Market value of the firms and RD investment: Theoretical overview and empirical estimation for the panel of countries

Josheski, Dushko and Magdinceva-Sopova, Marija

Goce Delcev University-Stip

31 January 2013

Market value of the firms and R&D investment: Theoretical overview and empirical estimation for the panel of countries

Dushko Josheski*

Marija Magdinceva Sopova*

Abstract

The aim of this paper is to investigate the issue of R&D investment and the market value of the firm. This idea dating back from Arrow paper, later developed by Paul Romer but in the area of economic growth. Zvi Griliches (1979), first introduced the production function, which later would be used in a vast literature from this area (Market value of the firms and R&D investment). In the theoretical section of this paper we are describing Tobin's original model, and Abel's (1984) model, this models relates Tobin's quotient with intangible assets of the company. In the empirical part we develop cross-section time series model (Feasible Generalized Least Squares Model), for a panel of countries in Europe including UK and Turkey, in total of 11 panels. Later we test that model by estimating the marginal effects of R&D investment with Tobin's q on a small economy such as R. Macedonia. The results exert positive and statistically significant relationship between market value of the firms and R&D investment.

Keywords: Tobin's q, R&D, knowledge absorption

* Goce Delcev University -Stip (dushkojosheski@gmail.com)
* Goce Delcev University –Stip (marija.magdinceva@ugd.edu.mk)

Introduction and literature survey

In this paper we examine the issue of R&D investment and the market value of the firm. R&D investment is different than other ordinary investment, according to Hall and Lerner (2009)[1], fifty percent or more of R&D spending is on salaries of highly educated scientist and engineers. The idea comes from Arrow (1962)[2], but the Arrow introduced growth model in which the per capita growth rate depends on the capital per worker and the average of the stock of capital of other workers[3]. In the empirical literature form this area one significant contribution is the paper by Connolly and Hirschey (2005), when comparing the R&D effect on Tobin's Q they find positive and statistically significant relationship across sample of manufacturing and non-manufacturing firms, and the found evidence which statistically significant and positive influence of R&D on Tobin's q[4].Earlier Connolly and Hirschey (1984)[5], considered relation between market structure, R&D and profits. And the find positive effect of R&D on profit, but also negative R&D concentration interaction effect[6]. As we said earlier with the Arrow paper (1962), and later Romer (1990), research and development expenditures have been valued in economic growth perspective (Warusawitharana, 2008)[7]. Also the same production that Zvi Griliches (1979)[8], used is vastly used in this literature, the functional form is as follows: $Y = F(K, L, T, u)$, here K and L are labor and capital inputs, and T is a measure of the current state of technical knowledge, and u are all unmeasured determinants of output and productivity. James Tobin (1978), also explains that q is a measure of profitable investment opportunities. Later Zvi Griliches and Cockburn (1988), relate the value of the firm with Tobin's q, as follows:

---

[1] Hall, B., H. & Lerner, J, (2010). "The Financing of R&D and Innovation,"UNU-MERIT Working Paper Series 012, United Nations University, Maastricht Economic and social Research and training centre on Innovation and Technology.

[2] Arrow, K.J. (1962). "The Economic Implications of Learning by Doing," *American Economic Review*, May *96*(2): pp. 308-312.

[3] $y = Ak^{1-\alpha}(\bar{k})^{\alpha} \quad 0 < \alpha < 1$ in equilibrium $k = \bar{k}$

[4] Connolly, R.,Hirschey,M.,(2005), Firm size and the effect of R&D on Tobin's *q*, R&D *Managemenl* 35. 2, 2005. cg Blackwell Publishing Ltd, 2005. Published by Blackwell Publishing Ltd,

[5] Connolly, R.,Hirschey,M.,1984), R & D, Market Structure and Profits: A Value-Based Approach, *The Review of Economics and Statistics*, Vol. 66, No. 4. (Nov., 1984), pp. 682-686.

[6] The firms in the more concentrated industries are less efficient researchers, or are willing to take riskier projects.

[7] Warusawitharana,M.,(2008), Research and Development, Profits and Firm Value:A Structural Estimation, Division of Research and Statistics, Board of Governors of the Federal Reserve System

[8] Griliches, Zvi(1979), R&D and Productivity: The Econometric Evidence, Chapter: Issues in Assessing the Contribution of Research and Development to Productivity Growth

$V = q(\text{tan}\,gible\ \ capital, \text{int}\,angible\ \ capital)$, so in this paper[9], q is related also to intangible capital. Megna and Klock (1993)[10], also examined the contribution of R&D stocks of the firms in semi-conductor industry, and find positive externalities of own R&D stock of the firms as well as the rivals stock of R&D on Tobin's q, but rivals patents negatively influenced Tobin's Q, this reveals that patents and R&D are distinctive measure of intangible assets, because patents are marketable and R&D are just initiative. Hall (1998)[11], introduced Cobb-Douglass production form with Tobin's q:

$$bV_t(TA, IA) = q_t TA^{\sigma t - at} IA_t^{at} \quad (1)$$

Here TA are tangible assets, and IA are intangible assets. Intertemporal elasticity of substitution is given by σ, symbol. While in logarithms this function is presented by the following functional form:

$$\log bV_t = \log q_t + \sigma_t \log TA + \alpha_t (\log IA/TA) \quad (2)$$

Later Hall, Thoma, and Torrisi (2007)[12], explain that the functional form of intertemporal maximization with several capital goods it's hard to derive, and most of the literature relies on the assumption that market valuation equation takes log-linear, or log-log presentation. Hall, Thoma, and Torrisi (2007), make a distinction between knowledge capital and physical assets. Adaptive multiplicative separable function can be written as follows (Damianova, 2005)[13]:

$$bV_t = (TA_t)^{\beta_1} \sum_{\theta=1}^{T} (IA_{t-\theta})^{\beta_2, \theta} \quad (3)$$

Here θ is the time lag, denoting that production of knowledge capital is different than production of physical capital since it involves projects with durations of several years.

[9] Cockburn, Iain & Griliches, Zvi, (1988). "Industry Effects and Appropriability Measures in the Stock Market's Valuation of R&D and Patents,"American Economic Review, American Economic Association, vol. 78(2), pages 419-23, May

[10] Megna, P. and Klock, M. 1993. The Impact of Intangible capital on Tobin's q in the Semiconductor Industry, *The American Economic Review* 83(2): 265 – 269.

[11] Hall, B.,(1998), Innovation and market value, University California Berkeley

[12] Bronwyn H. Hall & Grid Thoma & Salvatore Torrisi, 2007. "The market value of patents and R&D: Evidence from European firms,"NBER Working Papers 13426, National Bureau of Economic Research, Inc

[13] Damianova,K., (2005), The Conditional Value of R&D Investments**,** National Centre of Competence in Research Financial Valuation and Risk Management

Tobin’s q, the market value of the firms

Tobin's q is an indicator of the limit for the lowest market value of enterprises. Tobin's q is calculated as the rate between the market value of the enterprise and the cost of replacement assets in the assets. It is the quotient of the market value of a capital (activity, share or real capital) and reproduction costs for the specified capital. Enterprises, activity or shares are normally being purchased when the costs of purchase are lower than the initial construction costs-costs.

Anyone who wants to invest in the financial market is using this coefficient. At the beginning it was believed that Tobin's q is an indicator of the impact of interest rate of consumer’s behavior and enterprises in the financial market. The higher value of Tobin's q the greater the investment opportunities. If increasing the value of Tobin's q, the financial power of the consumers, population and the state, in general is increasing. Increased financial power on the one side, causes an increase in the consumption.

Lower Tobin's q means reducing investment consumption and reduce investment in research and development. Ideally, the market value of the enterprise and the cost of replacement capital will be equal or nearly equal, while it maintains a state of equilibrium. When Tobin's q is 1 there is a balance between the cost of the use of assets and profits. The market value of existing enterprises is expressed by the capital cost of replacing the existing relationship with Tobin's q ratio. According to this, the value of Tobin's q ratio should be at least 1. When the value of Tobin's q ratio is more than 1, recommend additional investment because profit is higher than the cost price for the use of invested assets. At the same time, smaller than 1 Tobin's q ratio shows that the cost invested by enterprises in the capital cannot be effected and the market value of the company would be lower than the invested assets.

In view of these enterprises, perhaps in this case it is best enterprises to reduce the costs through the sale. Tobin's q ratio is applied as a reliable indicator for assessing the market value of enterprises. But the assessment of the future activities of the enterprises is the best Tobin's q ratio is applied in combination with other indicators.

R&D and market value of the firm

R&D investment create "intangible" capital, and this affects the valuation of the company by the investors. Market value of the firm we treat as indicator for the success of the company, but only partial (Griliches, 1981)[14]. We use here the "definitional" model by Zvi Griliches:

$$MV = q(TA + IA) \tag{4}$$

Here MV represents the market value of the firm (equity plus debt), which is equal to q (which represents the current market valuation coefficient of the company's assets), multiplied by TA which represents tangible assets, plus IA intangible assets. From the expression above we have following $q = \frac{MV}{(TA + IA)}$ that is the expression for Tobin's Q (quotient).Here we state that, IA –intangible assets are the "stock of knowledge" of the companies. The reason why in the q-theory, Q>1, Q can be above 1, is because of the Intangible assets of the company. For the early Keynesians it was important, what is the position of the current cash flow and liquid assets, as a major determinants of investment (Akerlof, 2007)[15]. But later Modigliani -Miller, same as the other existing contemporary literature, assumed that the firm's financial position, is not important in investment decision, i.e. investment is independent of current cash flow and liquidity position. In the original paper by Tobin (1969), firms should invest up to the point where marginal costs of a new unit of capital is the valuation of such a unit capital in the market (Akerlof, 2007). Tobin like in neoclassical growth theory assumes some natural rate of growth y_n, and the equation $y_k * K = sY$, where s, is the savings ratio (marginal propensity to save), Y is the real income, marginal efficiency of the capital stock is $\overline{R}$, and $\overline{R} = rK$, where r is the interest rate or return of the capital stock. In such a case q=1, and investment equals saving. While Tobin defines $\overline{R} = rq$, in Tobin's paper q is the market price of existing capital goods, so $rq = rK$, i.e. $q = K$, so the firm should invest up to the point where the marginal unit of capital is equal to valuation of such a unit of capital in the stock market. So investment is independent of finance situation of the firm.

[14] Griliches, Z. (1981), 'Market value, R&D and patents', *Economics Letters*, 7 (2), 183-187

[15] Akerlof, George,(2007),Missing motivation in macroeconomics,*American Economic Review*, 2007, vol. 97, issue 1, pages 5-36

In his interpretation of Keynesian LM curve Tobin introduced $\frac{\overline{R}}{q}$ as the speed of investment that should be equal in equilibrium with $\frac{r}{K}$, or $\frac{\overline{R}}{q} = \frac{r}{K}$. Later on in 1977 paper, Tobin defines marginal efficiency of capital as follows:

$$V = \int_0^{\infty} E(t) e^{-\overline{R}t} dt \qquad (5)$$

Here V are the cost of capital(replacement value) and E(t) are the expected future earnings, we use the formula for integration by parts[16] , and replace $u = tE$, $dv = e^{-t\overline{R}} dx$,or $du = E^* dt$, $v = -\frac{e^{-t\overline{R}}}{\overline{R}}$,we replace, $\int udv = -\frac{tE * e^{-t\overline{R}}}{\overline{R}} - \int -\frac{E * e^{-t\overline{R}}}{\overline{R}} dt$,for the second half of the equation $\int -\frac{E * e^{-t\overline{R}}}{\overline{R}} dt$,if we replace $u = -t\overline{R}$,we should find a equation for $du = -R \ dt$,i.e $\frac{du}{-R} = dt$,now if we replace $\int -\frac{E * e^{u}}{\overline{R}} * -\frac{1}{\overline{R}} du$,if we simplify the integrand $\int \frac{E * e^{u}}{\overline{R}^2} du$,now if we substitute for u ,we solve $\frac{E * e^{-\overline{R}t}}{\overline{R}^2} + C$,if we substitute in the formula for integration by parts $-\frac{tE * e^{-t\overline{R}}}{\overline{R}} - \frac{E * e^{-\overline{R}t}}{\overline{R}^2} + C$,now to evaluate the integral we evaluate the upper solution from lower solution. We multiply upper bound solution by the expression, and then we subtract down bound solution.

$$-(\infty)\frac{tE * e^{-\infty\overline{R}}}{\overline{R}} - \frac{E * e^{-\overline{R}\infty}}{\overline{R}^2} - \left[-(0)\frac{tE * e^{-0\overline{R}}}{\overline{R}} - \frac{E * e^{-\overline{R}0}}{\overline{R}^2} \right] \qquad (6)$$

When we simplify $-\frac{E(\overline{R}e^{-\overline{R}} + e^{-\overline{R}} - 1)}{\overline{R}^2}$ .Now Tobin (1977) presents market value of capital goods of the firm and the expression is presented in the following expression:

---

[16] $\int_0^{\infty} f(t)g'(t) \ dt = f(t)g(t) - \int_0^{\infty} f'(t)g(t) \ dt$ $\int udv = uv - \int vdu$

$MV = \int_{O}^{\infty} E(t)e^{-rt}dt$,E(t) is constant, then V = E/$\overline{R}$, and MV = E/r ,

consequently $\frac{MV}{V} = \frac{R}{r}$,this is the expression for out quotient Q. Tobin extends model to macroeconomics (IS-LM) model defining the investment function , which is a change in capital as follows, $\frac{\Delta K}{K} = f(q - \bar{q}) + y_n$, $\bar{q}$ is some normal value of q, i.e. q=1, while y_n is the natural growth rate. And if $q = \bar{q}$,then $\Delta K = y_n K$,which represents net investment[17].Now since we explained market valuation models for the firm , will add up R&D to see the causality between the two. Abel (1984), did set up a model of market value of the firm and R&D. Abel (1984)[18] uses Bellman value function[19], for the market value of the firm.

$$MV(T_t, p_t) = \max_{L_t, \bar{R}_t} E_t\left[p_t L_t^{\alpha} T_t^{1-\alpha} - wL_t - a\bar{R}_t^2 + \beta V(T_{t+1, p_{t+1}})\right] \qquad (7)$$

Here E_t is conditional dynamic expectation, here $T_t^{1-\alpha}$ is the technology, which is accumulated to produce output, $\bar{R}$ again is the marginal efficiency of capital, but yet it is some R&D activity, here $a\bar{R}_t^2$ are R&D expenditures. Here, wL_t are the wages of the workers that influence the cash flow of the company, p_t is the price of the output, and $p_t L_t^{\alpha} T_t^{1-\alpha} = \pi$ is the profit of the firm. Abel used the Bellman equation to derive the expression for Tobin's q.

$$q_t = \frac{MV(T_t, p_t) - E_{t-1}MV(T_t, p_t)}{MV(T_{t-1, p_{t-1}})} \qquad (8)$$

Here E_{t-1} are the expectations from the past period, but E_{t-1} is multiplied by the present value of the firm, meaning that excess return are uncorrelated with any past information (Efficient market hypothesis).

---

[17] Tobin J, and Brainard W.C.(1977), *Asset Markets and the Cost of Capital*, Cowles Foundation Paper 440 Reprinted from Private Values and Public Policy, Essays in Honor of William Fellner, North-Holland, 1977

[18] Abel,B,Andrew (1984),, "R & D and the Market Value of the Firm: A Note". In R & D, Patents and Productivity, edited by Zvi Griliches, (1984), 261 - 269.

[19] Bellman equation has been used in economics amongst others also by Edmund Phelps, Robert Lucas, Sargent and others.

Methodology and data

Data we use here are from World Bank data site[20]. Tobin's is derived quotient from market value to the replacement cost of capital, their ratio. This is known as Tobin's (1969)[21]. In the next table we present the value of Tobin's q for the selected European countries including United Kingdom and Turkey.

Table 1 Tobin's q for the selected countries

Tobin's q													
year	**Austria**	**Belgium**	**Cyprus**	**Denmark**	**France**	**Germany**	**Greece**	**Italy**	**Luxembourg**	**Slovenia**	**Switzerland**	**Turkey**	**United Kingdom**
1993	1	1.04	1.01	1.03	1.04	1.02	1	1	1.1	0.96	1.07	1.06	1.09
1994	1	1.04	1.02	1.03	1.04	1.02	1.01	1.01	1.12	0.95	1.07	1.04	1.09
1995	1	1.04	1.05	1.03	1.04	1.02	1.01	1.01	1.11	0.89	1.08	1.03	1.09
1996	1	1.04	1.04	1.04	1.04	1.02	1.02	1.01	1.11	0.92	1.08	1.04	1.1
1997	1.01	1.05	1.04	1.05	1.05	1.04	1.03	1.03	1.12	0.97	1.1	1.07	1.1
1998	1	1.08	1.05	1.05	1.07	1.05	1.07	1.05	1.12	0.98	1.11	1.04	1.1
1999	1	1.06	1.09	1.06	1.08	1.06	1.11	1.06	1.12	0.98	1.11	1.09	1.11
2000	1	1.07	1.08	1.06	1.08	1.06	1.09	1.06	1.12	0.99	1.12	1.07	1.11
2001	0.99	1.06	1.09	1.05	1.08	1.05	1.07	1.05	1.1	0.99	1.11	1.06	1.1
2002	1	1.05	1.07	1.04	1.06	1.03	1.06	1.04	1.1	1.01	1.1	1.03	1.09
2003	1.01	1.05	1.06	1.05	1.07	1.04	1.06	1.04	1.11	1.02	1.1	1.06	1.1
2004	1.03	1.06	1.05	1.05	1.07	1.04	1.06	1.04	1.11	1.03	1.1	1.03	1.09
2005	1.04	1.06	1.06	1.06	1.07	1.04	1.07	1.04	1.11	1.02	1.11	1.04	1.1
2006	1.06	1.07	1.1	1.07	1.08	1.05	1.08	1.05	1.13	1.04	1.12	1.04	1.1
2007	1.06	1.07	1.12	1.07	1.08	1.05	1.08	1.04	1.15	1.06	1.11	1.05	1.1
2008	1.01	1.03	1.05	1.03	1.05	1.03	1.03	1.01	1.1	1.02	1.09	1.01	1.07
2009	0.99	1.05	1.03	1.05	1.06	1.03	1.01	1	1.12	1.02	1.11	1.05	1.09
2010	1.01	1.06	1.04	1.07	1.06	1.04	1.02	1	1.11	1.02	1.11	1.05	1.09

[20] http://search.worldbank.org/data?qterm=royalty&language=EN&format=

[21] J.Tobin, (1969). "A general equilibrium approach to monetary theory". *Journal of Money Credit and Banking* **1** (1): 15–29

Variables that we use to get the ratio between market value and replacement cost of capital are:

Table 2 variable description

Name of the variable	Variable label
Market capitalization of listed companies (current US$) (also known as market value)	Market capitalization (also known as market value) is the share price times the number of shares outstanding. Listed domestic companies are the domestically incorporated companies listed on the country's stock exchanges at the end of the year. Listed companies does not include investment companies, mutual funds, or other collective investment vehicles. Data are in current U.S. dollars.
Adjusted savings: consumption of fixed capital (current US$) (Replacement value)	Consumption of fixed capital represents the replacement value of capital used up in the process of production.
Royalty and license fees, payments (BoP, current US$) (knowledge absorption)	Royalty and license fees are payments and receipts between residents and nonresidents for the authorized use of intangible, nonproduced, nonfinancial assets and proprietary rights (such as patents, copyrights, trademarks, industrial processes, and franchises) and for the use, through licensing agreements, of produced originals of prototypes (such as films and manuscripts). Data are in current U.S. dollars.

Tobin's q in the table for European countries, Turkey and UK we get from the quotient

$$q = \frac{\text{Market value of the instaled capital}}{Replacement\ cost\ of\ the\ capital} = \frac{\text{Market capitalization of listed companies}}{\text{Adjusted savings: consumption of fixed capital}} \quad (9)$$

Then afterwards in the econometric section we introduce variable Royalty and license fees, payments (BoP, current US$), this is very important variable, it represents knowledge absorption

or R&D investment for the firms, so we test it empirically to see how it influences value of the firms. In the econometric model specification we use following regression (functional form):

$$Tobin's \quad q_{i,t} = \beta_0 + \beta_1 \log(knowledgeabsorption)_{i,t} + \varepsilon_{i,t} \qquad (10)$$

We use cross-section- time series model, i.e. panel model, data are gathered through time t, for the panels i. Than later we use the same functional form but in cross-section terms adjusted for Macedonia only.

Descriptive statistics

In this section we publish the descriptive statistics for the 11 panels of countries. The table is given next, the values are for Tobin's q and Royalty and license fees, payments. Here we announce that we used logarithms to adjust the values of market value and replacement cost of the companies[22], and knowledge absorption of the companies. That is to avoid measurement errors.

Table 3 Descriptive statistics

Variable	*Observations*	*Mean*	*Std. Dev.*	*Min*	*Max*
Tobin's q	*198*	*1.061465*	*0.037177*	*0.99*	*1.15*
R&D	*194*	*20.2958*	*1.950381*	*15.90016*	*23.59306*

For the table we can see that the Tobin's q is moving around 1. That is if the market solely reflected the recorded by the accountants' value of the company, Tobin's q would be around 1.if the value of Tobin's q>1, that means that market is overvaluing the company, and that the company can issue shares and with the revenues to invest in capital. In case q<1, that means that market is undervaluing the company, and market value is less than recorded value of the company. Form the table for Tobin's q quotient in the methodology section; we can see that Slovenia in the 1990's form 1993 to the year 2000 had Tobin's q less than one. That is Slovenia had been also transition country, from 1991 (when declared independence) to 2001, and Slovenia joined EU in 2004. Given in the table below are average Tobin's q values for the selected countries.

[22] See Appendix 1 adjusted market values of the companies and replacement cost of capital.

Table 4 Average Tobin's q ratio for the selected countries

Average Tobin's q ratio for the selected countries												
Austria	**Belgium**	**Cyprus**	**Denmark**	**France**	**Germany**	**Greece**	**Italy**	**Luxembourg**	**Slovenia**	**Switzerland**	**Turkey**	**United Kingdom**
1.0117	1.0544	1.0583	1.0494	1.0622	1.0383	1.0489	1.03	1.1144	0.9928	1.1	1.0478	1.0956

On the next tables we present the marginal effects of knowledge absorption, Tobin's q. Marginal effect is found mathematically with a following expression (just for the knowledge):

$$\frac{\partial y}{\partial x} = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h} \tag{11}$$

This is prediction f with only one argument. Marginal effect of x is partial derivative with respect to x variable.

Table 5 Marginal Tobin's q ratio for the selected countries

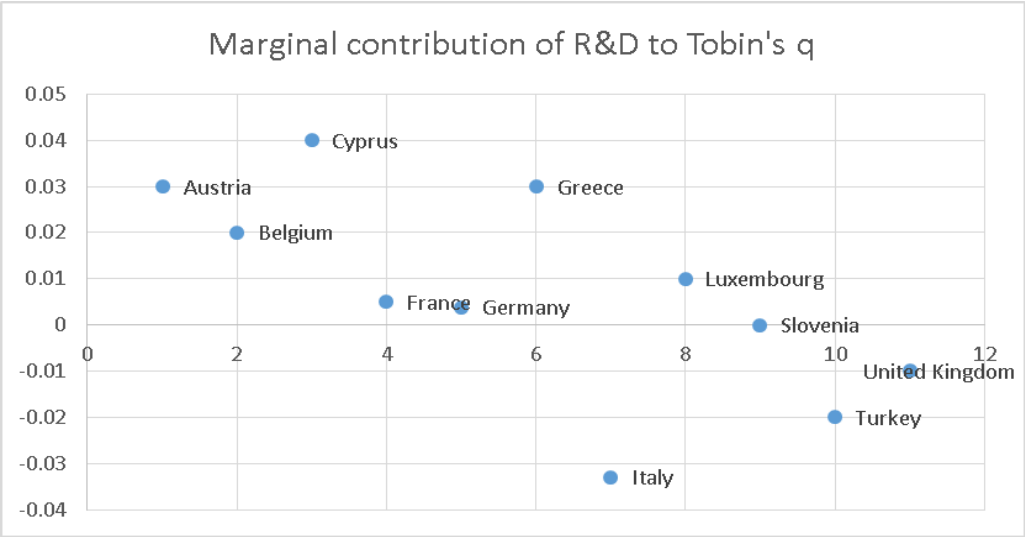
Marginal Tobin's q ratio for the selected countries							
	Austria	*Belgium*	*Cyprus*	*France*	*Germany*	*Greece*	*Italy*
R&D	*0.03*	*0.02*	*0.04*	*0.005*	*0.003821*	*0.03*	*-0.033*
p value	*0.01*	*0.00*	*0.05*	*0.796*	*0.837*	*0.053*	*0.045*

Table 5 continued

Marginal Tobin's q ratio for the selected countries				
	Luxembourg	*Slovenia*	*Turkey*	*United Kingdom*
knowledge absorption	*0.01*	*0.00*	*-0.02*	*-0.01*
p value	*0.558*	*0.53*	*0.208*	*0.635*

Marginal effect counts for the effect of additional investment in R&D (knowledge absorption).On the next picture, graphically it is depicted marginal contribution of R&D to Tobin's q.

Graph 1 Marginal contribution of R&D to Tobin's q.



Econometric estimation

We use panel data sample, with 198 observations divided in 11 panels. Panel has a cross-section and time dimension (1993-2011). Because of the difference variance that panels have, we decided that OLS is not efficient estimator. Alternatively we can use FGLS (Feasible Generalized Least Squares). This estimator is applied when variances of the observations are unequal (i.e. when there is heteroscedasticity). In such a case OLS technique can be misleading and lead to biased inferences.

Table 6 FGLS estimation with country effects

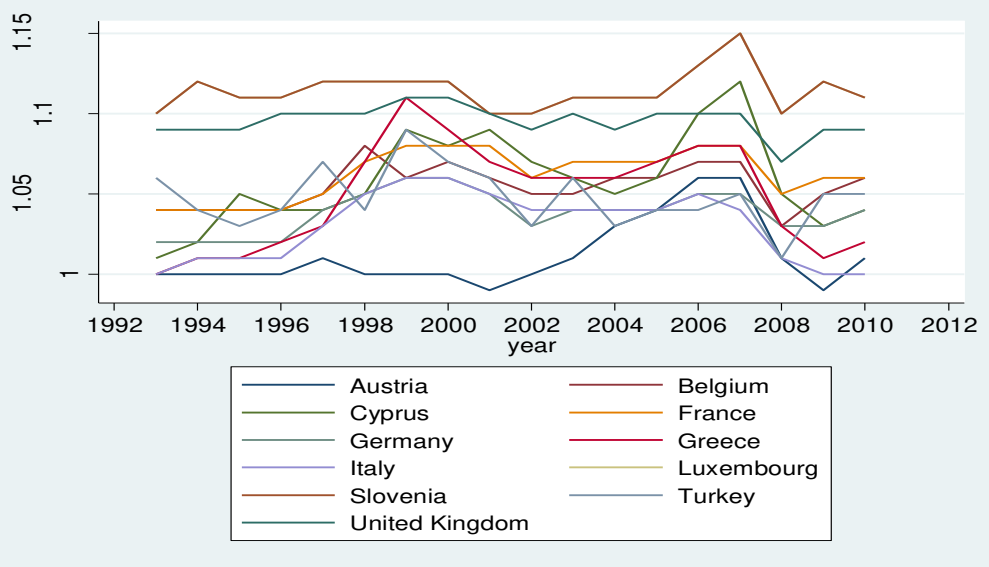
Tobin's q	*Coefficient*	*Standard error*	*P value*
knowledge absorption	*0.005*	*0.002*	*0.027*
Countries			
Belgium	*0.042*	*0.008*	*0.000*
Cyprus	*0.064*	*0.010*	*0.000*
France	*0.045*	*0.007*	*0.000*
Germany	*0.017*	*0.008*	*0.029*
Greece	*0.043*	*0.007*	*0.000*

Table 6 continued			
Italy	*0.015*	*0.007*	*0.021*
Luxembourg	*0.112*	*0.008*	*0.000*
Slovenia	*0.115*	*0.008*	*0.000*
Turkey	*0.042*	*0.007*	*0.000*
United Kingdom	*0.074*	*0.008*	*0.000*
Constant	*0.914*	*0.044*	*0.000*
Panels	*Homoskedastic*		
Number of observations	*183*		

*Austria I benchmark country

From the above table we can wee that R&D investment and Tobin's q, i.e. value of the firm divided by the replacement cost are in positive and statististically significant relationship. Coefficient on knowledge absorption is of small size (0.005), but highly significant which is positive for its economic interpretation. On the next graph it is presented Tobin's q for the selected countries and is movement from 1992 to 2012.Compared to the benchmark country Austria all of the countries in the sample

Graph 2 Tobin's q for the selected countries



Macedonian companies Tobin's q

Because in Macedonia stock exchange was established in 1995 Macedonian companies do have market valuation data since 1996 onwards. In the next table data will be presented for the market value of the total Macedonian companies listed on the stock exchange, and replacement value of the capital. Table Macedonian companies market value (stock exchange listed), Replacement value, Tobin's q and knowledge absorption

Table 7 Replacement value of capital, market value of capital, Tobin's q and R&D of Macedonian companies

	Replacement value	*Market value*	*Tobin's q*	*Knowledge absorption*
1996	*8.68*	*7.99*	*0.92*	*6.45*
1997	*8.77*	*6.90*	*0.79*	*6.35*
1998	*8.72*	*6.90*	*0.79*	*6.38*
1999	*8.73*	*6.88*	*0.79*	*6.74*
2000	*8.71*	*6.85*	*0.79*	*6.75*
2001	*8.72*	*7.66*	*0.88*	*6.74*
2002	*8.76*	*8.26*	*0.94*	*7.01*
2003	*8.92*	*8.56*	*0.96*	*6.84*
2004	*8.99*	*8.62*	*0.96*	*6.97*
2005	*9.02*	*8.81*	*0.98*	*7.02*
2006	*9.01*	*9.04*	*1.00*	*6.94*
2007	*9.14*	*9.43*	*1.03*	*7.29*
2008	*9.19*	*8.92*	*0.97*	*7.40*
2009	*9.22*	*8.96*	*0.97*	*7.31*
2010	*9.00*	*9.42*	*1.05*	*7.25*
2011	*8.50*	*9.40*	*1.11*	*7.39*

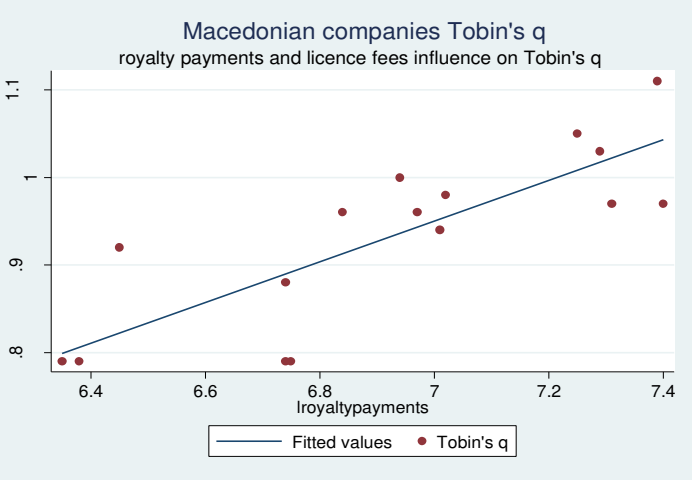
Since 2006, Tobin's q for Macedonian companies is close to 1 or >1.before that it was lower than 1, also Macedonian company since 1996 continuously increase their R&D investment (knowledge absorption).

Table OLS regression Tobin's q and knowledge absorption

Tobins q	***Coefficient***	***Pvalue***
Knowledge absorption	*0.23*	*0.000*
Constant	*-0.68*	*0.050*
R squared	*0.6507*	
Functional form (pvalue)	*0.74*	

Form the above equation OLS model, we can see that increase in knowledge absorption by 1%, increases Tobin's q quotient by 0.23 percentage points. This relationship is statistically significant at all levels of conventional significance (pvalue=0.000). Functional form also shows that if we reject the null of no omitted variables bias, we will make Type I error. Next we depict graphically Royalty payments and license fees trend with Tobin's q of Macedonian companies listed on Macedonian stock exchange.

Graph 3 R&D and Tobin's q of Macedonian companies



Conclusion

From this paper we concluded that there exist positive and statistically significant relationship between Tobin's q and investment in R&D, or as we name it, knowledge absorption, according to the Global Innovation Index 2012[23].This is one of important conclusions from this paper.

[23] http://www.globalinnovationindex.org/gii/

Appendix 1 Market values of the companies and replacement cost of capital

REPLACEMENT VALUE													
year	Austria	Belgium	Cyprus	Denmark	France	Germany	Greece	Italy	Luxembourg	Slovenia	Switzerland	Turkey	United Kingdom
1993.00	24.06	24.16	20.42	23.83	25.83	26.41	23.17	25.73	21.49	21.12	24.53	23.05	25.51
1994.00	24.12	24.25	20.53	23.90	25.87	26.47	23.25	25.76	21.58	21.27	24.60	22.93	25.56
1995.00	24.28	24.43	20.71	24.06	25.99	26.63	23.44	25.82	21.75	21.95	24.73	23.12	25.67
1996.00	24.27	24.44	20.71	24.08	25.99	26.61	23.51	25.92	21.75	22.01	24.69	23.16	25.70
1997.00	24.16	24.34	20.67	24.01	25.89	26.49	23.46	25.87	21.65	21.97	24.53	23.17	25.77
1998.00	24.19	24.37	20.71	24.04	25.91	26.50	23.48	25.90	21.70	22.04	24.56	23.25	25.82
1999.00	24.18	24.38	20.73	24.05	25.90	26.48	23.46	25.89	21.73	22.04	24.56	23.27	25.86
2000.00	24.09	24.29	20.64	23.95	25.83	26.37	23.38	25.80	21.70	21.95	24.51	23.29	25.85
2001.00	24.10	24.29	20.67	23.97	25.85	26.37	23.44	25.82	21.73	21.96	24.56	23.21	25.84
2002.00	24.19	24.37	20.79	24.06	25.95	26.44	23.55	25.93	21.73	22.05	24.65	23.49	25.93
2003.00	24.40	24.60	21.01	24.28	26.16	26.62	23.91	26.15	21.92	22.23	24.81	23.62	26.05
2004.00	24.53	24.75	21.18	24.41	26.31	26.73	24.07	26.29	22.11	22.37	24.90	24.55	26.23
2005.00	24.57	24.80	21.27	24.44	26.36	26.76	24.12	26.34	22.15	22.42	24.93	24.74	26.25
2006.00	24.62	24.88	21.36	24.49	26.43	26.79	24.19	26.40	22.26	22.48	24.95	24.84	26.33
2007.00	24.75	25.02	21.50	24.64	26.57	26.92	24.34	26.53	22.42	22.65	25.04	25.06	26.46
2008.00	24.87	25.15	21.66	24.75	26.70	27.01	24.48	26.64	22.61	22.81	25.19	25.19	26.35
2009.00	24.85	25.12	21.63	24.69	26.66	26.95	24.56	26.61	22.60	22.78	24.99	25.00	26.24
2010.00	24.69	24.90	21.82	24.52	26.59	26.84	24.41	26.36	22.81	22.54	25.06	25.20	26.46
MARKET VALUE													
year	Austria	Belgium	Cyprus	Denmark	France	Germany	Greece	Italy	Luxembourg	Slovenia	Switzerland	Turkey	United Kingdom
1993.00	24.07	25.08	20.70	24.46	26.85	26.86	23.23	25.64	23.69	20.20	26.33	24.35	27.77
1994.00	24.13	25.16	21.01	24.72	26.84	26.88	23.43	25.92	24.07	20.20	26.37	23.80	27.82
1995.00	24.20	25.38	21.65	24.75	26.98	27.08	23.56	26.07	24.14	19.56	26.80	23.76	27.97
1996.00	24.25	25.51	21.58	25.00	27.11	27.23	23.91	26.28	24.21	20.31	26.72	24.13	28.19
1997.00	24.30	25.64	21.42	25.26	27.24	27.44	24.25	26.57	24.25	21.21	27.08	24.84	28.32
1998.00	24.25	26.23	21.69	25.32	27.62	27.72	25.11	27.07	24.29	21.62	27.26	24.24	28.50
1999.00	24.22	25.94	22.66	25.38	28.02	27.99	26.04	27.31	24.31	21.50	27.26	25.45	28.71
2000.00	24.12	25.93	22.19	25.40	28.00	27.87	25.43	27.37	24.25	21.66	27.40	24.97	28.58

2001.00	23.92	25.83	22.55	25.20	27.79	27.70	25.18	26.99	23.89	21.77	27.16	24.58	28.40
2002.00	24.19	25.57	22.33	25.06	27.60	27.26	24.95	26.90	23.93	22.25	27.04	24.25	28.25
2003.00	24.73	25.88	22.29	25.52	27.94	27.71	25.39	27.14	24.34	22.69	27.31	24.95	28.53
2004.00	25.18	26.33	22.31	25.74	28.08	27.81	25.55	27.39	24.64	22.99	27.44	25.31	28.67
2005.00	25.55	26.39	22.61	25.91	28.20	27.83	25.70	27.41	24.66	22.79	27.57	25.81	28.75
2006.00	25.98	26.71	23.49	26.17	28.52	28.12	26.06	27.66	25.10	23.44	27.82	25.81	28.96
2007.00	26.16	26.68	24.11	26.35	28.65	28.38	26.30	27.70	25.84	24.09	27.87	26.38	28.98
2008.00	25.00	25.84	22.80	25.60	28.03	27.73	25.23	26.98	24.92	23.19	27.48	25.49	28.25
2009.00	24.70	26.29	22.33	25.95	28.31	27.89	24.73	26.48	25.38	23.19	27.70	26.14	28.66
2010.00	24.94	26.32	22.65	26.17	28.29	27.99	25.01	26.49	25.34	22.97	27.84	26.45	28.76
2011.00	25.13	26.16	21.77	25.91	28.08	27.80	24.24	26.79	24.94	22.57	27.56	26.03	28.70

References

1. Abel, B, Andrew (1984), "R & D and the Market Value of the Firm: A Note". In R & D, Patents and Productivity, edited by Zvi Griliches, (1984), 261 - 269.

2. Akerlof, George,(2007),Missing motivation in macroeconomics,*American Economic Review*, 2007, vol. 97, issue 1, pages 5-36

3. Arrow, K.J. (1962). "The Economic Implications of Learning by Doing," *American Economic Review*, May *96*(2): pp. 308-312.

4. Bronwyn H. Hall & Grid Thoma & Salvatore Torrisi, 2007. "The market value of patents and R&D: Evidence from European firms,"NBER Working Papers 13426, National Bureau of Economic Research, Inc
5. Cockburn, Iain & Griliches, Zvi, (1988). "Industry Effects and Appropriability Measures in the Stock Market's Valuation of R&D and Patents,"American Economic Review, American Economic Association, vol. 78(2), pages 419-23, May
6. Connolly, R.,Hirschey, M.,(1984), R & D, Market Structure and Profits: A Value-Based Approach, *The Review of Economics and Statistics*, Vol. 66, No. 4. (Nov., 1984), pp. 682-686.

7. Connolly, R.,Hirschey,M.,(2005), Firm size and the effect of R&D on Tobin's *q*, R&D *Managemenl* 35. 2, 2005. cg Blackwell Publishing Ltd, 2005. Published by Blackwell Publishing Ltd,
8. Damianova,K., (2005), The Conditional Value of R&D Investments**,** National Centre of Competence in Research Financial Valuation and Risk Management
9. Griliches, Z. (1981), 'Market value, R&D and patents', *Economics Letters*, 7 (2), 183-187
10. Griliches, Zvi(1979), R&D and Productivity: The Econometric Evidence, Chapter: Issues in Assessing the Contribution of Research and Development to Productivity Growth
11. Hall, B., H. & Lerner, J, (2010). "The Financing of R&D and Innovation,"UNU-MERIT Working Paper Series 012, United Nations University, Maastricht Economic and social Research and training Centre on Innovation and Technology

12. Hall, B.,(1998), Innovation and market value, University California Berkeley

13. Megna, P. and Klock, M. 1993. The Impact of Intangible capital on Tobin's q in the Semiconductor Industry, *The American Economic Review* 83(2): 265 – 269.

14. Share, W.F."Capital Asser Prices: A Theory of Market Equilibrium under Conditions of Risk", Journal of Finance 19,September, p.425-442

15. Tobin J, and Brainard W.C.(1977), *Asset Markets and the Cost of Capital*, Cowles Foundation Paper 440

16. Tobin,J. (1969). "A general equilibrium approach to monetary theory". *Journal of Money Credit and Banking* **1** (1): 15–29

17. Warusawitharana,M.,(2008), Research and Development, Profits and Firm Value: A Structural Estimation, Division of Research and Statistics, Board of Governors of the Federal Reserve System