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Young Innovative Companies: Are They High Performers in Transition Economies? Evidence for Vietnam*

Enrico Santarelli

Department of Economics, University of Bologna, Piazza Scaravilli, 2 – 40126 Bologna, Italy
Tel. +39 051 2098487; Email: enrico.santarelli@unibo.it

Hien Thu Tran

Business School, Edge Hill University, St Helens Road, Ormskirk (Lancs) – L39 4QP, United Kingdom
Email: Hien.Tran@edgehill.ac.uk

Abstract

We study the economic value of both embodied technological change and Research and Development (R&D) investment as proxies for the inputs of innovative activities conducted by Vietnamese firms. Our main focus is on the profitability of young innovative companies (YICs), private innovative companies (PICs), and small and young companies (SYCs). In particular, we test whether YICs could prove successful in fostering economic development through their technological change activities. Results show that *a)* although YICs are more R&D intensive and innovative than PICs and SYCs, in general they do not produce equivalent performance; however those specific YICs focusing on technological change potentially outperform their counterparts, and *b)* PICs are more capable than the other types of firms in translating their innovative effort to higher profitability.

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Keywords: Young innovative companies; Embodied technological change; R&D; Profitability; Vietnam.

JEL classification: L26; O31; O33.

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1. Introduction

Whereas advanced countries call for policies supporting the formation of innovative firms with the expectation of gaining from their breakthrough innovations (Klepper, 1996; Veugelers, 2008; Rosenbusch et al., 2011), developing countries generally focus on policies aimed at improving their institutional infrastructure and financial system to fulfill the gap. Among the developing countries, despite an average annual gross domestic product growth rate of over 7 percent since the *Doi Moi* economic reform of 1986, Vietnam still lags behind in both production of fundamental research and its conversion into technological innovation. Traditionally, the dominant sources of technological change and innovation of Vietnam are foreign direct investments (FDIs) from Western countries joined by some Northeast Asian mid-income economies and China (Kaplinsky, 2011).

Recently, innovation scholars have started to compare the profitability of different types of innovative and non-innovative firms (for a survey, see Czarnitzki and Delanote, 2013). These firms include: young innovative companies (YICs), which are firms that, according to the European Commission (article 35 of the General Block Exemption Regulation), are less than six years old, have fewer than 250 employees, and are highly research and development (R&D) intensive (R&D intensity > 15%); private innovative companies (PICs), which are private firms with R&D spending above zero; and small and young companies (SYCs), which are firms specified according to the YIC definition that do not have any R&D expenditures.

For Vietnam, we address the economic effect of internal and external sources of innovation on firms' profitability by comparing YICs with PICs and SYCs. The aim is to test whether YICs are the best performing components of the Vietnamese National System of Innovation, as in the case of some Western countries. The dataset is derived from the annual enterprise survey conducted by the General Statistics Organization (GSO) of Vietnam. The census data of more than 400,000 observations cover the whole population of existing firms from 2000 to 2005. The empirical results show that, although YICs are more R&D intensive than other types of firms, they do not produce equivalent outperformance. PICs are the type of firms that prove to be more capable of extracting higher profits from innovative activities.

The paper proceeds as follows. Section 2 presents the conceptual framework. Section 3 gives an overview of the National System of Innovation (NSI) in Vietnam in relation to innovative activities and outlines the research hypotheses. Section 4 describes the dataset and presents the variables together with their descriptive statistics and correlation matrix. Section 5 presents the methodological approach. Section 6 discusses the estimation results. Section 7 gives the concluding remarks and suggestions for policy action.

2. Conceptual framework

Endogenous growth models (Romer, 1986) postulate that technological change stimulates economic growth if the return to innovation with respect to human capital used in the R&D-intensive sectors is constant.

At the macro level, the relatively small total factor productivity growth found in East Asia (Chen, 1997) does not imply that technological change is not important for economic growth in this area. It simply reflects the fact that the major component of technological change in the region is quality improvement in factor inputs or embodied technological change rather than disembodied technological change. At the micro level, one may distinguish between two groups of studies: those focusing on the way innovation is obtained by firms of different sizes and those emphasizing the relationship between innovation and profitability.

As regards the first group, Hall and Ziedonis (2001) show that both in-house R&D and capital expenditures exert a positive impact on the innovative output of US semiconductor companies. Similarly, Branzei and Vertinsky (2006) show that capital investment catalyzes both the external absorption and the internal emergence of novel capabilities in small and medium enterprises (SMEs). Piergiovanni and Santarelli (2013) also support the idea that capital expenditures—taken as equivalent to technical change embodied in new machinery and capital equipment[1]—play a crucial role in the development of new patentable items by firms in high-tech industries. Whereas large firms show an overwhelming importance in innovation because of their ability to spread the fixed costs of R&D over a large sales volume and of their potential to undertake more innovation projects of the same magnitude (Van Dijk et al., 1997), SMEs rely successfully on the external or "used" R&D embodied in intermediate and capital goods (Santarelli and Sterlacchini, 1990). In this sense, R&D and capital expenditures are complementary forces and determinants in the overall innovation process in SMEs.

[1] Technological change is "embodied" when it takes the form of newer capital input (tangible internal investments in new machinery, equipment, and work-in-progress), whereas it is "disembodied" when resulting in intangible accumulation of knowledge.

As regards the second group, Geroski et al. (1993) identify for a sample of large, quoted UK firms a two-fold effect of innovation on profitability. On the one hand, innovation exerts a direct but transitory impact on profitability by enabling the production of a new product or the use of a new process. On the other hand, it exerts an indirect but stronger and more persistent effect by signaling the transformation of firms' internal capabilities associated with innovativeness. For Finland, Leiponen (2000) finds that the profitability of innovating firms differs in its determinants from that of non-innovating ones, with *a)* educational competencies being more important for innovators than for non-innovators and *b)* the determinants of profitability of product innovators differing from those of process innovators. Using a panel of UK manufacturing firms, Cefis and Ciccarelli (2005) find (i) a positive but decreasing overtime effect of innovation on profits, (ii) a difference in profitability between innovators and non-innovators, and (iii) a long-run persistence in profit differentials. Finally, using a panel of manufacturing plants in Ireland and Northern Ireland, Love et al. (2009) find that innovators and non-innovators have different profitability determinants and that the profitability of externally owned plants depends on factors different from those of indigenously owned enterprises.

Since the early 1980s, various studies have stressed the importance of technological learning in developing countries, showing that it is much more widespread than usually found when considering technology issues only in association with organized R&D activities (Bell and Pavitt, 1993; Kim and Nelson, 2000). Moreover, with respect to transition countries, technological change is a key element of their industrialization process. However, the development policy literature that considers Western technological trajectories as the dominant paradigm commonly conceptualizes technological progress in transition/developing countries as an externally driven process consisting of straightforward selection and implementation of foreign technology through FDIs (Barba Navaretti et al., 2002). Consistent with this view, the requirement of large resources for the application of Western technology implies the process of technological change to be prevalent among large firms only and disregards the possible contribution of SMEs (Romijn and Caniels, 2011).

In recent years, many transition and developing countries have started to question the effectiveness of such an FDI-led technological change strategy, calling for greater emphasis on autonomous innovative activities within SMEs and newborn firms as a driver of economic growth. According to Bell (2009), intensive technology-borrowing strategies carry the danger of lock-in or technological path dependence. Therefore, transition/developing countries can no longer rely solely on adoption and incremental adaptation of Western technology to reduce their technological dependence from abroad. Therefore, the following question arises: are YICs more profitable than other types of firms in transition/developing countries?

Although the idea of R&D cost spreading supports the advantage of large firms in R&D (Cohen and Klepper, 1996), new technology-based firms (NTBFs)[2] using highly skilled workers may show a propensity to perform R&D not less significant than that of large firms (Audretsch, 1995). A comparison of the effect of capital expenditure and R&D investment on the innovative output of large established firms and NTBFs may shed light on the relationship between R&D or embodied technical change and firm size. Public awareness about NTBFs arose in the early 1980s, when several traditional industries were in decline and some fast-growing new industries began to emerge (Licht and Nerlinger, 1998). NTBFs gained research attention because of their high growth potential, innovative nature, low failure rate, and ability to increase the science base of a country by successfully commercializing radically innovative products and services and by favoring technological diffusion (Licht and Nerlinger, 1998; Rickne and Jacobsson, 1999; Vaona and Pianta, 2008). For their ability to achieve higher levels of innovation performance in relation to other firms, especially new-to-market innovations, NTBFs have been the recipients of specialized government support in a number of countries, including the United States, the United Kingdom, and several European Union countries (Licht and Nerlinger, 1998; Ferguson and Olofsson, 2004; Schneider and Veugelers, 2010).

Recent research has focused on the complementary effect of smallness and newness of innovative firms, paying attention to YICs (cf. among others, Pellegrino et al., 2012), which are actually a subset of NTBFs. Despite conflicting arguments on the important role of YICs in the overall national economic performance, researchers still share one common consensus that their existence indeed stimulates technological change and productivity growth. According to Baumol et al. (2007), productivity growth in advanced economies over the last 15 years has been due to the development of innovative entrepreneurial companies (cf. also Hölzl, 2009). Correspondingly, Acs et al. (2014) point out that the "heroic entrepreneur" is not the sole determinant of entrepreneurial success, with the environment and the institutional context in

[2] NTBFs are independently owned firms, are less than 25 years old, and belong to a high-tech sector (Tether and Storey, 1998).

which the heroic entrepreneur acts playing an equally important function in nurturing new venture seeds into full-fledged, value-adding growth ventures. Accordingly, the country-level aspects of the entrepreneurial process that shapes the NSI, as well as ultimately influences entrepreneurial action and determines its likelihood of being successful, have to be considered when analyzing the innovation–performance relationship in YICs and other types of ventures.

Empirically, YICs have been proved to show a significantly higher innovative performance than other innovators or non-innovators in both developed countries, such as Germany (Schneider and Veugelers, 2010), the United Kingdom (Freel, 2000), Belgium (Czarnitzki and Delanote, 2013), and Spain (García-Quevedo et al., 2014) and rapidly developing ones, such as India (Kumar and Saqib, 1996), China (Hu et al., 2005), and Taiwan (Chuang and Lin, 1999).

3. Hypotheses development

Embodied technological change is by far the most important source of innovation for Vietnamese firms, with R&D focused on developing absorptive capacity for the exploitation of newly adopted technologies. The outputs of the overall innovation process are typically incremental process innovations accruing from the adoption of new equipment, machinery, and technical methods. Vietnam has witnessed a steady increase in the number of firms being active in technology-intensive industries (Figure 1), although its start-up rate in high-tech industries remains low compared with that in medium high-tech ones[3].

Figures 2 and 3 present the average firm size and the average sales per employee, respectively, for the whole private sector, medium high-tech industries, and the high-tech industries.

Technology-intensive firms generally show superior sales performance than the whole aggregate of private firms. Besides high-tech firms that exhibit substantial catch-up, many technologically weak firms learned to innovate by first imitating technologies created in developed economies. These firms usually rely on the external or "used" R&D embodied in intermediate and capital goods to make the transition from imitation to innovation overtime, including the creation of patentable knowledge (Hu et al., 2005). R&D and technological change

[3] We adopt the Statistical Classification of Economic Activities of the European Community at the three-digit level to aggregate manufacturing industries according to their technical intensity and classify them into high-technology (office, accounting and computing machines; radio, television, and communication equipment; medical, precision, and optical instruments), medium high-technology (chemicals and chemicals products; machinery and equipment, and motor vehicles; trailers and semitrailers), medium low-technology, and low-technology industries.

have both substitution and complementary relationships. On the one hand, technological change should substitute for firms' internal R&D effort. On the other hand, technological change stimulates firms to improve their learning and absorptive capacity through R&D to adapt the new technology to their infrastructure (Cohen and Levinthal, 1989). Therefore, a by-product of R&D is to enhance firms' absorptive capacity, which in turn boosts the efficacy of technological change. Kim and Nelson (2000) suggest that imitation through the adoption of existing technologies serves as an effective learning experience that paves the way for indigenous technological innovation. Accordingly, we propose the following hypothesis:

Hypothesis 1. Aside from R&D, embodied technological change also stimulates firm profitability.

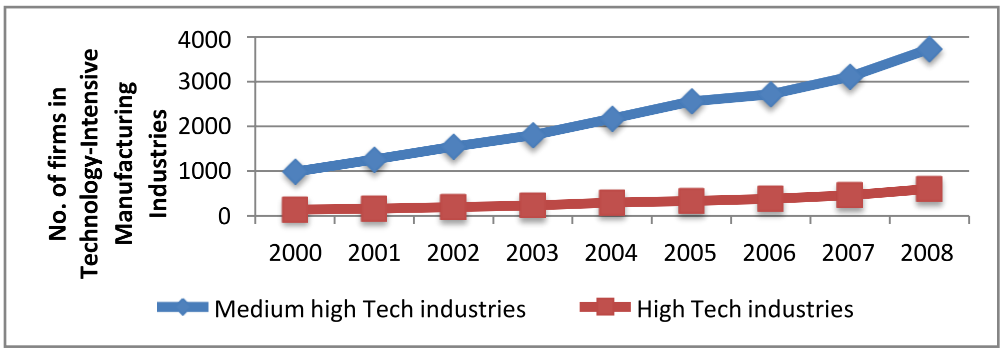

Figure 1: Number of firms in technology-intensive industries, 2000–2008 (Source: GSO)

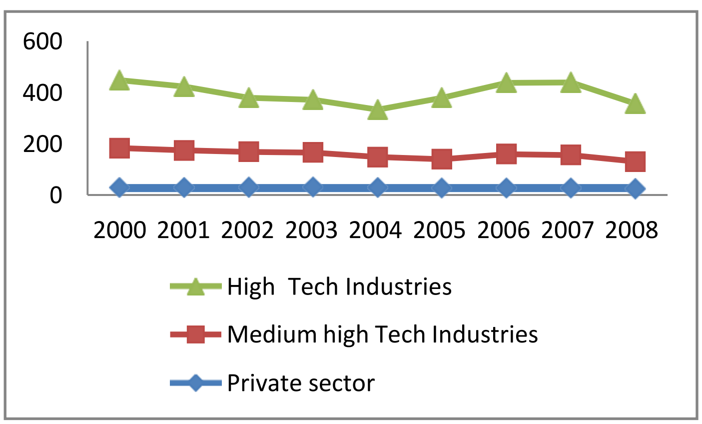

Figure 2: Average firm size, 2000–2008 (Source: GSO)

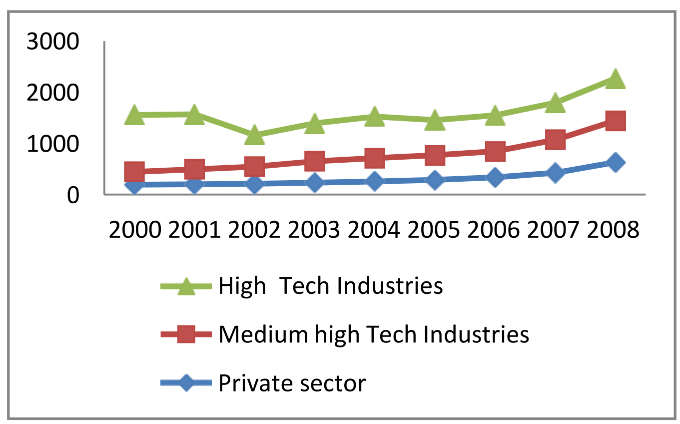

Figure 3: Average sales per employee, 2000–2008 (Source: GSO)

The fact that SMEs play a role similar to that of their counterparts in developed countries with respect to innovation is not so obvious. The majority of SMEs in Vietnam cannot afford R&D activities because of their high cost. Even within the group of innovative SMEs, most have a low innovative profile, as they mainly acquire, adapt, and apply external technology. Santarelli and Tran (2012) find that incumbents' growth generates positive knowledge spillovers and thus profitable opportunities for start-ups. Therefore, as YICs have attracted great attention from both academics and policy makers in advanced countries as engines of growth, job creation, and strong drivers of innovation, we want to determine whether the same phenomenon occurs in transition/developing countries by creating a benchmark study for the case of Vietnam:

Hypothesis 2. Young innovative firms have superior profitability than less technology-oriented small and young firms.

R&D performance also varies according to corporate governance and ownership structures (Hoskisson et al., 2002). As argued by agency theory, an effective firm response in rapidly changing environments hinges on an appropriate fit among ownership, control, and monitoring mechanisms (Wright et al., 2005). On the one hand, the agency perspective also postulates that concentrated ownership is important for technological activities because it provides effective monitoring mechanisms (Belloc, 2012). On the other hand, concentrated ownership has disadvantages in eliminating the private benefits of control, expropriating minority shareholders, and hindering diversification (Barclay and Holderness, 1989). Choi et al. (2011) find that concentrated ownership in Chinese firms does not play a positive role in monitoring and controlling managers' behaviors related to innovation. As Vietnam, similar to China, does not align with the Anglo-American or stakeholder models of corporate governance, concentrated ownership may not be positively associated with technological upgrading in this country.

The economic success of some Asian countries has been attributed to state-led technological development strategies (Haggard, 1994). However, Vietnam has focused on the privatization of state-owned enterprises (SOEs) under the assumption that state ownership has a negative impact on firm performance. Therefore, only recently has Vietnam witnessed the emergence of a dynamic private sector and been able to promote positive structural and market changes (Santarelli and Tran, 2012, 2013; Tran and Santarelli, 2014). Compared with the state sector, the private sector exhibits a higher net start-up rate and growth of sales per employee every year (Figures 4 and 5). In figure 4, the negative firm formation rate of state-owned firms results from the wave of privatizations in the past decade. Due to their poor performance at the mid 1990s, there was an urgent need for reforms. Around 2600 state-owned firms have been equitized since 1992 to provide a solid foundation for continued liberalization of the Vietnamese economy (Sjoholm, 2006).

Instead of isolating the smallness and newness of innovative firms, we intend to consider their ownership type under the hypothesis that private innovative firms have superior performance than their peers:[4]

Hypothesis 3. Private innovative firms have superior entrepreneurial performance than their counterparts.

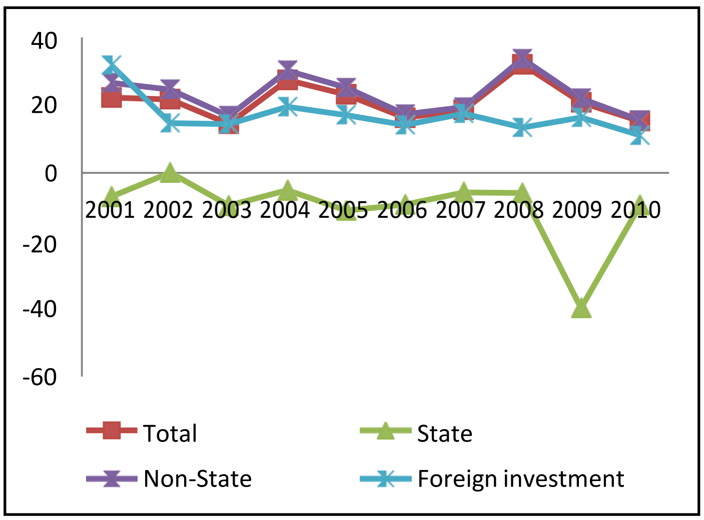

Figure 4: Rate of new firm formation by type of ownership 2001–2010 (Source: GSO)

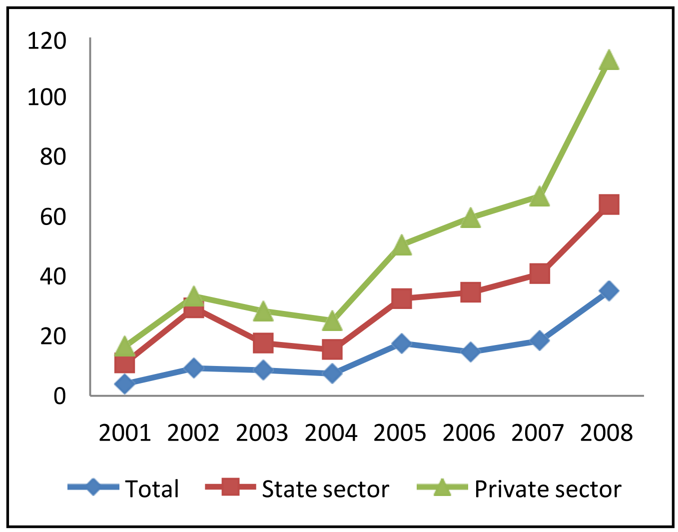

Figure 5: Growth of sales per employee by type of ownership 2001–2008 (Source: GSO)

4. Data description and definition of variables

4.1. Data

Setting the research in Vietnamese context is one of salient features of this study. During the last 3 decades, Vietnam has been known for its rapid expansion and development since its *doimoi* policy. In recent years, firms in Vietnam are undergoing a transformation from a labor-

[4] The participation of private sector actors in the innovation process has also been found to be preferable in European countries (Autio et al., 2007).

cost driven model to an innovative-driven one. New firms set up while backward incumbent firms exit or restructure to adapt with emerging competitive market.

The dataset used for the empirical analysis is based on the annual enterprise survey conducted by General Statistics Organization (GSO) of Vietnam from 2000 to 2005. It covers the whole population of existing firms in six years (408,492 observations)[5]. The GSO survey is comprehensive and harmonized across provinces and industries to obtain a coherent view on various aspects of firms, including segment data (ISIC code, industry sales, size, and assets), accounting data (debts, revenue, profit, and assets), basic demographic data (year of inception, ownership type, and size of labor force), and innovation data (R&D expenditure, innovation investment, and technical personnel). Generally, approximately 7% of firms are involved in R&D activities, although nearly 40% of the sampled firms invest in innovation activities. Nevertheless, 80% of the firms inject less than 10% of their investment into innovation activities, whereas only 3.7% can be considered to be innovation intensive according to the current definition (R&D expenditure larger than 15% of the total business expenditure).

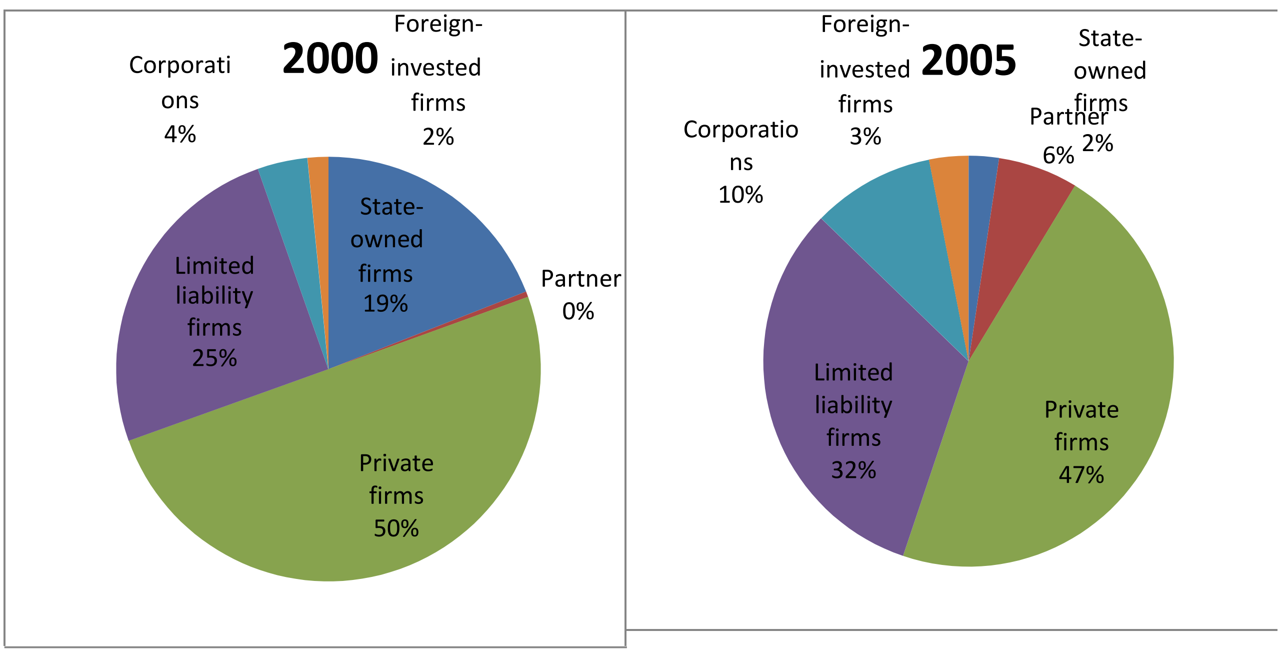

Figure 6: Pie chart of firms by ownership types (2000 and 2005)

[5]The data consist of 40,411 firms in 2000; 49,115 firms in 2001; 59,908 firms in 2002; 68,214 firms in 2003; 86,009 firms in 2004; and 104,835 firms in 2005.

Figure 6 presents the proportion of firms in Vietnam by ownership types in 2000 and 2005. We can observe that private firms and limited liability firms account for the majority (around 80%) of firm population. There was a substantial increase in the number of corporations, foreign-invested firms and cooperatives & partnerships, whereas the number of state-owned firms fell down sharply (from 19% in 2000 to 2% in 2005) due to the extensive privatization process currently undertaken by the government in Vietnam.

As our data cover the whole population of firms in Vietnam, non-random data collection is not a cause of concern. Any firm failing to appear in the next-year survey can be assumed to have gone bankrupt or have been taken over by other firms[6].

4.2 Variables

4.2.1 Dependent variable

Entrepreneurial performance: Geroski and Machin (1992) find relatively large and persistent differences in the profits of innovators and non-innovators. According to Freel (2000), small innovators may have slower growth in profits and lower levels of absolute profit than their less innovative counterparts, but they are likely to enjoy higher average profit margins. Small innovators may not enjoy higher net profits because of their need to repay initial investments or fund further investments. In this study, we consider the effect of innovation on profit margins (rate of return on sales)[7]. Return on sales (ROS) indicates how net income is earned from each thousand Vietnamese dong of sales and is the ratio between after-tax profits and sales. Why we use ROS as a proxy for entrepreneurial performance of both small, young firms and larger, older ones comes from the fact that Vietnamese market is undergoing a transition from labor-cost driven model to an innovative-driven one. This transition process facilitates the emergence of

[6]We apply the standard Heckman selection model to control for firm survival bias. Particularly, we address (i) whether firms engaging in R&D activities are more likely to exit the market and (ii) whether surviving firms have higher profit margin than other firms, consistent with the finding above. In the first stage, we estimate the probability of firm survival using the probit model (survival stage). Heckman's inverse Mills ratio computed from the first stage is included in the second stage to estimate the profitability of surviving firms (performance stage). We use average ROS and average firm size of the industry as the exclusion restrictions in the Heckman selection model. However, the insignificant Mills ratio indicates the absence of survival bias in our estimation model even at the 10% significant level. Therefore, we are confident that our estimation results do not overestimate the economic value of firms' R&D activities. The results can be obtained from the authors upon request.

[7]The rationales for using ROS rather than the widely used logarithm of profit or return on assets are as follows: 1) logarithm of profit excludes firms operating at loss (negative profit) from the analysis, and 2) sales is generally expressed in current monetary terms, whereas assets normally carry book values and require a longer time frame of availability (Geringer et al., 1989).

abundant entrepreneurial opportunities that are constantly available for firms' exploitation (Santarelli and Tran, 2012). All firms, regardless of size, sector, location, and ownership types are actively pursuing these arising entrepreneurial opportunities to see improvements in profitability. Thus in general, profit measures do reflect entrepreneurial efforts of all firms.

4.2.2. Independent variables

R&D intensity/Innovation investment rate: Aghion and Howitt (1998) define R&D intensity as the proper measure of the R&D input in the innovation production function. It is measured as the proportion of R&D expenditures to business expenditures, whereas innovation investment rate is the ratio of investment in innovative activities over the total annual investment of the firm[8]. In our estimates, both measures are expressed in decimal points and have values between 0 and 1. We allow for a nonlinear relationship by including their squared values in the regression. There are strong *a priori* reasons to expect the endogeneity of R&D and the innovation variable (Veugelers, 1997). Firms that invest in R&D are likely to have superior economic performance, as R&D enables the development of new products/processes and absorptive capacity to effectively absorb knowledge from outside (Cohen and Levinthal, 1990).

YICs: This is a dummy that indicates whether a firm is a YIC or not. A firm is a YIC when it meets the criteria for the first time in the period under analysis. The growth of YICs can be investigated overtime compared with that of other firms even if these YICs can exceed the size and age threshold of the YIC definition in the following years (Czarnitzki and Delanote (2013).

PICs/SYCs: Two dummies are included to analyze the influence of being a PIC and a SYC on growth and profitability. We check whether the size and age requirements solely significantly influence firm growth and profitability. Once a company is classified as a PIC or a SYC, its status remains for the rest of the period. In the regression analysis, we code these dummies as mutually exclusive variables to ease the comparison of performance among them.

We also investigate the interaction effect of our dummies classifying different types of firms and R&D intensity. These interaction terms indicates the indirect impact of technological change conducted by YICs, PICs and SYCs on their respective entrepreneurial performance.

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[8]In this paper, R&D expenditure is constructed from the direct question of "what are the costs for research and for technological development?" Innovation investment has three components: (i) construction and assembly works, (ii) machinery and equipment, and (iii) technology renovation. Therefore, it is largely a measure of technological change embodied in intermediate and capital goods, and it has been shown to be a major determinant of the overall innovation activity by SMEs (Santarelli and Sterlacchini, 1990). Whereas R&D reflects the internal input, embodied technological change represents the external input into the innovation process.

4.2.3. Control variables

Control variables: To isolate the relationship between R&D/innovation investment and entrepreneurial performance, we control for other variables that are likely to affect profitability.

- **Firm size**: Firm size is a standard proxy for competitive position and firms' advantage within an industry (Johnson et al., 1997). Studies on the relationship between firm size and firm growth have been developed around Gibrat's Law (Gibrat, 1931), which states that a firm's growth rate is independent of its size at the beginning of the period (for a survey, cf. Lotti et al., 2003 and 2009). We control for both labor and economic size. Labor size is measured as the natural logarithm of the total number of employees, whereas economic size as the natural logarithm of total assets. Quadratic terms are also added to establish a nonlinear relationship between firm size and its performance. The logarithm transformation is used because size is highly skewed and extreme values strongly affect correlations with other variables.

- **Firm age:** Empirical studies have shown that new/young firms are characterized by a relatively high risk of failure during the first years of their existence. The main reasons for such a "liability of newness" are the problems of setting an organizational structure and getting the new unit to work efficiently enough to keep pace with their competitors (Fritsch et al., 2006; Rosenbusch et al., 2011). For older firms, the "liability of aging" could be the inflexibility of established organizations, erosion of technology, products, and business concepts over time. Age as a proxy for experience, learning, and managerial competencies that a firm accumulates overtime is an important determinant of firm growth, although the growth rate decreases with firm age (Geroski and Gugler, 2004). The effect of firm age is explored by means of the number of years that the firm has been in continuous operation.

- **Capital intensity**: Some firms are, by the nature of technology, more capital-intensive than others. Within any particular industry, a firm may choose a highly automated process or a more labor-intensive one. Generally, high capital intensity imposes a greater degree of risk because assets are frozen in long-lived forms that may not be easily sold, and it hinders the setup and survival of new firms because of the relatively large amount of resources needed for attaining the minimum efficient size (Audretsch et al., 2002). Given that return (and risk) varies with capital intensity, the differences in profitability are likely to be associated with the differences in capital intensity between innovative and non-innovative firms. The present study uses the ratio of net fixed assets to the total number of employees.

- **Debt ratio**: The finance literature indicates that the leverage situation of firms strongly influences their value. According to Opler and Titman (1994), highly leveraged firms lose a substantial market share to their more conservatively financed competitors. Empirical studies find a negative relationship between a firm's debt ratio and R&D intensity, and entrepreneurial performance. Such findings reflect the fact that these firms pursue less R&D activities because they have access to new external funds and at the same time have to serve existing debt (Czarnitzki and Kraft, 2004). Therefore, the ratio of total debts to total assets (debt ratio), is adopted to isolate the effect of a firm's leverage capacity on entrepreneurial performance.

- **Technological resources**: Firms with higher internal technological capacity/skills endowment may be better both at absorbing incoming spillovers and at protecting their knowledge through different appropriation mechanisms (Piva and Vivarelli, 2009) than those with lower internal technological capacity/skills endowment. Technical resources have been widely recognized to be measured through indicators of R&D inputs, R&D processes, and R&D outputs (Audretsch, 1995). We adopt the rate of qualified R&D teams and technical employees in the total labor force of firms as a proxy for their technological resources. Skilled technical workers compared with their unskilled counterparts are more capable to deal with the complexity of innovation (Song et al., 2003), more likely to absorb knowledge and consequently reinforce the absorptive capacity of a given organization (Cohen and Levinthal, 1990), and more successful in exploiting innovative ideas.

- **Exports**: The literature proposes a positive link between innovation and exports, and in turn between exports and firm performance. Exporting firms are more likely to innovate because of the benefits of product upgrading and because of the lower costs of production and thus lower selling prices that export firms are able to charge. However, some studies have found an insignificant relationship between R&D investment and export intensity (for a survey, cf. Castellani, 2002). Influential international trade models developed by Krugman (1979) suggest that innovation is the driving force behind export. In the current study, "export" is a dummy indicating whether a firm is involved in exporting its products/services or not.

- **Diversification**: Diversified firms realize higher profit margins than firms with a highly concentrated product/process spectrum (Santarelli and Tran, 2013). The impact of diversification on firm performance is mixed. For example, García-Quevedo et al. (2014) found for Spain that the degree of product diversification is more important in fostering R&D activities among mature firms, with young firms' spending on R&D appearing to be more sensitive to demand-pull variables. In our study, diversification is a dummy that is coded 1 if the firm diversifies its production into another industry and 0 otherwise.

- **Industry effects:** As we include observations across multiple industries, considering the industry-level fixed effects is essential. The effect of industry life-cycle is proxied by average firm size in each two-digit industry. A larger size indicates the maturity of the industry, whereas a smaller one suggests both the availability of abundant profit opportunities and the growing stage of the industry. To measure industry-level performance, we use the average ROS (i.e., net profit as a percentage of sales) of all firms in the two-digit industry l.

- **Province control**: Regional factors add significantly to the explanation for new business survival (Fritsch et al., 2006). According to North and Smallbone (1995), a strong correlation can be found between local characteristics and firm growth. A total of 64 province dummies are included to isolate unobserved heterogeneity across different Vietnamese provinces.

- **Ownership type:** Six dummies representing state-owned firms, partnership and cooperatives, private firms, limited liability firms, joint stock firms, and foreign invested firms are included in the analysis to isolate the impact of legal ownership type on firms' innovation activities and entrepreneurial performance.

The Durbin-Wu-Hausman test later indicates the endogeneity of innovation investment rate. The popular treatment of endogeneity is to find an appropriate instrumental variable (IV) for then endogenous one. Hu et al. (2005) show that proper industry variables can become effective instruments to correct for firm specific effects. These variables define the environment in which firms operate and yet are independent of a firm's specific characteristics. Therefore, we use the industry entry rate as the IV here, assuming that the dynamics or turbulence of the industry in which they belong significantly influences the innovative efforts of firms (i.e., how much they will invest in R&D) but plays an insignificant role in determining firm-level profitability, which is more likely a function of firm-level variables. Appendix 1 presents the construction and descriptive statistics of all variables. Appendix 2 shows the pair-wise correlation matrix of the dependent and independent variables.

5. Estimation models

We consider both static and dynamic treatments of the performance equation. In the dynamic model, the lagged dependent variable is included to isolate the effect of potential performance shocks and to account for the necessary time lag until the pay-off of R&D investment can be recognized. Firm profitability is measured by return on sales (ROS_{it}), an indicator that is commonly used to compare the economic performance of firms of differing sizes (cf., among others, Guiso and Rustichini, 2011). The firm profitability equation can be written as follows:

$$ROS_{it} = ROS_{it-1}\delta_1 + RDint_{it}\delta_2 + INNinvest_{it}\delta_3 + z_{it}\delta_4 + u_i + c_{it} \quad (1)$$

$(i = 1,2, \ldots, n; t = 1,2, \ldots, T)$.

In Equation (1), $ROS_{it-1}$is the one-year lagged value of ROS of firm $i$in year t; $RDint_{it}$ is the R&D intensity of firm i; $INNinvest_{it}$ is the rate of innovation investment of firm i; z_{it} is a set of controls for firm-level, province-level, and industry-level characteristics; u_i is an unobserved firm-specific time-invariant effect that allows for heterogeneity in the means of the ROS_{it} series across firms; and c_{it} is a disturbance term. The disturbances c_{it} are assumed to be independent across individuals. We also treat the firm-effects u_i as stochastic, which means that they are necessarily correlated with the lagged dependent variable ROS_{it-1} . Besides, we check for possible violations of the underlying estimation assumptions in order to choose the most appropriate estimation method. In what follows, we therefore address and discuss common violations to the assumptions.

Test for violations of estimation assumptions: $E(c_{it} c_{i'F} {}_{t'F}) = \begin{cases} \sigma^2_g & i = i', t = t' \quad (A1) \\ 0 & otherwise \quad (A2) \end{cases}$

We apply the likelihood ratio test for heteroskedasticity to the panel data to determine the existence of strong heteroskedasticity in our data[9]. Thus assumption A1 is violated. For assumption A2, the Wooldridge test for first-order autocorrelation in the panel data is insignificant even at the 10% level. This finding indicates the absence of first-order serial correlation in the ROS equation[10]. Finally, we

[9]White/Koenker nR2 test statistic: $3^2(81)$= 327.967; p-value = 0.000.
[10]Wooldridge first-order serial correlation test: F (1,62074) = 1.079; p-value = 0.299

test the endogeneity of R&D intensity and innovation investment rate: The Durbin–Wu–Hausman test indicates the endogeneity of innovation investment rate but not of R&D intensity[11].

Given the test results above, we apply the instrumental variable generalized method of moments (GMM) approach to estimate the static model (cluster by firms). As discussed in section 4, industry entry rate will be used as IV in this model. The under-identification and over-identification test (Hansen J statistic) confirm the relevance and validity of our IV[12]. For the dynamic model, we apply the Blundell–Bond (1998) difference dynamic GMM estimation.[13] The lagged levels of endogenous regressor $INNinvest_{it}$ are used as exogenous instruments. Therefore, the endogenous variable becomes pre-determined and is thus not correlated with the error term in equation (1). By transforming the regressors by first differencing, the fixed firm-specific effect is removed because it does not vary with time:

$$\Delta ROS_{it} = \beta_1 \Delta ROS_{it-1} + \beta_2 \Delta INNinvest_{it} + \beta_3 \Delta z_{it} + \Delta c_{it}\,. \qquad (2)$$

6. Results

The sign and the statistical significance of the estimated parameters (Table 1) are consistent, although the magnitude is a bit larger than that of the coefficients obtained from the static GMM model. As the lagged ROS is not statistically significant in the GMM treatment of the dynamic model, the preferred model is the static GMM, based on which we will discuss our results.

Statistical evidence in Table 1 supports **Hypothesis 3**, which shows that PICs significantly outperform the other types of firms. The economic effect is much stronger when we consider the performance of all three types of firms together in treatment (3). The coefficient for YICs and SYCs is positive but not statistically significant. Therefore, **Hypothesis 2** is not supported. The combination of smallness, newness, and innovativeness fails to fulfill the profit expectation for the innovative efforts of YICs in Vietnam. However, statistical significance may not imply

[11] H_0: "Innovation investment rate" is exogenous

Durbin-Wu-Hausman 3^2 test	$3^2(1)$= 10.639	P-value	= 0.001

H_0: "R&D intensity" is exogenous

Durbin-Wu-Hausman 3^2 test	$3^2(1)$ = 0.013	P-value	= 0.907

[12] Under-identification test $3^2(1) = 4.121; p - value = 0.01$
Over-identification test (Hansen J statistic) $3^2(1) = 0.027; p - value = 0.869$

[13] Extending the work of Arellano and Bond (1991), they propose a system estimator that uses moment conditions in which lagged differences are used as instruments for the level equation aside from the moment conditions of lagged levels as instruments for the differenced equation.

economic significance. Looking at the numerical magnitude of the three coefficients, we can see that the effect size is rather small: ceteris paribus, return on sales will be approximately 1 percentage point higher for PICs. It is worth noting that since we use a large sample size (consisting of all firms in Vietnam), even a small numerical but statistical significant coefficient still gives meaningful influence on the dependent variable (Kennedy, 2008)

We find a significant positive effect of embodied technological change on profitability. The economic size of both R&D intensity and innovation investment is quite large as well. Other things being equal, 10 percentage points increase in innovation investment would lead to around 13 percentage points increase in return on sales. However, the significant and negative quadratic term of innovation investment rate indicates a non-linear relationship between investment into innovation activities and firm performance: profit increases as innovation investment is exploited up to the optimal point, but it starts to fall off marginally when investment goes beyond this optimal point. Accordingly, **Hypothesis 1** is only partially supported.

Interestingly, when we take into account the interaction effects of our dummies and technical change, only the joint effect of YICs and R&D intensity exerts a positive and statistically significant impact on the dependent variable. This indicates the fact that if young innovative firms having higher R&D intensity, i.e. conducting more technological change, are likely to be more profitable than their counterparts. Although the economic effect is rather small, the finding does suggest a useful policy implication in the sense that national business development services (BDS) should focus on supporting young firms' conducting technological change rather than stimulating all types of innovation activities.

Both capital-intensive and highly leveraged firms are found to be less profitable. As 92% of the sample firms are SMEs, the debt burden imposes an impediment to firm value. Nevertheless, the magnitude of capital intensity's parameter is too small to suggest a noticeable economic effect. We also find statistical evidence for the outperformance of firms operating in multi-business sectors and/or exporting their products/services to international markets. Again, due to large sample size, the effect size of diversification and export is rather small. Other things held constant, return on sales is approximately 0.9 and 0.8 percentage point higher for exporting firms and diversified firms respectively. With respect to the effect of firm size, the results are contradictory between economic size and labor size. As land accounts for the majority of firms' total assets and land evaluation is biased and problematic (Tran and Santarelli, 2014), firms with a larger asset pool are normally capital intensive and thus incur higher sunk and transaction costs because of their "asset specificity," which impedes their profit margins. This finding is also consistent with the negative effect of capital intensity on firms' profitability. However, firms with larger labor size are found to have better performance than those with smaller labor size.

Regarding the industry control variables, firms active in growing industries with substantial profit opportunities obtain positive spillover effects from the industry to stimulate their growth. With respect to ownership type, we find the superior performance of private firms and limited liability firms over their state-owned counterparts. The statistical effect is significant at 1 percent level, while the magnitude effect is quite substantial: private firms are likely to perform at 12 percentage points of profitability higher and limited liability firms perform at around 9 percentage points of profitability higher than state-owned enterprises. This finding confirms the underperformance of SOEs in Vietnam, caused by a host of different factors: lack of strategic direction, poor management, and soft budget constraint (Sjoholm, 2006). Firms in big cities and urban areas inherently outperform those in less agglomerated areas.

- **TABLE 1 About Here -**

7. Conclusions and policy implications

Micro–level organizations such as PICs and YICs may play a more essential and active role in facilitating technological change and emergence or diffusion of new innovations in developing and transition countries than national institutions do.

By controlling for endogeneity of technological factors using the instrumental variable GMM and differenced GMM methods, we offer in this paper valuable insights on the impact of embodied technological change and R&D activities on the performances of YICs, PICs, and SYCs. The most remarkable estimation result shows that PICs significantly outperform the other types of firms. In other words, the combination of newness, smallness, and innovativeness in YICs does not clearly bring the expected high entrepreneurial performance as found in advanced countries. However, although YICs in general are not as profitable as their counterparts, those focusing their innovation efforts on technological change do have higher profitability. This finding is especially meaningful for the government in developing countries, including Vietnam, to design a technological 'catch-up' framework through which they can foster economic growth and bridge the gap with advanced countries by providing business development services and support to YICs and PICs in conducting their technological change activities.

Other note-worthy findings include (i) technological resources, proxied by the rate of technical employees over the total firm labor force, are positively and significantly associated with firms' entrepreneurial performance. This is consistent with Cohen and Levinthal (1990) in showing that technological capacity enables firms to absorb incoming spillovers and protect their own knowledge; (ii) both capital intensive and highly leveraged YICs are less profitable; (iii) firms operating in multi-business sectors and/or exporting their products/services abroad outperform their peers. This confirms the recent findings from Garcia-Quevedo et al. (2014), Santarelli and Tran (2013), and Tran et al. (2015); and finally, (iv) a contradictory effect exists between labor size and economic size. Firms endowed with a large asset pool are normally capital intensive and thus incur high sunk costs and transaction costs because of their "asset specificity". This finding is consistent with the negative effect of capital intensity on firms' profitability. However, firms with large labor size are found to have superior performance.

For the last twenty years, Vietnam has been increasingly engaged in the process of international economic integration (as a member of AFTA-ASEAN Free Trade Area, BTA-Bilateral Trade Agreement with the US, and WTO). Vietnam's 'open door' policies for 'catching up' purposes include: greater openness to foreign trade and foreign trade investments, the opening up of indigenous industries for global competition, and greater support for private enterprises and entrepreneurial activity; along with co-current policies toward technological development. However, in looking at the economic liberalization efforts of Vietnam, the state has played a significant role in carrying out reforms and shaping the innovation system. Thus, Vietnam's National System of Innovation, the product of a single political party and a tendency toward central planning, relies very much on downward streams of information. As a result, similar to China, Vietnam might be less capable than other comparable transition countries in meeting the needs of rapidly changing and increasingly complex industries such as ICT and biotech. Beside some strengths such as a large pool of technical personnel to carry out R&D, numerous weaknesses in Vietnam's NSI result from poor quality of employees, impractical studies, poor research infrastructure and modest R&D financing (Ca, 2002).

In light of the above findings, to improve the country's international competitiveness, one important measure is to facilitate the interaction between PICs / YICs and the institutional context in which they operate. First, this interaction should be facilitated by selective actions of bridging intermediaries such as industry associations, Vietnam Chambers of Commerce and Industry (VCCI) aimed at facilitating knowledge flows between policy makers and innovators, and specifically promoting YICs' technological change by supporting investment in new machinery and capital equipment. Second, a favorable environment should be created for new entrepreneurial ventures in general (Veugelers, 2008), in which linkages between R&D institutions and the productive sectors are strengthened. Particularly, private firms which account for the majority of firm population and have constantly sustained a higher entrepreneurial performance should be the priority in the government's BDS (business development services) schemes. Third, in consideration of the results outlining the key role of technical employees, the creation of a solid repository of human resources and the hiring of qualified personnel should be promoted. Regrettably, most innovation policies try to promote the opposite; that is, fostering the formalization of in-house innovative activities through R&D expenditures when the lack of highly skilled personnel can be a deterrent to undertake R&D in SMEs.

Table 1: Performance of YICs, PICs, and SYCs

Variables	Return on sales (ROS)							
	Static GMM model				Dynamic GMM model			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ROS, t-1					0.031 (0.026)	0.031 (0.026)	0.031 (0.026)	0.035 (0.028)
YICs	0.0063 (0.0082)		0.0129 (0.0083)	0.014 (0.008)	0.038 (0.054)		0.036 (0.057)	0.037 (0.058)
PICs		0.007* (0.0037)	0.0108** (0.0045)	0.0112** (0.0052)		0.023** (0.009)	0.021 (0.013)	0.022 (0.015)
SYCs			0.0051 (0.0035)	0.0052 (0.0035)			-0.004 (0.013)	-0.004 (0.015)
R&D intensity	0.109** (0.017)	0.111** (0.018)	0.104** (0.018)	0.101** (0.017)	0.105 (0.067)	0.103 (0.067)	0.105 (0.067)	0.107 (0.068)
YICs*R&D intensity				0.0071* (0.0037)				0.145 (0.101)
PICs*R&D intensity				0.031 (0.033)				0.044 (0.071)
SYCs*R&D intensity				-0.075 (0.068				0.0002 (0.106)
Innovation investment	0.135** (0.028)	0.135** (0.028)	0.134** (0.028)	0.143** (0.035)	1.25** (0.324)	1.33** (0.336)	1.332** (0.337)	1.325** (0.335)
Innovation investment Squared	-0.277** (0.055)	-0.276** (0.055)	-0.276** (0.055)	-0.327** (0.075)	-1.63** (0.407)	-1.731** (0.423)	-1.732** (0.424)	-1.628** (0.388)
Technical personnel	0.055** (0.016)	0.054** (0.016)	0.055** (0.016)	0.057** (0.018)	0.04* (0.017)	0.039* (0.017)	0.039* (0.017)	0.041* (0.018)
Capital intensity	-0.0005** (0.0002)	-0.0005** (0.0002)	-0.0005** (0.0002)	-0.000** (0.000)	-0.00004 (0.0001)	-0.00004 (0.0001)	-0.00004 (0.0001)	-0.0000 (0.000)
Export	0.0095* (0.005)	0.0093* (0.005)	0.0095* (0.005)	0.009* (0.005)	0.013 (0.01)	0.012 (0.01)	0.012 (0.01)	0.0115 (0.07)
Diversification	0.0083** (0.0025)	0.0082** (0.0025)	0.0082** (0.0025)	0.008** (0.002)	0.002 (0.004)	0.002 (0.004)	0.002 (0.004)	0.003 (0.004)
Debt ratio	-0.024** (0.0067)	-0.024** (0.0067)	-0.024** (0.0067)	-0.032** (0.007)	-0.029** (0.011)	-0.03** (0.011)	-0.03** (0.011)	-0.05** (0.021)
Labor size	0.0132** (0.005)	0.0131** (0.005)	0.0128** (0.005)	0.0131** (0.005)	0.0002 (0.016)	0.0002 (0.016)	0.0002 (0.016)	0.0002 (0.017)
Labor size squared	-0.0018** (0.0006)	-0.0018** (0.0006)	-0.0018** (0.0006)	-0.002* (0.001)	-0.0007 (0.0019)	-0.0007 (0.0019)	-0.0007 (0.0019)	-0.000 (0.001)

Economic size	-0.0515** (0.0068)	-0.0515** (0.0068)	-0.051** (0.0068)	-0.057** (0.007)	-0.022 (0.017)	-0.024 (0.017)	-0.024 (0.017)	-0.028 (0.018)
Economic size squared	0.0035** (0.0004)	0.003** (0.0004)	0.0035** (0.0004)	0.0035** (0.0004)	0.001 (0.0009)	0.001 (0.0009)	0.001 (0.0009)	0.001 (0.000)
Firm age	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.00001 (0.0001)	-0.000 (0.000)	0.006** (0.0022)	0.006** (0.0023)	0.006** (0.0023)	0.007** (0.002)
Industry ROS	0.223** (0.092)	0.224** (0.092)	0.222** (0.091)	0.222** (0.092)	0.069 (0.108)	0.069 (0.108)	0.07 (0.108)	0.067 (0.105)
Average firm size	-0.0002 (0.0002)	-0.0002 (0.0002)	-0.0002 (0.0002)	-0.0002 (0.0002)	0.00006 (0.0002)	0.00005 (0.0002)	0.00005 (0.0002)	0.0000 (0.000)
Private firms	0.124** (0.003)	0.121** (0.003)	0.121** (0.003)	0.121** (0.003)	0.138** (0.023)	0.135** (0.021)	0.131** (0.022)	0.129** (0.021)
Limited liability firms	0.091** (0.02)	0.093** (0.02)	0.093** (0.02)	0.095** (0.02)	0.101** (0.05)	0.102** (0.06)	0.102** (0.06)	0.105** (0.08)
Province dummies	$3^2(60) =$ 840.03**	$3^2(60) =$ 840.69**	$3^2(60) =$ 842.87**	$3^2(60) =$ 857.11**				
Intercept	0.166** (0.021)	0.167** (0.021)	0.164** (0.022)	0.165** (0.022)	0.036 (0.064)	0.04 (0.064)	0.044 (0.065)	0.045 (0.067)
F-value	F(85) = 80.19**	F(85) = 80.23**	F(85) =81.45**	F(85) =83.5**				
Wald statistic					$3^2(23) =$ 469.79**	$3^2(23) =$ 469.33**	$3^2(23) =$ 490.10**	$3^2(23) =$ 497.23**
Under identififcation test	$3^2(1) =$ 3.98**	$3^2(1) =$ 4.01**	$3^2(1) =$ 4.12**	$3^2(1) =$ 4.13**				
Hansen J statistic of excl instr.	$3^2(1) =$ 0.038	$3^2(1) =$ 0.32	$3^2(1) =$ 0.027	$3^2(1) =$ 0.027				
Observations	241053	241053	241053	241053	99818	99818	99818	99818

*Note: *: significant at 5% level; **: significant at 1% level;*
Standard errors are used in both methodological treatments to adjust for clustering on firm code

Appendix 1: Descriptive statistics

Indicators	Variables	Measure	Obs.	Mean	Std. Dev.	Min	Max
Accounting measures	ROS: Return on sales	$ROS = \frac{Operatingprofit}{Totalsales}$	408492	0.0047	0.216	-17.75	13.54
Types of firms	Young innovative firms (YIC)	$YIC_{it} = \begin{cases} 1 \text{ if} age_{it} < 6 \& labor_{it} < 250 \& R\&D_{it} > 15\% \\ 0\ otherwise \end{cases}$	408492	0.009	0.095	0	1
	Private innovative firms	$PIC_{it} = \begin{cases} 1 \text{ if} ownership_{it} = private\text{firms} \& R\&D_{it} > 0 \\ 0\ otherwise or \text{if} YIC_{it} = 1 \end{cases}$	408492	0.064	0.245	0	1
	Small and young firms	$SY_{it} = \begin{cases} 1 \text{ if} age_{it} < 6 \& labor_{it} < 250 \\ 0\ otherwise or \text{if} PIC_{it} = 1\ or YIC_{it} = 1 \end{cases}$	408492	0.538	0.498	0	1
Innovation	R&D expenditures	Natural logarithm of R&D spending / expenditure	408492	1.081	2.394	0	12.231
	R&D intensity	The ratio between R&D expenditure and total production expenses	408492	0.022	0.098	0	0.994
	Innovation investment rate	The ratio between investment into innovation activities and total annual business investment	408492	0.075	0.166	0	1
	Technical human resources	The rate of technical personnel in total firm labor force	408492	0.057	0.163	0	1
Firmsize	Labor size	Natural logarithm of the number of total employees	408492	3.009	1.682	0	9.171
	Economic size	Natural logarithm of total assets	408492	7.807	2.045	0	16.494
Firm age	Firm age	Number of years firm has been operating	408492	9.386	8.126	0	105
Firm export	Export	The dummy attains 1 if the firm exports, 0 otherwise	408492	0.115	0.319	0	1
Firm diversification	Diversification	The dummy attains 1 if the firm diversifies, 0 otherwise	408492	0.146	0.353	0	1
Financial leverage	Debt ratio	$Debtratio = \frac{Totaldebt}{Totalassets}$	408492	0.346	0.324	0	1
Capital intensiveness	Capital intensity	$Capitalintensity = \frac{Fixedassets}{Numberofemployees}$	408492	102.37	628.95	0	437000
Control variables	Ownership types	Dummy variables for 6 ownership types: (1) State-owned firms; (2) Cooperatives and Partnership; (3) Private firms; (4) Limited liability firms; (5) Joint stock firms; (6) Foreign-invested firms					
	Province	Dummy variables for 64 provinces of Vietnam					
	Industry: average firm size	The ratio between total employees in the industry and the number of firms in the industry	408492	71.753	120.86	9.64	3387.03
	Industry: average industry ROS	$\frac{1}{n}\sum_{i}^{n}\frac{Operatingprofit_i}{Totalsales_i}$ (n firms in the industry)	408492	0.022	0.043	-0.281	0.411

Appendix 2: Pairwise correlation matrix

	ROS	R&D intensit	Innov. Invest	Tech.p erso	Capital intensit	Export	Labor size	Eco. Size	Debt ratio	Firm age	Indus try ROS	Average firmsize
ROS	1.000											
R&D intensity	.032*	1.000										
Innovation invest.	-.022*	.117*	1.0000									
Technical personnel	-.004	-.021*	-.011*	1.000								
Capital intensity	-.075*	.018*	.0005	.065*	1.0000							
Export	-.012*	.022*	.019*	.0025	.011*	1.0000						
Labor size	-.013*	.068*	.08*	.042*	.038*	.311*	1.0000					
Economic size	-.029*	.062*	.051*	.108*	.206*	.276*	.783*	1.0000				
Debt ratio	-.027*	.021*	.031*	.116*	.051*	.153*	.445*	.555*	1.0000			
Firm age	.0039	.027*	-.019*	-.0075	.0009	.043*	.147*	.157*	.103*	1.0000		
Industry ROS	.032*	.045*	.025*	.045*	.054*	.0072	.153*	.134*	.096*	.043*	1.000	
Average firm size	-.025*	.049*	.039*	-.013*	.0078	.192*	.375*	.22*	.108*	.011*	.107*	1.0000

*Note: *:significantat 1% level*

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