously operate.

Following this rationale, it is estimated that organizations with the willingness to enter new sectors (often dynamic) and thus operate in developing markets have to confront changes over space and time. The integration of business models is found to be adequate for new ventures in terms of the expected improvement in the organizational performance. As it has already been mentioned above, the specific direct and positive effects of business models on the firm performance have been investigated by many researchers (Hawawini et al., 2003; McGahan and Porter, 2002; Rumelt, 1991) although they cannot replace the specific effects caused by the specific organizational and industry effects as accurately pointed out by Zott and Amit (2006).

[Insert Table 3 here]

Having examined the relationship between business model innovation and performance, we turn to the estimation of Eq. (6). In this section, we investigate the determinants of business model innovation which is channeled, through the previous discussion, to increased firm performance. We opt for dynamic specifications of these empirical models, since endogeneity concerns might still remain.[13] As regards estimation of the dynamic model of Eq. (6), we use the

[13] The drawback of the static model results is that the right-hand side variables maybe endogenous and, therefore, affected by the dependent variable. To account for persistence in the dependent variable and endogeneity of right-hand side variables, we resort to a dynamic model estimation that uses an instrumental variable approach to proxy for endogenous variables.

system GMM estimator[14] proposed by Blundell and Bond (1998).[15] The Blundell-Bond method accommodates for possible endogeneity by means of appropriate instruments.[16] The endogeneity of explanatory variables can make the coefficient estimates obtained through the traditional OLS estimation biased and inconsistent (Greene, 2000). To take into account the possibility of endogeneity, following Arellano and Bond (1991) and Blundell and Bond (1998), we apply the system-GMM estimators.

To determine whether our instruments are valid in the system GMM approach, we use the specification tests proposed by Arellano and Bond (1991) and Arellano and Bover (1995). First, we apply the Sargan test, a test of over-identifying restrictions, which tests the overall validity of the instruments[17] by analysing the sample analog of the moment conditions used in the estimation procedure, to determine any correlation between instruments and errors. For an instrument to be valid there should be no correlation between the instrument and the error terms. The null hypothesis is that the instruments and the error terms are independent. Thus, failure to reject the null hypothesis could provide evidence that valid instruments are used. Second, we test whether there is a second order serial correlation with the first differenced errors. Under the null hypothesis of no second-order serial correlation, this test has a standard-normal distribution. The GMM estimator is consistent if there is no second order serial correlation in the error term of the first-differenced equation. Thus, failure to reject the null hypothesis could supply evidence that valid orthogonality conditions and instruments are used. The second test examines the hypothesis of absence of second-order serial correlation in the first-difference residuals AR(1). In our models, this hypothesis of second-order serial correlation is always rejected. Although there is

[14] The first attempt to deal with the problem of bias and inconsistency in dynamic models was made by Anderson and Hsiao (1982), who suggested an instrumental variables estimator based on the first-differenced form of the original equation. Arellano and Bond (1991) note that the Anderson-Hsiao estimator lacks efficiency, as it does not exploit all the available instruments. They suggest that efficiency gains can be obtained by using all available lagged values of the dependent variable plus lagged values of the exogenous regressors as instruments.

[15] As shown by Blundell and Bond (1997), this system estimator reduces the potential biases in finite samples and asymptotic imprecision associated with the difference estimator. The estimator uses lagged differences of the explanatory variables as instruments.

[16] We choose the two-step estimator, since it is asymptotically more efficient than the respective one-step estimator, and we account for its downward bias by using the finite-sample correction to the two-step covariance matrix derived by Windmeijer (2000). Assuming that there is no serial correlation, all the lagged levels of variables can be used as valid instruments in the first-differenced equation. Under these moment conditions, Arellano and Bond (1991) propose a two-step GMM estimator. In brief, the one-step estimator assumes homoskedastic errors while the two-step estimator uses the first-step errors to construct heteroskedasticity-consistent standard errors. Therefore, the one-step estimators are less efficient than the two-step estimators even in the presence of homoskedasticity of the error terms.

[17] If not, the results are consistent with the presence of measurement errors, since the instruments used would be weak.

first-order serial correlation AR(1) in the differentiated residuals, it is due to first differences in models. Even though the equations indicate that negative first-order autocorrelation is present, this does not imply that the estimates are inconsistent. Inconsistency would be implied if second-order autocorrelation was present (Arellano and Bond, 1991), but this case is rejected by the test for AR(2) errors.

The model seems to fit the data reasonably well, having fairly stable coefficients, while the Wald test indicates fine goodness of fit and the Sargan test shows no evidence of over-identifying restrictions. The choice of the lagged levels and lagged first-differences as instruments is made in a way that guarantees validity of the resulting overidentifying restrictions.

The results obtained from the estimation of the dynamic model (Eq. 6) are reported in Table 3. The highly significant coefficient of the *lagged BI* variable confirms the dynamic character of the model specification. In the present study, α is highly significant across all models, and takes a value of 0.35 on average, which means that *BI* persists to a moderate extent, justifying the use of dynamic panel data modeling. This implies that there may be considerable power to the argument that the previous business innovation process may require time to be smoothed out, even when the transition is rapid. Therefore, a dynamic model may better approximate the potential impact of the variables considered.

In the following set of regressions we first include the individual level variables that have been shown to be instrumental in explaining business innovation and consecutively we control for the organizational, country level and industry indicators. As expected, a high *HC* ratio is associated with higher levels of business innovation. The size of human capital is found to be influential for an organization either in terms of the number of human capital per se or in terms of the nature of human capital. More specifically, the more employees engaged in innovative projects the more interaction within an organization is achieved. This further could mean that employees are able not only to effectively exchange and distribute the knowledge they already possess but also to effectively acquire new knowledge from their colleagues. Additionally, the creation of Communities of Practice (CoP) in an ad-hoc basis facilitate employees to obtain the necessary knowledge (particularly tacit knowledge which is hardly codified) to make effective implementations thus helping them to respond effectively to ever demanding innovative portfolios. However, the matter of cohesion between employees, which often rises when we investigated cases of large teams within an organization, needs further consideration.

Our findings seem to be more favorably inclined towards the strand of literature suggesting a positive correlation between larger boards and more innovative processes. Following the aforementioned rationale behind the human capital ratio, big boards can also suggested as a positive determinant for the integration of innovative portfolios. Bigger boards could be translated in terms of higher levels of experience, expertise and tacit knowledge possessed by their members. Nevertheless, the idiosyncratic traits of board members, which are shaped under specific conditions, should also be examined. Very often, extremely uncertain conditions, which the members of boards often have to deal with make them feel the sharing of certain amounts of their personal knowledge and experience equal to the creation of a new competitor who constitutes a threat to them. Such reluctance, though, may be limited to circumstances such as the successful implementation of the innovative project, in which knowledge keepers are supposed to share amounts of the knowledge they possess. In these circumstances, the board members may also put to the test their participation in knowledge exchange procedures with the other members, based on their beliefs that such actions may be beneficial for them in terms of networking creation.

The latter could also justify our finding concerning the board independence which independence appears to affect innovation in a positive way. It is also worth mentioning that independent members who participate in a firm's board are more oriented to innovative actions undertaken by the organization aiming at the maximization of the business rather to pure short-term profit. This supposition is seems to justify the fact that concentrated ownership of large percentage by a limited number of shareholders has a negative influence on innovation. Another issue of meaningful importance is that larger companies seem to be more innovative, as well as companies with the present of foreign ownership. A basic characteristic of the organizations which are characterised as innovative performers is that they are seek to acquire new knowledge and know-how since as the ever changing environmental dynamic needs increase (Milliken, 1987, 1990). Also, taking into consideration issues such as time constraints as well as prompt and effective implementation of the innovative projects undertaken, it is supported that the presence of foreign ownership operates as a source of new knowledge and know-how which enhances an organizations ability to innovate. This could be further explained in terms of the cross-cultural issues which the members of organization may have mutually but implicitly made. Specifically, those involved in innovative projects may wish to exchange knowledge and ideas with others

with different cognitive background and culture since they feel that they have a chance to expand their knowledge and to keep it alive with new information. This supposition though cannot underestimate previous findings which supports that those who possess experience and cognition similar to that of the interacted members increase the chances of inter-community knowledge exchange, adoption and learning (Tsai, 2001). Moreover, according to Patel and Pavitt (1998) the UK has a higher proportion of national technological activities performed by foreign firms, especially in electrical and electronics technologies, where foreign firms are more than twice as important as national firms in British technological activities.

As regards the macroeconomic variables, GDP per capita has a positive impact on business innovation. A notable result is the insignificant effect of inflation. Food industry, construction, retail trade, hotels and education seem not to favour business innovation while publishing, chemicals, electricity, transport, defence, technology and pharmaceutical industries invest a lot in business innovation models. The proportion of firms' innovative activities increases with the technology intensity of the industry. Such industries are operate in extremely dynamic environments in which technological development is rapid, product life-cycle is quite often short, an organization's ability for prompt action before its competitors is crucial for success and consequently the integration of unique and innovative business models are required (Jantunen, 2005).

5. Conclusions

In the era of business evolution many researchers have placed great emphasis on the contribution of business model innovations to an organization's overall performance outcomes. Using a sample of industry-wide UK firms over 2002-2009, our study innovates in that firm performance is measured in terms of both cost and profit efficiency, while the impact of business model innovation is captured within a stochastic frontier framework. Our results strongly suggest that, indeed, innovative firms are more efficient. Moreover, we specified an empirical framework to investigate the effect of individual, organizational and country level determinants on business innovation models. Our results suggest that larger board systems with more independence enhance business innovation. Larger firms and firms with more human capital seem to favor innovation. Increased concentration in the hands of large shareholders does not improve business model innovation. Also, promoting foreign entry may be desirable since, as our results

demonstrate, this should improve innovative processes. Finally, after introducing industry dummies, we conclude that certain industries such as chemical, pharmaceutical and technology are associated with more intensive innovative processes. Finally, with respect to the macroeconomic variables, GDP has a positive effect on innovation, while inflation has no significance. Our results provide new insights into the current debate regarding business model innovation and the firm performance as well as its determinants that could serve as the impetus for further research and cross-country analysis.

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Table 1
Descriptive statistics (2002-2009)

Variables	Mean	Std. Dev.	Min	Max
Business Innovation (R&D)	23,167.02	19,990.90	15,00	46,000
Board structure				
Board size	27.96	16.57	7.00	56.00
Board composition	67.45	27.30	35.00	85.00
Dependent variables				
Total cost	930232,53	947,755.53	3,450.75	2,805,000
Total profit	163,395.61	98,200	-162,900	486,000
Inputs				
Price of labor (personnel expenses / total assets)	2.97	3.2	0.7	19.7
Price of physical capital (total depreciation and other capital expenses/total fixed assets)	67.5	51.0	39.0	82.8
Outputs				
Total sales	1,247,862.17	772,589.4	13,836	15,362,330
Risk variables				
Equity/total assets	10.73	4.32	3.49	50.58
Liquid assets/total assets	43.76	49.56	9.87	83.25
Macroeconomic variables				
GDP per capita	40,785	2,810	30,438.75	42,352
Inflation	2.1	0.8	1.7	3.1
Other variables				
No of employees	7,272.24	6,642.71	1,000	86,170
Total assets	2,375,246.54	3,559,021.10	324,127	12,227,000
Ownership variables				
Independence Indicator (OI)	1.35	0.9	1.00	3.00
Foreign ownership (FO)	33.92	14.97	5.81	49.36

***Source**:* Annual reports of the credit institutions; Fame Database; World Bank's World Development Indicators.
Note: Board size: Number of directors; Board composition: proportion of non-executives in the board of directors; H-H index: Herfindahl-Hirschman index; OI: Independence Indicator to signify the degree of independence of a company with regard to its shareholders. Figures are expressed in percentages for all variables (except of board size and GDP per capita) and in £ for GDP per capita. Figures other than ratios and indices are expressed in thousand £.

Table 2
The effect of business model innovation on firm efficiency

	Cost inefficiency	Profit inefficiency
Constant	-3.05 (-1.46)	-0.47 (-0.20)
ln(BI)	-0.87 (-2.94)***	-0.37 (-3.80)***
ln(net sales)	0.54 (3.21)***	0.35 (1.99)**
ln (price of labor)	0.16 (3.71)***	0.11 (2.02)**
ln (price of physical capital)	0.19 (4.47)***	0.17 (1.99)**
1/2ln(net sales)^2	0.02 (1.87)*	-0.07 (-1.45)
1/2ln(price of labor)^2	0.05 (2.01)**	0.23 (2.01)**
1/2ln(price of physical capital)^2	0.11 (2.86)***	0.25 (1.86)*
ln(net sales)*year	-0.01 (-3.12)***	-0.08 (-0.89)
ln (price of labor)*year	-0.02 (-3.01)***	-0.10 (-2.18)**
ln (price of physical capital)*year	-0.15 (-2.05)**	-0.07 (-2.96)***
ln(net sales)* ln (price of labor)	0.21 (3.45)***	-0.05 (-1.90)*
ln (price of labor)* ln (price of physical capital)	0.14 (2.77)***	0.13 (1.85)*
Year	-0.16 (-1.98)**	-0.27 (-1.99)**
1/2year^2	0.04 (1.16)	0.36 (1.29)
GDP per capita	-0.01 (-2.20)**	-0.26 (-1.94)*
Inflation	-0.41 (-3.92)***	-0.06 (-2.57)**
ln(equity/total assets)	-0.31 (4.00)***	-0.13 (-0.38)
Ln (liquid assets/total assets)	-0.85 (-1.98)**	0.35 (2.35)**
Sigma-squared	0.78	1.38
LR-test	-179.2***	-569.4***

Note: BI: business model innovation. The t-statistics are presented in parentheses. The ***, **, and * indicate 1 per cent, 5 per cent and 10 per cent significance levels, respectively. LR-test: Likelihood ratio test that all parameters in the model are zero.

Table 3
Determinants of business model innovation

Dep var:BI	I	II	III	IV
Lagged BI	0.326***	0.331***	0.386***	0.339***
HC	0.182***	0.184***	0.155***	0.179***
BS	0.079**	0.059**	0.067***	0.268***
BC	0.033***	0.027***	0.039***	0.035***
OI	-0.055**	-0.048***	-0.029***	-0.057***
FO	0.039***	0.037***	0.048***	0.042***
SIZE		0.055***	0.065***	0.049***
GDP		0.018**	0.013**	0.014**
INF		0.010	0.021	0.025
D_{year}			0.031*	0.042**
Food, beverages, tobacco				-0.023*
Textiles, leather				0.012
Publishing, printing				0.019**
Chemicals, plastics				0.145***
Metals, metal products				0.008*
Gas, water, electricity				0.178**
Construction				-0.017**
Wholesale, retail trade				-0.241**
Hotels, restaurants				-0.103*
Transport				0.052**
Post, telecommunications				0.074
Public administration, defense				0.185***
Education				-0.019**
Technology, computers				0.237***
Health, pharmaceuticals				0.169***
Constant	-0.005***	-0.032***	-0.020***	0.077
AR(1)	z=-7.88	z=-7.89	z=-7.26	z=-7.27
p-value	0.000	0.000	0.000	0.000
AR(2)	z=0.56	z=0.35	z=0.43	z=0.66
p-value	0.575	0.725	0.667	0.510
Sargan	95.79	94.85	71.61	98.02
p-value	0.342	0.315	0.322	0.417
Wald test	131.47	133.01	120.17	139.21

Note: BI: business model innovation; HC: human capital; BS: board size; BC: board composition; OI: independence indicator; FO: foreign ownership; SIZE: natural logarithm (total assets); GDP: GDP per capita; INF: inflation rate; D_{year}: yearly dummy variable; D_{IND}: dummy variable for the industry sector. AR (1): Arellano-Bond test that average autocovariance in residuals of order 1 is 0 (H_0: No autocorrelation); AR (2): Arellano-Bond test that average autocovariance in residuals of order 2 is 0 (H_0: No autocorrelation); Sargan: The test for over-identifying restrictions in GMM dynamic model estimation. The ***, **, and * indicate 1 per cent, 5 per cent and 10 per cent significance levels, respectively.