Hai-Chin Yu (Taiwan), Dung Phuong Tong (Taiwan)

Banking relationships, R&D investment, and growth opportunities in China

Abstract

This study investigates whether the relationships with banks moderate the relationship of innovation investment and firm growth. Using panel data of Chinese-listed firms from 1999 to 2008, this study examines the effect of banking relationships on innovation investment and the influence of such investment on firm growth opportunities. After employing a two-stage least squares simultaneous equation model, find a non-linear relationship between banking relationships and innovation investment, which in turn has a positive and significant effect on firm growth opportunities. Results suggest that maintaining relationships with one or two banks is optimal for firms to maximize their innovation capacity and achieve significant growth. When firms borrow from five banks or more, their innovation investment starts to decline. Our findings provide evidence in support of the relationships with banks affect innovative investment and facilitate firm growth opportunities.

Keywords: R&D, innovation, banking relationships, growth opportunity.
JEL Classification: G32, L33, O31, O43.

Introduction

Innovation has been viewed as one of the key factors for firms to keep sustainable growth, profits, and survival. Innovation can be new products, processes, or markets to meet customers' new needs (Brouwer, 1991).

Prior studies indicated that innovation is the core factor behind the intensification of firm growth and the relationship between innovation and firm growth have been investigated over the past decades. Schumpeter (1934) claimed that innovation positively affects firm profitability. This view has been considered true for the last few decades. Sirelli (2000) suggested that firms are encouraged to innovate because doing so leads to higher growth rates. Klette and Griliches (2000) presented the model of endogenous firm growth with innovation as an engine of growth. Bottazzi et al. (2001) analyzed the world's largest pharmaceutical companies and provided evidence that innovative chemical entity or patent products have a significant effect on firm growth. The present work attempts to fill the gap in the literature on the relationship between innovation and firm growth in the context of China.

China is a typical example of an economy that has undergone considerable growth. Since the mid-1990s, the Chinese government has nurtured technology-based industries and encouraged firms to innovate products and processes. Wu (2011) explored the force behind China's economic growth using provincial statistics and found innovation as the decisive factor for China's rapid economic growth.

However, innovation investment is uncertain and involves greater asymmetric information than physical investments. These features hinder investors from easily measuring the effect of innovation on firm growth. Despite the mixed empirical results, the topic still draws the interest of researchers. Chan et al. (1990) and Zantout and Tsetsekos (1994) identified a positive (negative) market response to innovation among firms in high-tech (low-tech) industries. Acs and Isberg (1996) indicated that the effect of innovation on Tobin's Q varied with firm size. Many researchers suggested a significant relationship between innovation and firm growth[1]. By contrast, Link (1981) and Sassenou (1988) claimed that innovation has a limited or even a negative effect on corporate performance.

Due to innovation is the core of firm growth, many scholars have been exploring the financing of innovation. Innovation entails high-risk and uncertainty that internal sources such as free cash flow are not favorable because of the agency problem. Shareholders prefer to stable dividends instead of uncertain investments. Equity is also an obstacle for financing innovation because of the costly process and the possible dilution of ownership. Therefore, firms may need external funding from private lenders such as banks to finance their innovation. Bilateral contracts between banks and firms require firms to attach the details of their innovation investments. In this case, banks, as insiders, may reduce the asymmetric information on the firms. The banking relationships are obviously crucial for the innovation capability of firms. Our issue is whether endogenous innovation via banking relationships indirectly influences firm growth.

Hai-Chin Yu, Professor, Department of International Business, Chung Yuan Christian University, Chung-Li, 32023, Taiwan.
Dung Phuong Tong, Ph.D. Candidate, College of Business, Chung Yuan Christian University, Chung-Li, 32023,Taiwan.

[1] See, for example, Nelson and Winter (1982), Aghion and Howitt (1992), Klette and Griliches (2000), and Klette and Kortum (2004).

Theoretically, banks are information producers and processors (see, for example, Leland and Pyle, 1977; Diamond, 1984; Fama, 1985). Firms with good relationships with banks may reduce asymmetric information from investors. Due to the information of innovative projects is confidential, fewer banks to be dealing with may keep the advantage for innovation. The extant research demonstrates that in addition to innovation, banking relationships are known to influence firm growth. The extant research addressed a close banking relationships to facilitate firm growth via established reputation and less asymmetric information (Diamond, 1984), or less information leaking (Campbell, 1979). Firms may also lower costs through easy loans and preferential interest rates (Peterson and Rajan, 1995). On the other side, some certain risks may emerge. Dass and Massa (2006) indicated that banks do not prefer high-risk projects and novel innovations. Moreover, the lock-in problems may appear when banks hold private information. Castelli et al. (2006) revealed that firm profitability decreases as the number of banking relationships increases. Fok (2004) indicated a negative correlation between firm performance and domestic bank relationships, whereas a positive correlation between firm performance and foreign bank relationships. Therefore, the idea of this study is to expand the literature by examining whether banking relationships influence firm growth via innovation.

In this work, we consider a large panel of Chinese firms with data covering the period 1999-2008. The unique characteristics of bank-firm relations in China are quite different from those in other emerging economies: large firms favor multiple banking relationships; small and medium firms maintain a single banking relationship (Yin and Matthews, 2014). Although the single banking relationship allows firms to reduce the monitoring costs and collateral requirements (Farinha and Santos, 2002), it is likely to be locked-in that a high switching cost may face. By contrast, multiple banking relationships reduce information lock-in and liquidity risks, high monitoring costs may be combined (Yin and Matthews, 2014). Based on the large variation in banking relationships, this study examines the investment in innovation by taking into account the number of banking relationships and explore whether different relationships with banks significantly influence the relationship of innovation investment and firm growth.

This study differs from prior research in some points. First, we use Tobin's Q to measure firm growth, which is usually based on sales growth or profitability growth. Second, we employ two-stage least squares (2SLS) regression to examine the effect of innovation on firm growth through a number of banking relationships. In other words, we use banking relationships as an instrumental variable for innovation investment to determine the relation between innovation and firm growth.

The remainder of the study is organized as follows. Section 1 summarizes the theories on the relationship among the three dimensions. Section 2 describes the data and methodology used in this study. The third section reports the estimation and the expected results. The final section presents the results and suggestions.

1. Literature review

The idea to link innovation and banking relationships is discussed in theoretical literature. Banks directly affect the quantity of R&D and investment spending. They affect the nature of selected projects, the quality of internal inputs, and their effectiveness in generating innovation. First, when firms launch innovative products, banking relationships may assist them in selecting appropriate distribution channels. Second, firms can improve the quality of internal inputs by disclosing information to the relationship bank without worrying about unauthorized disclosure to competitors. Finally, the bank can offer firms multi-period contracts, which are more effective (saving transaction costs) and safe (extracting information) than one-shot contracts. Thus, the arrangement allows firms to commit resources to innovative activities. Giannetti (2009) suggests a higher share and a longer relationship with a main lending bank having a positive impact on the innovation capacity of high-tech firms. Herrera and Minetti (2007) test the correlation of the information of firms' main bank – measured by the duration of credit relationship and innovation and state that it fosters the probability of the firm's innovation. Also, using Italian SMEs data during the period 2004-2009, Frazzoni et al. (2014) show that the strength of banking relationships significantly affects the probability of innovation in introducing product. Lagaras (2014) sheds light on the banking relationships stimulating firm innovation in the US. Atanassov (2014) then uses a large US panel data and finds firms borrowing from multiple banks having more citations per patent.

Companies that innovate successfully have superior performance to that of their less able competitors. To survive, a firm must not only produce a given set of goods or employ a given set of inputs and process technologies, but also develop the ability to innovate and profit from that innovation (Nelson, 1991). Roper (1997) emphasizes on SMEs and indicates that innovative products significantly contribute to the sales growth of SMEs, which grow faster than non-innovative SMEs. This topic has been observed largely in European countries. The researches of Italian firm-level data of Cainelli et al. (2006) suggest that the growth of innovative firms is higher than non-innovative firms. Engel et al. (2004) analyze German SMEs and conclude that the sales turnover of innovative SMEs grows faster than that of non-innovative firms. Yang and Huang (2005) examine the effect of R&D on firm growth and find that firms with intensive R&D are associated with high growth rates. Niefert (2005) also finds evidence on the positive effects of innovation on firm growth. Using micro data from Brazilian manufacturing firms, Goedhuys (2007) reports that innovation activities are important to explain firm's productivity and ultimately sales growth. Consistently, Lee, Choi and Choe (2007) confirm the significant impact of innovation as Korean innovative firms show better growth in sales, employment and labor productivity than non-innovative firms. However, the empirical evidence from Stam and Wennberg (2009) addresses that innovation activities only have positive effect on the growth for fast-growing firms while it does not help foster the growth for average firms. Freel and Robson (2004) implement a survey of 1,347 respondents of enterprise in Scotland and Northern England, and hypothesize that, at least in the short term, a negative relationship between product innovation and growth in sales. Conversely, process innovation is positively related to sales growth for service firms. Goedhuys et al. (2006) investigate Tanzanian firms but find out a significant association between innovation output as well as R&D and firm growth.

Coad and Rao (2008) also relate innovation to sales growth for high-tech firms using quantile regression approach. They addressed that innovation is crucial for "superstar" fast-growing firms. Demirel and Mazzucato (2012) contribute to the emerging literature by exploring how innovation affects firm growth of small and large US pharmaceutical firms. The results divulge that R&D boosts firm growth for a subset of small firms that have patents persistently for a minimum of five years; while R&D has a negative impact on firm growth for large firms. More recent, Segarra and Teruel (2014) also indicate that innovation is the key factor for driving a firm to become a highly growing firm using Spanish firms.

In sum, the prior studies relate to how banking relationship affects R&D investment and growth is still lacking. Our study fills this gap.

2. Data and methodology

2.1. Data. Data are collected from four sources, namely, (a) the China Stock Market and Accounting Research (CSMAR) database, (b) the Ju-Chao website on Listed Firms Information Release Panel, (c) the Shanghai Stock Exchange, and (d) the Shenzhen Stock Exchange. We obtained 10,929 observations from approximately 1400 firms listed on the Shanghai and Shenzhen exchanges of financial data and 6,407 observations of banking relationship data from 1999 to 2008.

2.2. Methodology. Because the two equations are estimated using the same data, their error terms may be correlated. To address this problem, we use a 2SLS regression model, an extension of the linear regression model, to solve correlated errors between equations.

This study investigates the nature of the relation between innovation and firm growth as measured by Tobin's Q using a 2SLS regression for Chinese listed firms. The study also examines the difference of innovation and growth between stated-owned firms (SOEs) and private-owned firms (POEs). We use the percentage of shares owned by the state as a proxy for state owner diverse. Firms with more than 50% public ownership are defined as state-owned, whereas firms with less than 50% public ownership are considered private firms.

Our simultaneous equations are expressed as Equations (1) and (2).

$$GROWTH = \beta_0 + \beta_1 INNOVATION_{t-1} + \beta_2 AGE + \beta_3 SIZE + \beta_4 DEBT\_TA + \beta_5 CAPEX\_TA + \beta_6 \mathrm{FCF}\_TA + \beta_{7\text{-}12} INN\_D + \beta_{13} POETs + \varepsilon_t. \quad (1)$$

$$INNIVATION = \gamma_0 + \gamma_1 BR + \gamma_2 SIZE + \gamma_3 AGE + {} + \gamma_4 FCF_{TA} + \gamma_5 POE_S + \gamma_{6\text{-}11} INN_D + \propto_t \quad (2)$$

2.2.1. Description of variables in Equation (1). We use Tobin's Q as a proxy for growth opportunities *GROWTH*. Tobin's Q is measured by the market value of assets (the market value of equity plus the book value of debt) divided by the book value of assets. For a given year, growth companies are firms with Tobin's Q greater than the median for that year.

One determinant of *GROWTH* is *INNOVATION*, as measured above. We use the ratio of expenditure on intangible assets to total assets, the R&D expenditure ratio and property rights, to present *INNOVATION*. The data on the R&D expenditure ratio are incomplete before 2005, it is more complete after that. Roper (1997) and Engel et al. (2004) find a strong relationship between firm innovation and growth opportunity. Yasuda (2005) shows a significant correlation between R&D expenditure per employee and firm growth. We expect the significant and positive effect of *INNOVATION* on *GROWTH*.

Firm age and size are the two most common independent variables that affect firm growth. The *SIZE* logarithm of total assets and *AGE*, which pertains to the age or maturity of the company, are labeled as firm size and firm age. Almus and Nerlinger (1999) find that firm age affects growth negatively, implying that old firms grow more slowly than young firms. Hall (1987) analyzes US manufacturing firms and indicates that large firms are associated with low growth. Becchetti and Trovato (2002) also find an inverse relationship between growth and size. Following the most recent findings, we expect that the size and age of firms negatively affect the growth of firms.

The capital expenditure ratio (*CAPEX_TA*) is the ratio of capital investment expenditure to total assets. The evidence from Houston and James (1996) documents that market value (Tobin's *Q)* definitely relies on firm growth opportunities, which are impacted by capital expenditure. We control the firm liquidity by cash ratio (*CASH_RT*). It is calculated by the ratio of total cash and cash equivalents to total liabilities. This determinant suggests that companies grow faster if they hold a sustained level of current assets to pay off their short-term liabilities. An increase in the cash ratio reinforces the liquidity position of the firm. Gill and Mathur (2011) suggest that maintaining a high liquidity level helps firms face less severe financing constraints. We expect that liquidity positively affects firm growth. The debt ratio (*DEBT_TA*) is the ratio of short-term debt to total assets. According to Majumdar and Chhibber (1999), it is found to have significantly negative impact on firm performance for the sample of Italian firms. Conversly, Abor (2005) reveals the evidence to support that short-term debt to total assets is significantly positively correlated with firm profitability (measured by ROE).

We also add different industry dummies (*IND_D*) to control for industry-specific differences in growth rates. Firms in different industries exhibit different growth. Harhoff (1998) suggests that the effects of different growth factors are slightly different in four selected industries, namely, the manufacturing, construction, trade, and service industries. Dunne and Hughes (1994) include 19 industry dummies in their investigation. We investigate the possibility that the effect of the independent variables varies with the industry. Furthermore, we run the model including six industries, namely, public utilities, real estate (property) development, general, industrial (manufacturing), commercial and other industries

We include *POEs* as a dummy variable to measure the growth difference of two types of owners' diverse. *POEs* is 1 for private-owned firms or 0 otherwise. Because each firm has different characteristics, we expect different rates of growth.

2.2.2. Description variables in Equation (2). Our dependent variables are presented by *INNOVATION*. Consistent with Equation (1), we use the ratio of expenditure on intangible assets to total assets, including the expenditure on R&D expenditure and property rights, to represent innovation.

We add the number of the banking contacts of firms to this model as a control variable. We use *BR* to measure the closeness of the bank-borrower relationship. *BR* is the number of banks the firm borrows from, that is, borrowing concentration. Benfratello et al. (2008) indicate that banking relationships significantly affect process innovation but weakly affect product innovation. Bhattacharya and Chiesa (1995) point out that an inverse relationship exists between firm innovation and the number of banking relationships because of information dissemination problems.

The variables that describe the internal structure of the company include variable *SIZE*, which shows the size of the business; the natural logarithm of total assets; and *AGE*, which shows the age or maturity of the company. Fernández (1996) claims that large companies have advantages to innovate, such as economy of scale, low risk, large market, and great opportunities for appropriation. Thus, we find a report on the positive relationship between size and innovation. On the age variable, an old firm indicates that the experience and knowledge it accumulated throughout its history are advantageous to the creativity and communication necessary to innovate (Galende and De la Fuente, 2003). Therefore, the expected sign for the age variable is positive, consistent with literature.

The free cash flow ratio (*FCF_TA*), which pertains to the availability of the internal cash of the firm, is one key determinant of innovation. It is measured by taking free cash flow divided by total assets. The variable is considered such a determinant and the main form of financing innovation because of its lower cost and risk than external finance. Pinkowitz et al. (2012) indicate that if firms have insufficient internal funds, innovations may be suspended. Therefore, we hypothesize that firms with higher free cash flow invest more in innovation activities and are thus more innovative.

We also include ownership, which may significantly affect firm innovation. *POEs* is the owner-types dummy variable. *POEs* is given a "1" or a "0" for private-owned or others. According to prior research, inefficient and unprofitable firms are not forced into bankruptcy because of state intervention. Policies reduce the incentive of *SOEs* to develop new methods and products and thereby reduce innovation. By contrast, *POEs* face the threat of bankruptcy and the constraints of financing. They are constantly under pressure to meet their target profits. *POEs* have strong incentive to adopt new practices and introduce innovative products that would further increase their innovation capacity because of the pressure.

The last determinant of innovation is industry-specific characteristics, which, in the form of knowledge externalities, may determine innovation activity (Cohen et al., 1987). We cluster the sample firms into six groups according to firm type as in Equation 1, namely, public utilities, real estate (property) development, general, industrial (manufacturing), commercial and other industries. We employ firm diversification as the dummy variable. For example, 1 denotes the public utility industry, and 0 denotes others; 1 denotes the general industry, and 0 denotes others.

3. Empirical results

Panel A of Table 1 shows the results of the summary statistics on the endogenous and exogenous variables for full sample. For the endogenous variable *GROWTH*, the highest value of Tobin's Q is 40774.68, whereas the lowest is 0.6. All sample firms grow, but significant differences are observed in growth among them. The mean of *GROWTH* is 6.59 (with a median of 1.82) which is high compared to U.S. firms that have an average of 2.89 (Cui and Mak, 2002). The second endogenous variable is *INNOVATION*, which has a mean of 0.04, which is low compared to American firms that have average of 0.1 to 0.16 (Ho et al., 2006; Cui and Mak, 2002). The minimum is 0 and reveals that some firms even do not spend expenditure on any innovation projects.

The average banking relationships are 2.63 (with a median of 2), which imply that Chinese firms tend to deal with fewer banks compared with other emerging market firms. And this number is close to U.S. of 2. The 1th quartile of *BR* is 0, implying that almost 25% sample do not borrow from any banks. By contrast, some firms even deal with as many as 15 banks. *SIZE* represents the size/scale of the firm and has an average value of 21.12, which significant is higher in comparison of U.S. firms that have the mean of 17.89 (Cui and Mak, 2002), implying that the difference in firm size may exist. The average age of firms is 26, the youngest firms are 3, and the oldest is 107 years old. The *DEBT_TA* mean is 0.67 while the average value of *CAPEX_TA* is -0.19. Free cash flow to total assets ratio (*FCF_TA*) has the value approximately equal to cash ratio (*CASH_RT*) with the mean and median equal to 0.14 and 0.12 respectivly.

Panel B of Table 1 presents the comparison on statistics of variables for firms with multiple and single banking relationships. Firm that maintain single banking relationships have extremely larger *GROWTH* than those with multiple banking relationship (21.4 compared to 2.77) even the R&D expenditure of two type firms are almost equivalent (0.04). Firms that deal with single bank have the average size and age of 21.1 and 24.88; whereas those values of multiple-bank lending firms are 21.22 and 26.49, indicating that small and young firms tend to deal with single bank while large and old firms are in favor of multiple banks. These results are consistent with the study of Yin and Matthews (2014).

Panel C of Table 1 reports the different statistics which is classified by owner diverse. The mean (median) of Tobin's Q for *POEs* is 14.24 (1.71) and range from 0.6 to 40774.68, which implies the far different growth opportunity among private firms. *SOEs* even have lower Tobin's Q on average (2.38) but it substantially changes from 0.65 to 52.91, which is significantly different to the range of *POEs*. The mean of *BR* (3 vs 2) and cash ratio (0.14) of two type firms are close similar. Not surprisingly, POEs show higher growth opportunity (14.24 vs 2.38), higher innovation expenditure (0.046 vs 0.038), extremely higher debt ratio (0.91 vs 0.14) and larger size (21.43 vs 21.06). However, it shows a lower median capital expenditure ratio (0.02 vs 0.03) and free cash flow ratio (0.12 vs 0.48) compared to *SOEs*. It implies that *POEs* are lager, spend more on innovation projects, have higher liquidity capability and higher growth opportunity. However, these firms have lower capital expenditure and free cash flow.

Panel D summarizes the selective statistics on different industries. Commercial industry shows the highest innovation expenditure of 5% associated with the highest growth opportunity of 9.16 and the highest banking relationship of 2.9, followed by general and other industries. Public utilities remain the lowest innovation expenditure of 3.7% associated with 1.56 growth opportunity and 0.69 number of banking relationships. The results in panel D and chart 2 demonstrate the correlation of innovation expenditure and growth opportunity within an industry.

Table 2 shows the sample distribution and the Tobin's Q and innovation across different years, industries, ownership types. First, the growth opportunity of Chinese enterprises decreased from 2000 to 2005 and then increased from 2006 to 2008. Innovation rose twice from 0.032 to 0.065 during the decade (panel A). Panel B implies different firm opportunities and innovations across the five industries. Commercial has the highest firm opportunity innovation, whereas public utilities have the lowest value. Panel C measures the change in innovation and banking relationship based on the number of banking relationships. Firms obtain the highest innovation expenditure at three banking relationships for both full sample and two ownership types. We also note that innovation is increasing with an increasing of banking relationship when banking relationships are less than three. When banking relationships are greater than three, innovation turns out to be decreasing with an increasing of banking relationships. These are the evidenced to expect the significant effect of banking relationship on innovation.

Table 3 shows the results of the simultaneous equation model, implying that growth opportunity and innovation are endogenous variables. Column (1) shows the results of the full sample. It reports an insignificant impact of number of banking relationships on innovation expenditure. However, when we divide the full sample in to three sub-samples by the number of banking relationships, the results are different. For the first sub-sample ($0 < BR < 3$), banking relationships significantly affect innovation expenditure with positive coefficient of 0.003. It suggests dealing with one or two banks, which is optimal for firm to innovate since firms may access to abundant capital but the cost paid not too high. Firm size and free cash flow are decreasing with innovation coefficients equal to -0.01 and -0.082, respectively which means small firms are more likely spend much more on innovation and firms with high free cash flow are not interested in investing in innovation projects. Firm owner diverse is positivel related to innovation with a coefficient of 0.009, indicates that *POEs* have higher innovation expenditure compared to *SOEs*. The second regression on firm growth opportunity in column (6) reports the significant positive relationship between innovation and growth opportunity. Innovation is increasing with growth opportunity with the coefficient of 350.8 which reflects that innovation is the powerful determinant of firm growth opportunity. However, owner diverse is negatively correlated with growth opportunity suggesting that even *POEs* invest much more in innovation than *SOEs* but they have lower growth opportunity compared to *SOEs*. The other variables also have significant impacts on growth opportunity as we expected.

For the second sub-sample ($3 \leq BR < 5$), we do not find the significant effect of banking relationship on innovation, which implies that dealing with three or four banks does not help to explain the expenditure on ($5 \leq BR \leq 15$) innovation. The results of the last sample are reported in columns (4) and (8). Column (4) provides the significant and negative coefficient of banking relationships on innovation expenditure (-0.002), and points out that borrowing from numerous of banks (from five to fifteen banks) leads to low innovation. It is converse to the positive relationship between those variables in the first sub-sample which demonstrates that banking relationships effect is nonlinear rather than linear. This finding sounds reasonable: main banking relationships with one or two banks help reduce asymmetric information problem and save costs so firms, having great advantages and resources to innovate. In contrast, innovation investment is destroyed for those firms which maintain more than five banking relationships. Dealing with too many banks put firms in the pressure of information leakage and exstremely high transactional costs, thus innovation expenditure declines compared to other firms.

Although banking relationships shows different impact on innovation in each sub-sample, the correlation between innovation and growth opportunity is consistent. Innovation adds value to Tobin's Q with a coefficient of 33.447. The significant coefficients of *AGE*, *DEBT_TA* and *CASH_RT* are -0.018, 1.303 and 3.995 respectively, and show that small firms, high debt ratio and cash ratio have higher growth opportunity. The effect of *SIZE* and *POEs* are insignificant while the effect of *CAPEX_TA* is significantly negative. This finding differs from most of the extant literature.

The coefficients on the industry dummies (*IND_D1* – *IND_D6*) in models (1)-(4) show that there is no effect of industry type on innovation expenditure. For growth opportunity regression, just only *IND_D1* is correlated with Tobin's Q suggesting that firm growth opportunity is increasing in public utilities industry.

Conclusion

Using 2SLS SEM approach of the Chinese firm-level data, our findings have implications for the understanding of the effect of innovation on firm growth opportunity through the number of banking relationships. First, we find that innovation investment significantly and positively influences a firm's Tobin's Q. Secondly, a non-linear relationship between banking relationships and innovation was found. Banking relationships add value to firms via innovation investment when firms deal with one or two banks; whereas it destroys innovation investment and the reflective Tobin's Q when firms maintain more than five banking relationships. Additionally, we hypothesize that POEs spend more innovation investments compared to SOEs; however, these investments may not be efficient enough than lower Tobin's Q on *POEs* was found. Besides, we find significant industry effects on growth opportunities, while it is insignificant on innovation expenditure, implying that innovation investments do not differ significantly across various industries.

Enterprises, especially some special industries, should make more efforts to create the comparative advantage via created close rather than fragmented banking relationships and innovation investment.

References

1. Abor, J. (2005). The effect of capital structure on profitability: an empirical analysis of listed firms in Ghana, *Journal of Risk Finance*, 6 (5), pp. 438-445.
2. Acs, Z.J. and Isberg, S.C. (1996). "Capital structure, asset specificity and firm size: a transaction cost analysis", in Behavior norms, technological progress, and economic dynamics: studies in Schumpeterian economics, University of Michigan Press.
3. Atanassov, J. (2014). Arm's Length Financing and Innovation: Evidence from Publicly Traded Firms, *Management Science*, forthcoming.
4. Becchetti, L. and Trovato, G. (2002). The determinants of growth for small and medium sized firms, the role of the availability of external finance, *Small Business Economics*, 19 (4), pp. 291-306.
5. Benfratello, L., Schiantarelli, F. and Sembenelli, A. (2008). Banks and innovation: Micro econometric evidence on Italian firms, *Journal of Financial Economics*, 90, pp. 197-217.
6. Bhattacharya, S. and Chiesa, G. (1995). Proprietary information, financial intermediation, and research incentives, *Journal of Financial Intermediation*, 4, pp. 28-357.
7. Brouwer, M. (1991). Schumpeterian Puzzles: Technological competition and economic evolution, University of Michigan Press, Michigan, 1991.
8. Bottazzi, G., Dosi G., Lippi M., Pammolli F. and Riccaboni M. (2001). Innovation and Corporate Growth in the Evolution of the Drug Industry, *International Journal of Industrial Organization*, 19, pp. 1161-1187.
9. Campbell, T.S. (1979). Optimal invesment financing decisions and the value of confidentiality, *Journal of Financial and Quantative Analysis*, 14, pp. 232-257.
10. Cainelli, G., Evangelista, R., Savona, M. (2006). "Innovation and economic performance in services: a firm level analysis", *Cambridge Journal of Economics*, 30, pp. 435-458.
11. Castelli, A., Dwyer, G.P. Jr. & Hasan, I. (2006). "Bank relationships and small firms' financial performance", Federal Reserve Bank of Atlanta, Working paper, 2006-2005.
12. Chan, S.H., Martin, J. and Kensinger, J. (1990). Corporate research and development expenditures and share value, *Journal of Financial Economics*, 26 (2), pp. 255-276.
13. Coad, A., Rao, R. and Tamagni, F. (2008). Growth Processes of Italian Manufacturing Firms, Jena Economic Research Papers 2008-039, Friedrich-Schiller-University Jena, Max-Planck-Institute of Economics.
14. Cohen, W.M., Levin, R.C. and Mowery, D.C. (1987). Firm size and R&D intensity: A re-examination, *Journal of Industrial Economics*, 35, pp. 543-563.
15. Cui, H. & Mak, Y.T. (2002). The relationship between managerial ownership and firm performance in high R&D firms, *Journal of Corporate Finance*, 8 (4), pp. 313-336.
16. Dass, N. & Massa, M. (2006). The Dark Side of Bank-Firm Relationships: The (Market) Liquidity Impact of Bank Lending, Georgia Institute of Technology, Working paper.
17. Demirel, P. and Mazzucato, M. (2012). Innovation and firm growth: Is R&D worth it?, *Industry and Innovation*, 19 (1), pp. 45-62.
18. Diamond, D. (1984). Financial Intermediation and Delegated Monitoring, *Review of Economic Studies*, 51, pp. 393-414.
19. Dunne, P. and Hughes, A. (1994). Age, size, growth and survival: UK companies in the 1980s, *Journal of Industrial Economics*, 42 (2), pp. 115-140.
20. Engel, D., Rothgang, M. & Trettin, L. (2004). Innovation and their Impact on growth of SME – Empirical evidence from Craft Dominated Industries in Germany, Paper presented at the EARIE 2004 Conference, 2-5 September, Berlin, Germany.
21. Fama, E. (1985). What's different about banks? *Journal of Monetary of Economics*, 15, pp. 29-39.
22. Farinha, L.A. and Santos, J.A.C. (2002). Switching from Single to Multiple Bank Lending Relationships: Determinants and Implications, *Journal of Financial Intermediation*, 11, pp. 124-151.
23. Farinha, L.A. and Santos, J.A.C. (2002). Switching from Single to Multiple Bank Lending Relationships: Determinants and Implications, *Journal of Financial Intermediation*, 11, pp. 124-151.
24. Fernández, E. (1996). Innovación, tecnología y alianzas estratégicas: Factores clave de la competencia, Biblioteca Civitas Economía y Empresa, Madrid.
25. Fok, C.W., Chang, Y.C., & Lee, W.T. (2004). Bank relationships and their effects on firms performance around the Asian financial crises: evidence from Taiwan, *Financial Management*, Summer, pp. 89-112.
26. Frazzonia, S., Mancusib, M.L., Rotondic, Z., Sobrerod, M. and Vezzulli, A. (2014). Relationships with banks and access to credit for innovation and internationalization of SMEs, Working paper.
27. Freel, M.S. and Robson, P.J.A. (2004). Small Firm Innovation, Growth and Performance: Evidence from Scotland and Northern England, *International Small Business Journal*, 22 (6), pp. 561-575.
28. Galende, J. and Fuente, J.M. (2003). Internal factors determining a firm's innovative behavior, *Research Policy*, 32 (5), pp. 715-736.
29. Giannetti, C. (2009). Relationship Lending and Firm Innovativeness, Discussion Paper.
30. Gill, A. and Mathur, N. (2011). Factors that Affect Potential Growth of Canadian Firms, *Journal of Applied Finance & Banking*, 1 (4), pp. 107-123.
31. Goedhuys, M., Janz, N., Mohnen, P. (2006). What drives productivity in Tanzanian manufacturing firms: technology or institutions?, UNU-MERIT working paper 2006-039, Maastricht.

32. Goedhuys, M. (2007). The impact of innovation activities on productivity and firm growth: evidence from Brazil, MERIT Working Papers 002, United Nations University – Maastricht Economic and Social Research Institute on Innovation and Technology (MERIT).
33. Hall, B. (1987). The relationship between firm size and firm growth in the US manufacturing sector, *Journal of Industrial Economics*, 35, pp. 583-606.
34. Harhoff, D. (1998). R&D and Productivity in German Manufacturing Firms, *Economics of Innovation and New Technology*, 6, pp. 29-49.
35. Herrera, A.M. and Minetti, R. (2007). Informed finance and technological change: evidence from credit relationships, *Journal of Financial Economics*, 83, pp. 223-269.
36. Ho, Y.K., Tjahjapranata M. and Yap, C.M. (2006). Size, leverage, concentration, and R&D Investment in generating growth opportunities, *Journal of Business*, 79 (2), pp. 851-876.
37. Houston, J.F. and James, C. (1996). Banking relationships, financial constraints and investment: are bank dependent borrowers more financially constrained? *Journal of Financial Intermediation*, 5 (2), pp. 211-221.
38. Klette, T.J. and Griliches, Z. (2000). Empirical Patterns of Firm Growth and R&D Investment: A Quality Ladder Model Interpretation, *The Economic Journal*, 110, pp. 363-387.
39. Lagaras, S. (2014). The Bank Lending Channel and Corporate Innovation, Working paper.
40. Lee, K.J., Choi, S.H. and Choe, B.H. (2007). Innovation Heterogeneity and Firm Growth in the Korean Service Industry, Conference in Busan, Korea.
41. Leland, H.E. and Pyle, P.H. (1977). Informational Asymmetries, Financial Structure, and Financial Intermediation, *Journal of Finance*, 32 (2), pp. 371-387.
42. Link, A. (1981). Research and Development activity in US manufacturing, Praeger, New York.
43. Majumdar, S.K. and Chhibber, P. (1999). Capital Structure and Performance: Evidence from a Transition Economy on an aspect of Corporate Governance, *Public Choice*, 98 (3-4), pp. 287-305.
44. Nelson, R.R. (1991). Why do firms differ, and how does it matter? *Strategic Management Journal*, Winter Special Issue, 12, pp. 61-74.
45. Niefert, M. (2005). Patenting behavior and employment growth in German start-up firms, ZEW Discussion Paper 05-03, Centre for European Economic Research.
46. Petersen, M. and Rajan, R. (1995). The Effect of Credit Market Competition on Lending Relationships, *Quarterly Journal of Economics*, 110, pp. 406-443.
47. Pinkowitz, L., Stulz, R.M. and Williamson, R. (2012). Multinationals and the high cash holdings puzzle, NBER Working Paper No. 18120.
48. Roper, S. (1997). Product innovation and small business growth: A comparison of the strategies of German, UK and Irish companies, *Small Business Economics*, 9, pp. 523-537.
49. Sassenou, M. (1988). Recherche-developpment et productivity dans les enterprizes Japonaises: Une etude econometrique sur donnees de panel, Doctoral Dissertation, Ecole des Hautes Etudes en Sciences Sociales, Paris.
50. Schumpeter, J.A. (1934). *The Theory of Economic Development*, Harvard University Press, Cambridge.
51. Segarra, A. and Teruel, M. (2014). High-growth firms and innovation: An empirical analysis for Spanish firms, *Small Business Economics*, 43 (4), pp. 805-821.
52. Sirelli, G. (2000). Innovation and firm performance, summary of session C, Conference innovation and enterprise creation: Statistics and indicators, France.
53. Stam, E. and Wennberg, K. (2009). The role of R&D in new firm growth, Jenna Economic Research Papers 2009-004, Friedrich-Schiller_University Jena.
54. Yang, C.H. and Huang, C.H. (2005). R&D, size and firm growth in Taiwan's electronics industry, *Small Business Economics*, 25 (5), pp. 477-487.
55. Yasuda, T. (2005). Firm growth, size, age and behavior in Japanese manufacturing, *Small Business Economics*, 24, pp. 1-15.
56. Yin, W. & Matthews, K. (2014). The determinants and profitability of switching costs in Chinese banking, Cardiff Economics Working Papers.
57. Wu, Y. (2011). Innovation and economic growth in China: Evidence at the provincial level, *Journal of the Asia Pacific Economy*, 16 (2), pp. 129-142.
58. Zantout, Z. and Tsetsekos, G. (1994). The wealth effects of announcements of R&D expenditure increase, *Journal of Financial Research*, 17, pp. 205-216.

Appendix

Table 1. Summary statistics

This Table shows the results of a two-stage least squares SEM. The first model is based on firm innovation (*INNOVATION*), and the second model is based on firm growth (*GROWTH*).

GROWTH is the firm growth opportunity; measured by Tobin's Q. Tobin's Q is given by the market value of assets (the market value of equity plus the book value of debt) divided by the book value of assets. *INNOVATION* refers to R&D expenditure, determined by the ratio of R&D expense to the total assets of the firm. *BR* is the number of banks the firm has to access loans. *SIZE* shows the size of the business, the natural logarithm of total assets, and the variable *AGE* shows the age or maturity of the company. *CAPEX_TA* is the capital expenditure ratio, which is captured by the ratio of capital expenditure and total assets. *FCF_TA* is the free cash flow ratio, which is free cash flow divided by total assets. *DEBT_TA* is the debt ratio, measured as short-term debt divided by total assets. *CASH_RATIO* is the ratio of cash and cash equivalent and total liabilities.

Panel A: Full sample								
Variables	Obs	Mean	Median	Max	Min	25%	75%	Std
Endogenous								
GROWTH	10.894	6.59	1.82	40774.68	0.60	1.32	2.78	391.87
INNOVATION	10.885	0.04	0.02	0.84	0	0	0.05	0.06
Exogenous								
BR	6407	2.85	2	15	0	1	4	2.35
SIZE	10928	21.12	21.10	28.08	10.84	20.525	21.79	1.09
AGE	10928	26.16	22	107	3	13	31	16.3
CAPEX_TA	10912	-0.19	0.03	0.81	-1386.05	0	0.08	17.31
DEBT_TA	10927	0.67	0.5	877.25	0	0.36	0.62	8.7
FCF_TA	10909	0.14	0.12	1	0	0.07	0.19	0.11
CASH_RT	10910	0.14	0.12	1	0	0.06	0.19	0.11
Panel B: Single banking relationship vs. multiple banking relationships								
Multiple *BR*								
Single *BR*								
Variables	Obs	Mean	Median	Max	Min	25%	75%	Std
Endogenous								
GROWTH	2235	21.4	1.89	40774.68	0.68	1.37	2.87	862.72
INNOVATION	2230	0.04	0.019	0.63	0	0	0.04	0.06
Exogenous								
BR	2245	0.72	1	1	0	0	1	0.45
SIZE	2244	21.1	20.98	28.08	10.84	20.37	21.69	1.26
AGE	2245	24.88	20	107	3	12	31	15.45
CAPEX_TA	2240	-0.52	0.02	0.78	-1159.75	0	0.07	24.55
DEBT_TA	2244	0.6	0.43	142.71	0	0.25	0.59	40.4
FCF_TA	2227	0.18	0.14	1	0	0.08	0.25	0.14
CASH_RT	2227	0.18	0.14	1	0	0.08	0.25	0.14
Variables	Obs	Mean	Median	Max	Min	25%	75%	Std
Endogenous								
GROWTH	8659	2.77	1.81	3001.08	0.60	1.31	2.76	33.05
INNOVATION	8655	0.04	0.0213	0.84	-0.027	0	0.05	0.06
Exogenous								
BR	4162	4.01	3	15	2	2	5	2.15
SIZE	8683	21.22	21.12	27.68	12.31	20.55	21.81	1.05
AGE	8683	26.49	23	107	4	13	31	16.48
CAPEX_TA	8672	-0.11	0.02	0.81	-1386.05	0	0.08	14.88
DEBT_TA	8683	0.68	0.51	877.25	0.01	0.38	0.63	9.53
FCT_TA	8682	0.13	0.11	0.85	0	0.06	0.18	0.1
CASH_RT	8682	0.13	0.11	0.85	0	0.06	0.18	0.09

Table 1 (cont.). Summary statistics

Panel C: Owner types								
Private-owned enterprises								
Variables	Obs	Mean	Median	Max	Min	25%	75%	Std
GROWTH	3872	14.24	1.71	40774.68	0.60	1.25	2.65	657.3
INNOVATION	3903	0.046	0.025	0.84	0	0	0.05	0.07
Exogenous								
BR	2854	3.14	2	15	0	1	5	2.59
SIZE	3904	21.43	21.36	28.08	10.84	20.66	22.11	1.25
AGE	3905	23.22	17	107	3	12	31	15.7
CAPEX_TA	3898	-0.64	0.02	0.81	0.77	0	0.07	28.97
DEBT_TA	3904	0.91	0.52	877.25	0	0.38	0.65	14.5
FCT_TA	3901	0.14	0.12	1	0	0.06	0.19	0.11
CASH_RT	3901	0.14	0.12	1	0	0.06	0.19	0.11
Stated-owned enterprises								
Variables	Obs	Mean	Median	Max	Min	25%	75%	Std
Endogenous								
GROWTH	7022	2.38	1.89	52.91	0.65	1.37	2.83	1.75
INNOVATION	6982	0.038	0.019	0.79	-0.02	0	0.04	0.06
Exogenous								
BR	3553	2.63	2	14	0	1	4	2.11
SIZE	7023	21.06	20.97	27.32	17.12	20.45	21.61	0.97
AGE	7023	27.79	25	107	5	16	31	16.3
CAPEX_TA	7014	0.05	0.03	0.81	-2.45	0	0.08	0.11
DEBT_TA	7008	0.14	0.11	0.78	0	0.66	0.19	0.1
FCT_TA	7023	0.53	0.48	43.07	0	0.34	0.61	0.72
CASH_RT	7008	0.14	0.11	0.78	0	0.06	0.19	0.1

Panel D: Industry diversify			
Industries	*GROWTH*	*INNOVATION*	*BR*
D = 1 (Public utilities)	1.56	0.037	0.69
D = 2 (Real estate development)	2.06	0.040	2.72
D = 3 (General)	2.59	0.045	3.21
D = 4 (Manufacturing)	2.38	0.042	2.86
D = 5 (Commercial)	9.16	0.050	2.9
D = 6 (Other industries)	2.5	0.045	2.7

Table 2. Sample distribution analysis

Panel B: Endogenous variables and five largest shareholder ownerships by industry							
	GROWTH	*INNOVATION*	TOP1	TOP2	TOP3	TOP4	TOP5
1999	2.88	0.032	44.924	8.199	3.241	1.827	1.235
2000	3.93	0.037	44.413	8.116	3.182	1.736	1.156
2001	3.00	0.035	44.019	8.206	3.251	1.724	1.097
2002	2.38	0.029	43.696	8.608	3.365	1.813	1.131
2003	1.91	0.025	42.869	9.114	3.506	1.867	1.153
2004	1.63	0.020	42.386	9.539	3.734	1.965	1.240
2005	1.47	0.017	40.584	9.732	3.859	2.066	1.320
2006	4.39	0.042	35.920	8.966	3.570	2.003	1.397
2007	5.16	0.045	35.390	8.496	3.383	1.976	1.359
2008	9.87	0.053	36.130	8.488	3.434	1.957	1.360
Public utility	GROWTH OPPORTUNITY	INNOVATION	TOP1	TOP2	TOP3	TOP4	TOP5
Real estate development	1.56	0.037	22.357	6.645	4.801	3.990	2.824
General	2.06	0.040	42.342	10.108	3.718	1.869	1.117
Industrial	2.59	0.045	41.545	7.090	2.274	1.486	1.038
Commercial	2.38	0.042	36.949	9.739	4.314	2.281	1.468

Table 2 (cont.). Sample distribution analysis

INNOVATION			
BR	Full sample	SOEs	POEs
0	0.0327	0.0361	0.0294
1	0.0523	0.0395	0.0420
BR	Full sample	SOEs	POEs
2	0.0594	0.0489	0.0547
3	0.0679	0.0639	0.0652
4	0.0550	0.0498	0.0533
5	0.0534	0.0478	0.515
6	0.0523	0.0469	0.491
7	0.0475	0.0417	0.448
8	0.0403	0.0334	0.0416
9	0.0342	0.0310	0.0374
10	0.0211	0.0211	

Table 3. Results of 2SLS simultaneous equation model between banking relationships, R&D investment, and growth opportunity

This table shows the results of a two-stage least squares SEM. The first model is based on firm innovation (*INNOVATION*), and the second model is based on firm growth (*GROWTH*).

GROWTH is the firm growth opportunity, measured by Tobin's Q. Tobin's Q is given by the market value of assets (the market value of equity plus the book value of debt) divided by the book value of assets. *INNOVATION* refers to R&D expenditure, determined by the ratio of R&D expense to the total assets of the firm. *BR* is the number of banks the firm has to access loans. *SIZE* shows the size of the business, the natural logarithm of total assets, and the variable *AGE* shows the age or maturity of the company. *CAPEX_TA* is the capital expenditure ratio, which is captured by the ratio of capital expenditure and total assets. *FCF_R* is the free cash flow ratio, which is free cash flow divided by total assets. *DEBT_TA* is the debt ratio, measured as short-term debt divided by total assets. *CASH_RATIO* is the ratio of cash and cash equivalent and total liabilities.

Model	*INNOVATION*				*GROWTH*			
	Full sample	0 < *BR* < 3	3 ≤ *BR* < 5	5 ≤ *BR* ≤ 15	Full sample	0 < *BR* < 3	3 ≤ *BR* < 5	5 ≤ *BR*
Coefficients	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
INNOVATION					14882.45*** (2468.91)	350.8** (181.664)	354.174*** (168.458)	33.447*** (9.745)
BR	0	0.004*** (0.001)	-0.002 (0.003)	-0.002** (0.001)				
SIZE	-0.009 *** (0)	-0.01(***) (0)	-0.009*** (0.001)	-0.007*** (0.001)	118.1*** (23.4)	5.924*** (1.934)	3.137*** (1.57)	-0.091 (0.091)
AGE	0.0002*** (0)	0** (0)	0*** (0)	0*** (0)	-3.676*** (0.652)	-0.027 (0.039)	-0.092** (0.048)	-0.018*** (0.005)
FCF_TA	-0.083 *** (0.007)	-0.082*** (0.008)	-0.069*** (0.017)	-0.087*** (0.024)				
POEs	0.012 *** (0.001)	0.009*** (0.002)	0.014*** (0.003)	0.019*** (0.004)	-166.585*** (30.446)	-4.972*** (1.938)	-4.386** (2.455)	-0.151 (0.197)
DEBT_TA					-56.052*** (0.29)	-5.197*** (0.243)	6.33*** (0.076)	1.303*** (0.014)
CAPEX_TA					-39.296*** (0.146)	-35.747*** (0.399)	1.841*** (0.048)	-0.911*** (0.321)
CASH_RT					1233.043*** (210.13)	29.69** (16.761)	31.632*** (11.799)	3.995*** (0.952)
IND_D1	0.009 (0.015)	0.007 (0.017)			83.945*** (36.723)		-16.681*** (7.441)	
IND_D2	0.01*** (0.005)	0.009 (0.007)	-0.013 (0.031)	-0.017 (0.012)	-12.214 (11.103)	6.689 (8.991)	-8.594** (4.561)	0.4** (0.212)
IND_D3			-0.039 (0.032)			11.736 (9.241)		0.326 (0.271)
IND_D4	0.007** (0.004)	-0.001 (0.006)	-0.014 (0.031)	0 (0.01)	-13.357 (10.039)	11.808 (8.915)	-8.742*** (4.375)	-0.172 (0.22)
IND_D5	0.005 (0.004)	0 (0.006)	-0.015 (0.031)	-0.009 (0.009)	-3.196 (9.551)	11.146 (8.85)	-8.204*** (4.048)	0.131 (0.164)
IND_D6	0.001 (0.005)	0.007 (0.007)	-0.004 (0.031)	-0.012 (0.012)	-12.183 (2469.1)	9.183 (9.072)	-11.921*** (5.983)	

Table 3 (cont.). Results of 2SLS simultaneous equation model between banking relationships, R&D investment, and growth opportunity

Model	*INNOVATION*				*GROWTH*			
Residual					-14991.27*** (2469.09)	-344.312** (181.852)	-352.991*** (168.484)	-34.592*** (9.761)
Constant	0.241*** (0.016)	0.265*** (0.022)	0.257*** (0.046)	0.223*** (0.039)	-3123.06*** (606.521)	-146.845*** (51.378)	-75.003*** (35.746)	1.447 (2.222)
	Full sample	0 < *BR* < 3	3 ≤ *BR* < 5	5 ≤ *BR* ≤ 15	Full sample	0 < *BR* < 3	3 ≤ *BR* < 5	5 ≤ *BR*
R-squared	0.06	0.07	0.06	0.05	0.927	0.99	0.99	0.89
Obs	6202	3361	1555	1286	6163	3340	1548	1275

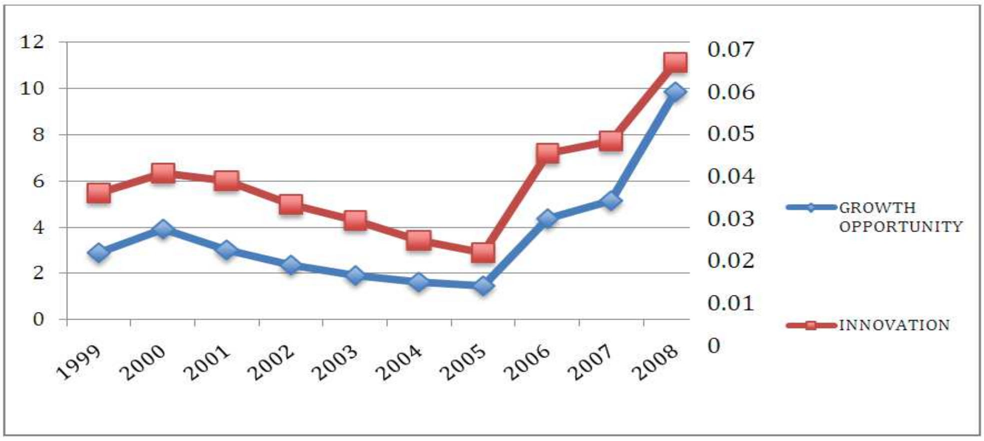

Fig. 1. Relationships between firm growth and innovation across years (1999-2008)

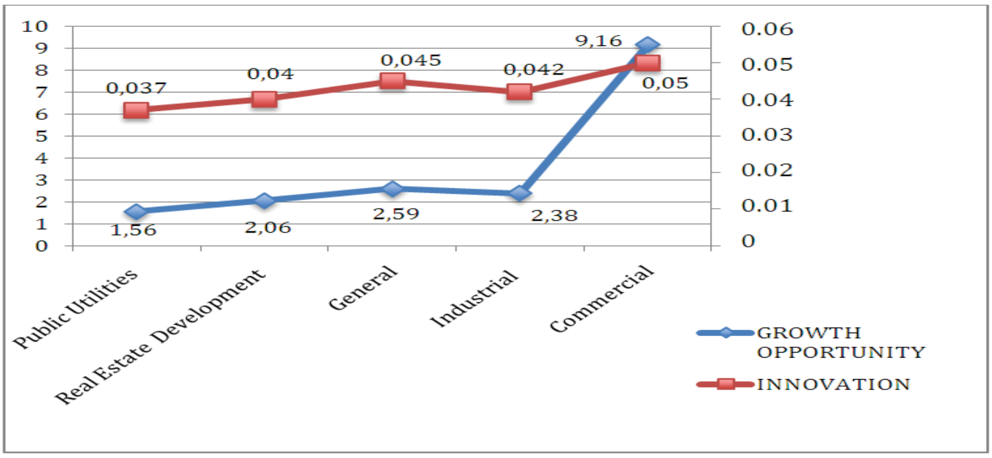

Fig. 2. Relationships between firm growth and innovation across different industries

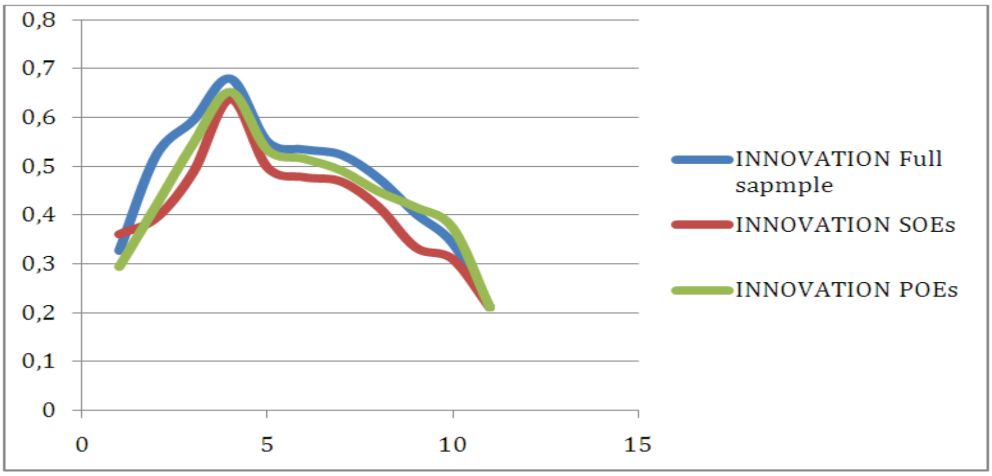

Fig. 3. Relationships between innovation and banking relationships based on number of banking relationships