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TOBIN'S Q AND R&D INVESTMENT IN CESEE COUNTRIES

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Abstract

In this paper Tobin's and R&D investment issue has been subject of investigation. Tobin's q quotient is derived by the ratio of market value (market capitalization of listed companies excluding investment companies and mutual funds) and replacement value of capital used in production (Adjusted savings: consumption of fixed capital). Further, the influence of democracy indices Freedom House political rights and Freedom house civil liberties as proxies for democracy has been investigated along with the some government related variables as well as other macroeconomic variables. The basic idea of this paper is being derived from Arrow paper. ZviGriliches first introduced production function that relates market value of the firms, tangible and intangible assets. This model also can be applied in a small and simple Keynesian framework, where change in capital stock (investment) is a function of the difference between actual q and normal qi.e. normal $\bar{q}$ = 1, and some natural growth rate (actually fitted values of the output growth), when q = $\bar{q}$ = 1 investment equals savings, i.e. there exists macroeconomic equilibrium. In the empirical section theories had been tested on a pooled data from sample of 12 CESEE countries.

Keywords: *Tobin's q, R&D, Market value, Replacement value, CESEE countries*

Introduction

In this paper we examine the issue of R&D investment and the Tobin's q . R&D investment is different than other ordinary investment, according to Hall and Lerner (2009)[27], fifty percent or more of R&D spending is on salaries of highly educated scientist and engineers. The idea comes from Arrow (1962)[28], 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[29]. In the empirical literature form this area one significant contri-

27) 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.

28) Arrow, K.J. (1962). "TheEconomicImplicationsofLearningbyDoing," AmericanEconomicReview, May96(2): pp. 308-312.

29) $y = Ak^{1-\alpha}(\bar{k})^{\alpha}$ $0 < \alpha < 1$ in equilibrium $k = \bar{k}$

bution 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[30]. Earlier Connolly and Hirschey (1984)[31], 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[32]. 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)[33]. Also the same production that ZviGriliches (1979)[34], 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 ZviGriliches and Cockburn (1988), relate the value of the firm with Tobin's q, as follows:

V = q (tan*gible capital,* int*angible capital*), so in this paper[35], q is related also to intangible capital. Megna and Klock (1993)[36], 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)[37], introduced Cobb-Douglass production form with Tobin's q:

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

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

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

Later Hall, Thoma, and Torrisi (2007)[38], 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)[39]:

30) Connolly, R., Hirschey,M., (2005), Firmsizeandtheeffectof R&D onTobin'sq, R&D Managemenl 35. 2, 2005. cg Blackwell PublishingLtd, 2005. Publishedby Blackwell PublishingLtd,

31) Connolly, R., Hirschey, M.,1984), R & D, Market Structureand Profits: A Value-Based Approach, The Reviewof Economicsand Statistics, Vol. 66, No. 4. (Nov., 1984), pp. 682-686.

32) The firms in the more concentrated industries are less efficient researchers, or are willing to take riskier projects.

33) Warusawitharana, M., (2008), Research and Development, Profits and Firm Value: A Structural Estimation, Division of Researc hand Statistics, Board of Governor sof the Federal Reserve System

34) Griliches, Zvi (1979), R&D and Productivity: The Econometric Evidence, Chapter: Issuesin Assessingthe

ContributionofResearchandDevelopmenttoProductivityGrowth

35) 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

36) Megna, P. andKlock, M. 1993. TheImpactofIntangiblecapitalonTobin's q intheSemiconductorIndustry, TheAmericanEconomicReview83(2): 265 – 269.

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

38) 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

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

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

Here 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.

R&D and Tobin's q

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)[40]. We use here the "definitional" model by ZviGriliches:

$$MV = q(TA + IA) \quad (4)$$

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)[41]. 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 $\bar{R}$, and, $\bar{R} = rK$, 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 $\bar{R} = rq$, 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.

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

$$V = \int_0^{\infty} E(t) e^{-\bar{R}t}\, dt \quad (5)$$

Here V are the cost of capital (replacement value) and E(t) are the expected future earnings,

For a definite integral solution is $-\frac{1}{r+1} \text{ for } Re(r) < -1$, Now Tobin (1977) presents market value of capital goods of the firm and the expression is presented in the following expression:, $MV = \int_0^{\infty} E(t) e^{-rt}\, dt$,E(t) E(t) is constant, then $V = E/\bar{R}$, 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 is the natural growth rate. And if ,then ,which represents net investment[42].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

40) Griliches, Z. (1981), 'Marketvalue, R&D and patents', Economics Letters, 7 (2), 183-187

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

42) 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

of market value of the firm and R&D. Abel (1984)[43] uses Bellman value function[44], for the market value of the firm.

$$V(T_t, p_t) = \max_{L_t, \bar{R}_t} E_t \left| p_t L_t^{\alpha} T_t^{1-\alpha} - wL_t - a\bar{R}_t^2 + \beta V(T_{t+1}, p_{t+1}) \right| \quad (6)$$

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.

$$q_t = \frac{V(T_t, p_t) - E_{t-1} V(T_t, p_t)}{V(T_{t-1}, p_{t-1})} \quad (7)$$

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). Here we set hypothesis that Tobins'qis more positively affected by the tangible capital i.e. physical capital, and that R&D. Actually, Tobins' q quotient was introduced as a measure

Democracy, other economic variables and stock market performance

Throughout literature there is no clear indication as how political regime impacts economic growth. Though democracy has very attractive features, this model of political organization may lead to inefficient policies and high levels of income redistribution, Acemoglu (2008)[45]. As Barro (1999)[46] noted more democracy encourages rich to poor redistributions and may enhance the power of interest groups. Or as Barro (1997)[47] once again concludes the net effect of democracy on economic growth is inconclusive. When financial development in matters some papers find positive association between financial development and the quality of political institutions, but this result is conditioned by the quality the institutional framework,

Ghardallou,Boudriga(2006)[48]. On the other hand Yang (2011)[49],found out that democracy is not positively related to stock market development. Here is set hypothesis that the effect of democracy on Tobin's q is positive, since democracy affects positively on the financial institutions. As the measures for democracy here are used Freedom house political rights and Freedom house civil liberties. The effect of government size appears to be negatively associated with the financial efficiency but positively associated with the financial sector size in low income economies, in some recent studies, like the one of Cooray, (2011)[50]. The hypothesis here is that the government consumption effect is positively associated with the Tobin's q.

Methodology

In this paper one can see that time series models and panel model had been used jointly. In the first section in order to see the long run coefficient and the causality between R&D and tobins'q paper starts with the

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

44) Bellman equation has been used in economics amongst others also by Edmund Phelps, Robert Lucas, Sargent and others.

45) Acemoglu, D. (2008), Oligarchic versus democratic societies, Journal of the European Economic Association.

46) Barro, R.(1999), Determinants of Democracy, Journal of Political Economy 107(S6): 158-183.

47) Barro, R.(1996), Determinants of economic growth: a cross-country empirical study, NBER Workingpaper.

48) Ghardallou,Boudriga(2006),Financial Development and Democracy: Does the Institutional Quality Matter?,

49) Yang, B., (2011), "Does democracy foster financial development? An empirical analysis", Economic Letters, 112, pp.262-265.

50) Cooray, A. (2011). The role of the government in financial sector development. Economic Modeling, 28 (3), 928-938.

usual cointegration testing. From the cointegration test paper uses Johansen test for cointegration.This test it is well known that allows for more than one cointegration relationship. This approach is similar to augmented Dickey-Fuller test but it requires for VAR approach.

$$x_t = A_t x_{t-1} + \varepsilon_t ; \quad (8)$$

$$\Delta x_t = (A_1 - idMATRIX) x_{t-1} + \varepsilon_t \quad (9)$$

$$\Delta x_t = v\, x_{t-1} + \varepsilon_t \quad (10)$$

$$v = (A_1 - idMATRIX) \quad (11)$$

So in Johansen cointegrating relationship IDmatrix is identity matrix, A_1 is a g - g matrix, x_t and y_t arecointegratingvectors. The rank of v is the number of cointegrating relationships. After one determines the number of cointegrating relationships ,one can use VECM model to capture the long run relationship between variables in the model.Vector Error Correction Models (VECM) are the basic VAR, with an error correction term incorporated into the model and as with bivariate cointegration, multivariate cointegration implies an appropriate VECM can be formed. We are estimating the error correction mechanism by using the lagged residuals u_{t-1}.

$$\Delta Y_t = \beta_0 + \beta_1 \Delta X_t - \beta_2 (Y_{t-1} - C - \beta X_{t-1}) \quad (12)$$

Now the error correction mechanism is:

$$EC = Y_{t-1} - C - \beta X_{t-1} \quad (13)$$

In the cointegrating regression

$$Y_t = C + X_t + u_t$$
$$u_t = Y_t - C - X_t \Rightarrow u_{t-1} = Y_{t-1} - C - \beta X_{t-1} \quad (14)$$

u_{t-1} in the last expression represents error correction mechanism. And further in the second section there exist joint tests of IS-LM and IS-MP-IA framework with the tobin's q paper uses GMM estimation i.e. well known Arellano-Bond estimation technique. In order to capture the long run as well short run effect, paper uses level independent as well as lagged independent variable.In order to test for the validity of restrictions one can use Sargan test. Next for the panel data section, this paper uses panel unit root test first. This test is of Fischer type and it is based on the augmented Dickey-Fuller test. Null hypothesis is that all panels contain unit root, alternative is that at least one panel is stationary. Next, to the unit root test panel cointegration tests have being performed in order to test for the long run relationship of the variables in the model. These tests were based on Westerlund (2007)[51] procedure. Data used in this paper cover period from 1993 to 2011 for 12 countries[52].

Johansen test for cointegration

This test[53] as noted before allows for more than one cointegrating relationship unlike Engle Granger, but it is a subject to asymptotic properties i.e. requires large sample[54]. In this series of test for each country in the sample the null hypothesis is either $r(\Pi) = 0$ or $r(\Pi) = 1$ this depends on the power of the test.If there is evidence of cointegration, one can estimate the ECM using the lagged residuals u_{t-1}

$$\Delta Y_t = \beta_0 + \beta_1 \Delta X_t - \beta_2 (Y_{t-1} - C - \beta X_{t-1}) \quad (15)$$

51) Westerlund, J.(2007). ***Testing for error correction in panel data***. Oxford Bulletin of Economics and Statistics 69: 709–748.

52) See Appendix 1 Definitions on some of the variables used in the models

53) Johansen,S.,(1988), Statistical analysis of cointegration vectors, Journal of economic dynamics and Control

54) Though Johansen test for cointegration works and with not so small samples.

In the previous expression EC Mechanism º (Y_{t-1} - C - βX_{t-1}).And in the cointegration regression one can get:

$$Y_t = C + \beta X_t + u_t u_t = Y_t - C - \beta X_t \Rightarrow u_{t-1} = Y_{t-1} - C - \beta X_{t-1} \Rightarrow \quad (16).$$
$$u_{t-1} \equiv \text{EC mechanism}$$

The results prove that for every country in the sample there exist one cointegrating relationship between Tobin's q and knowledge absorption as proxy for R&D. The results are presented in the following table.

Table 1 Johansen test for cointegration

				JohansenTracetest			
Country	**Null hypothesis**	**Variables**	**Deterministic term**	**Lag order**	**Trace statistics**	**5% critical value**	**Decision**
Bulgaria	*rc* (Π) = 0	q_t *knowledgeabsorbtion*$_t$	Constant	1	16.6237*1	15.41	Reject the nul hypothesis that cointegration rank is zero, and accept alternative that cointegration rank is 1
Croatia	*rc* (Π) = 1	q_t *knowledgeabsorbtion*$_t$	Constant	1	3.7365*	3.76	Insufficient evidence to reject the null hypothesis that cintegration rank is 1.
Czech Republic	*rc* (Π) = 0	q_t *knowledgeabsorbtion*$_t$	Constant	1	0.5846*	3.76	Insufficient evidence to reject the null hypothesis that cointegration rank is 1.
Estonia	*rc* (Π) = 1	q_t *knowledgeabsorbtion*$_t$	Constant	2	3.0070*	3.76	Insufficient evidence to reject the null hypothesis that cointegration rank is 1.
Hungary	*rc* (Π) = 1	q_t *knowledgeabsorbtion*$_t$	Constant	2	0.0367	3.76	Insufficient evidence to reject the null hypothesis that cointegration rank is 1.
Macedonia	*rc* (Π) = 1	q_t *knowledgeabsorbtion*$_t$	Constant	1	3.5754*	3.76	Insufficient evidence to reject the null hypothesis that cointegration rank is 1.
Moldova	*rc* (Π) = 1	q_t *knowledgeabsorbtion*$_t$	Constant	2	14.5442*	15.41	Insufficient evidence to reject the null hypothesis that cointegration rank is 1.
Romania	*rc* (Π) = 1	q_t *knowledgeabsorbtion*$_t$	Constant	2	13.3169*	15.41	Insufficient evidence to reject the null hypothesis that cointegration rank is 1.
Russian Federation	*rc* (Π) = 0	q_t *knowledgeabsorbtion*$_t$	Constant	2	18.1933	15.41	Reject the nul hypothesis that cointegration rank is zero, and accept alternative that cointegration rank is 1
Slovak Republic	*rc* (Π) = 1	q_t *knowledgeabsorbtion*$_t$	Constant	2	0.97	3.76	Insufficient evidence to reject the null hypothesis that cointegration rank is 1.
Slovenia	*rc* (Π) = 1	q_t *knowledgeabsorbtion*$_t$	Constant	1	1.16*	3.76	Insufficient evidence to reject the null hypothesis that cointegration rank is 1.
Ukraine	*rc* (Π) = 1	q_t *knowledgeabsorbtion*$_t$	Constant	2	1.8507	3.76	Insufficient evidence to reject the null hypothesis that cointegration rank is 1.

After one had determined the number of cointegrating relationship, the analysis can continue to the Vector Error correction model, i.e. determining long run coefficient between Tobins'q and R&D.

Table 2 VECM models

Country	Cointegration vectors	Interpretation of cointegrationg vector
Bulgaria	$q_t = \underset{(-3.14)}{0.62} logknowledgeabsorbtionec_t^{FCLS} + ec_t^{FCLS}$	1 percentage point increase in payments for royalties and licence fees would lead to an increase of the Tobin's q by 0.0062%
Croatia	$q_t = \underset{(0.96)}{0.077} logknowledgeabsorbtione_t + ec_t^{FCLS}$	t-stat lower than 1.61 proves that between knowledge absorption variable and Tobin's q do not exist cointegration relationship.
Czech Republic	$q_t = -\underset{(2.89)}{3.42} logknowledgeabsorbtione_t + ec_t^{FCLS}$	1 percentage point increase in payments for royalties and licence fees would lead to an decrease of the Tobin's q by 0.0342%
Estonia	$q_t = -\underset{(9.10)}{2.23} logknowledgeabsorbtione_t + ec_t^{FCLS}$	1 percentage point increase in payments for royalties and licence fees would lead to an decrease of the Tobin's q by 0.0023%
Hungary	$q_t = \underset{(-2.94)}{14.7} logknowledgeabsorbtione_t + ec_t^{FCLS}$	1 percentage point increase in payments for royalties and licence fees would lead to an increase of the Tobin's q by 0.1470%
Macedonia	$q_t = \underset{(-4.47)}{1.21} logknowledgeabsorbtione_t + ec_t^{FCLS}$	1 percentage point increase in payments for royalties and licence fees would lead to an increase of the Tobin's q by 0.0121%
Moldova	$q_t = -\underset{(3.21)}{7.49} logknowledgeabsorbtione_t + ec_t^{FCLS}$	1 percentage point increase in payments for royalties and licence fees would lead to an decrease of the Tobin's q by 0.0749%
Romania	$q_t = -\underset{(3.11)}{1.60} logknowledgeabsorbtione_t + ec_t^{FCLS}$	1 percentage point increase in payments for royalties and licence fees would lead to an decrease of the Tobin's q by 0.016%
Russian Federation	$q_t = \underset{(5.12)}{0.66} logknowledgeabsorbtione_t + ec_t^{FCLS}$	1 percentage point increase in payments for royalties and licence fees would lead to an increase of the Tobin's q by 0.0066%
Slovak Republic	$q_t = -\underset{(3.42)}{0.32} logknowledgeabsorbtione_t + ec_t^{FCLS}$	1 percentage point increase in payments for royalties and licence fees would lead to an decrease of the Tobin's q by 0.0032%
Slovenia	$q_t = \underset{(3.34)}{0.079} logknowledgeabsorbtione_t + ec_t^{FCLS}$	1 percentage point increase in payments for royalties and licence fees would lead to an increase of the Tobin's q by 0.00079%
Ukraine	$q_t = \underset{(3.24)}{0.06} logknowledgeabsorbtione_t + ec_t^{FCLS}$	1 percentage point increase in payments for royalties and licence fees would lead to an increase of the Tobin's q by 0.00006%

*Note: *** statistical significance at all levels of significance;** statistical significance at 5%,*statistical significance at 10%*

Positive sign on the independent variable means absence of long term positive association, and instead one should look for a short term relationship between variables. According to the results from the table, there exists positive association between Tobin's q and R&D in Bulgaria, the coefficient is positive **0.62** and significant at levels of statistical significance. In Croatia the coefficient is positive though is statistically insignificant. This proves that between R&D and Tobin's q there does not exist long run association. In Czech Republic marginal contribution of R&D to Tobins'q is negative. The coefficient is large -3.42, it means that on long run 1 percentage point increase in Royalty and license fees payments would decrease Tobins'q by **0.0342%.** In Estonia the coefficient is also negative. For Estonia, one can conclude that 1 percentage point increase in Royalty and license fees payments would decrease Tobins'q by **2.23 %.** In Hungary marginal contribution of knowledge absorption to Tobin's q is huge and the coefficient proves that 1 percentage point increase in R&D would lead to **0.1470%** increase in the ratio between market value and replacement value

of enlisted companies. In Macedonia, as the VECM model proves 1 percentage point increase in R&D investment would lead to **0.0121%** increase in the Tobin's q of enlisted companies. In Moldova marginal contribution of R&D investment to Tobin's q is negative 1 percentage point increase in R&D investment lowers the q quotient by **0.049 %.** In Romania 1 percentage point increase in R&D investment lowers the q quotient by **0.0160 %.**In Russian federation 1 percentage point increase in R&D investment increase the q quotient by **0.0066 %.**

In Slovak Republic 1 percentage point increase in R&D investment lowers the Tobin's q by **0.0032 %.**In Slovenia 1 percentage point increase in the R&D investment leads to an increase of the Tobin's q by **0.00079%.**In Ukraine 1 percentage point increase in payments for royalties and licence fees would lead to an increase of the Tobin's q by **0.0006%**. So from the results the association between R&D investment and Tobins'q only in Croatia is not significant. So from the countries in sample in six countries the result is positive and in five countries the association is negative. In the countries where the sign on the coefficient is negative policy implication would be that the R&D policy should develop more, and that the current state of that policy is underdeveloped.

Or that this policy does not exists at all. In Czech Republic the funding system was also obsolete. So in general the result is inconclusive whether the investment in R&D affects positively on Tobin's q. This finding is consistent with the notion that there exist U-shaped association between R&D intensity and firm value i.e. there exist diminishing marginal return to each unit of money spent on R&D, Huang, Liu (2006)[55].In the next table are published the results for the average Tobin's q for selected countries in the sample. Tobin's q is derived in a following way:

$$\text{Tobin's q} = \frac{\text{Market value of the instaled capital}}{\textit{Replacement cost of the capital}} = \frac{\text{Market capitalization of listed companies}}{\text{Adjusted savings: consumption of fixed capital}} \qquad (17)$$

Table 3 Tobin's q for the selected countries in the sample[56]

Year\Country	Bulgaria	Croatia	CzechRepublic	Estonia	Hungary	Macedonia
1993	n.a.	n.a.	n.a.	n.a.	0.90	n.a.
1994	0.87	n.a.	0.976675	n.a.	0.93	n.a.
1995	0.76	0.91	1.01	n.a.	0.94	n.a.
1996	0.71	0.98	1.02	n.a.	0.98	0.90
1997	1.02	1.00	1.00	1.03	1.02	0.79
1998	0.96	0.99	1.00	0.99	1.02	0.79
1999	0.95	0.98	1.00	1.05	1.03	0.79
2000	0.95	0.99	1.00	1.05	1.02	0.79
2001	0.96	0.98	0.99	1.03	1.01	0.88
2002	0.99	0.99	1.00	1.05	1.01	0.94
2003	1.00	1.00	1.00	1.06	1.01	0.96
2004	1.02	1.01	1.01	1.07	1.03	0.96
2005	1.04	1.03	1.02	1.03	1.03	0.98
2006	1.07	1.06	1.02	1.05	1.04	1.00
2007	1.02	1.09	1.03	1.04	1.04	1.03
2008	1.01	1.04	1.01	0.98	0.99	0.97
2009	1.00	1.05	1.01	0.99	1.01	0.97
2010	1.01	1.05	1.01	0.99	1.01	0.96
2011	1.02	1.05	1.00	0.96	1.00	0.95

55) Huang, C. J., & Chun J. L. (2006). Exploration for the Relationship Between Innovation, IT and Performance, Journal of Intellectual Capital 6(2): 237-252

56) See also Appendix 2 Market capitalization of firms in stock markets in CESEE countries

Table 3 continued Tobin's q for the selected countries in the sample

Year\Country	Moldova	Romania	Russian Feder.	Slovak Rep.	Slovenia	Ukraine
1993	n.a.	n.a.	0.68	n.a.	n.a.	n.a.
1994	n.a.	0.81	0.77	0.95	0.93	n.a.
1995	n.a.	0.84	0.93	0.94	0.89	n.a.
1996	0.93	0.81	0.97	0.96	0.92	n.a.
1997	0.95	0.92	1.03	0.95	0.96	0.96
1998	0.94	0.93	0.97	0.92	0.98	0.88
1999	0.94	0.93	1.05	0.92	0.98	0.93
2000	n.a.	0.91	1.03	0.93	0.99	0.95
2001	n.a.	0.94	1.05	0.94	0.99	0.93
2002	n.a.	0.96	1.06	0.94	1.01	0.97
2003	n.a.	0.96	1.08	0.95	1.02	0.98
2004	n.a.	0.99	1.08	0.96	1.03	1.01
2005	n.a.	1.00	1.10	0.96	1.02	1.04
2006	n.a.	1.02	1.12	0.96	1.04	1.06
2007	n.a.	1.02	1.12	0.97	1.06	1.09
2008	n.a.	0.98	1.06	0.95	1.02	1.02
2009	n.a.	1.00	1.10	0.95	1.02	1.01
2010	n.a.	1.01	1.10	0.94	1.01	1.04
2011	n.a.	0.98	1.09	0.94	0.99	1.01

From the tables one can see that the average Tobin's q quotient for the selected countries move s around 1, i.e. the market value is almost equal to replacement value of capital. Next, in a table descriptive statistics of some of the variables it has been published.

Table 4 Descriptive statistics of the variablesin the model

Variable	Mean	Standard deviation	Minimum	Maximum	Observations
Tobin's q overall	0.823819	0.372374	0.0	1.286.911	N = 228
between		0.230658	0.2	1.042.841	n = 12
within		0.299463	-0.2	1.591.731	T = 19
R&D overall	562.848	0.290129	5.0	6.013.715	N = 228
between		0.097486	544349.0	5.747.852	n = 12
within		0.274636	4884992.0	6.068.262	T = 19
Government consumption overall	9.085.602	2.535.866	4.8	19.28	N = 216
between		211.436	5351111.0	1.389.778	n = 12
within		1.521.047	5725602.0	155.806	T = 18
Inflation overall	4.840.662	1.823.138	6.7	91.2	N = 216
between		1.370.293	2878222.0	7.357.944	n = 12
within		1.262.774	1501717.0	8.119.662	T = 18
Log Real GDP overall	9.111.734	0.660963	7290968.0	1.020.836	N = 216
between		0.649226	7568224.0	9.897.315	n = 12
within		0.220691	8587443.0	9.579.037	T = 18
Investment overall	0.085839	0.272361	-1.0	0.811422	N = 216
between		0.036422	0.0	0.135191	n = 12
within		0.270109	-1.0	0.785633	T = 18
Interest rate overall	3.197.315	1.039.439	492849.0	1443.61	N = 221
between		2.371.037	8687191.0	8.870.354	n = 12
within		101.359	-4739956.0	1386.88	T-bar = 18.4167
Log of M2 overall	3.695.929	0.475326	2424803.0	4.422.449	N = 225
between		0.310588	3355081.0	4.150.556	n = 12
within		0.371439	2765651.0	4.643.561	T = 18.75

From the above table one can see that the average value of Tobins'q overall is 0.82.The other variables statistics is presented in the table. In the descriptive statistics table also information are available for interest rate, monetary aggregate M2, investment and logarithm of real GDP, as well as inflation.Next in a table are presented results from panel unit root test.

Table 5 Panel Unit root test Fisher test Based on Augmented Dickey Fuller

Ho: All panels contain unit roots	Ha: At least one panel is stationary	Statistic	p-value	Decision	transformation required
Tobin's q	Inverse P chi-squared(24)	387,2395	0.000	Accept alternative hypothesis: At least one panel is stationary	none
R&D	Inverse P chi-squared(24)	694.394	0.000	Accept alternative hypothesis: At least one panel is stationary	none
Inflation	Inverse P chi-squared(24)	391.261	0.0265	Accept alternative hypothesis: At least one panel is stationary	Cross-sectional means removed
Log of Real GDP	Inverse P chi-squared(24)	523.633	0.0007	Accept alternative hypothesis: At least one panel is stationary	Cross-sectional means removed
Government consumption	Inverse P chi-squared(24)	512.302	0.001	Accept alternative hypothesis: At least one panel is stationary	none
Logarithm of M2	Inverse P chi-squared(24)	**473.332**	0.003	Accept alternative hypothesis: At least one panel is stationary	Cross-sectional means removed
Lending interest rate	Inverse P chi-squared(24)	**235.156**	0.000	Accept alternative hypothesis: At least one panel is stationary	none
World interest rate	Inverse P chi-squared(24)	**81.178**	0.000	Accept alternative hypothesis: At least one panel is stationary	none
Investment	Inverse P chi-squared(24)	130.767	0.000	Accept alternative hypothesis: At least one panel is stationary	none

From the above table one can see that in all cases with every variable one can reject the null hypothesis of unit root an accept alternative that at least one panel is stationary. Some variables ask for removal of cross sectional means otherwise no transformations are necessary.

In the next table are reported results for the panel cointegration test. Westerlund (2007)[57] test uses the following specification:

$$\Delta y_{it} = c_i + a_{i1} * \Delta y_{it-1} + a_{i2} * \Delta y_{it-2} + \cdots . + a_{ip} * \Delta y_{it-p} + b_{i0} * \Delta x_{it} + b_{i0} * \Delta x_{it-1} + \cdots \Delta x_{it-p} + a_i (y_{it-1} - b_i * x_{it-1}) + u_{it} \quad (18)$$

The speed of convergence in the ECM mechanism is :

$$y_{it} = -\left(\frac{b_i}{a_i}\right) * x_{it} \quad (19)$$

G_a and G_t statistics test: $H_0: a_i = 0 \; \forall i$ and $H_1: a_i < 0$ for at least one *i*. The Pa and Pt test statistics pool information over all the cross-sectional units to test $H_0: a_i = 0$ and $H_1: a_i < 0$ for all *i*

57) Westerlund, J. 2007. *Testing for error correction in panel data. Oxford Bulletin of Economics and Statistics* 69: 709–748.

Table 6 Panel cointegration test Westerlund (2007) specification

variables	model set up	constant	trend	Gt	Ga	Pt	Pa	decision	Average AIC selected lag and lead lag length
tobin's q-R&D	lags(1 3) leads(0 3) lrwindow(3) westerlund	✔	✔	0.0000	0.0001	0.0000	0.0000	reject null hypothesis of no coin-tegration	2.08 and 2.83
tobin's q-Log of M2	lags(1 3) leads(0 3) lrwindow(3) westerlund	✔	✔	0.0000	0.0510	0.0680	0.1780	reject null hypothesis of no coin-tegration	2.5 and 2.08
tobin's q-Freedom house political rights	lags(1 3) leads(0 3) lrwindow(3) westerlund	✔	✔	0.0000	0.0000	0.0000	0.0000	reject null hypothesis of no coin-tegration	2.17 and 2.58
tobin's q-Freedom house civil liberties	lags(1 3) leads(0 3) lrwindow(3) westerlund	✔	✔	0.0000	0.896	0.0000	0.0000	reject null hypothesis of no coin-tegration	2.5 and 2.08
tobin's q-investment	lags(1 3) leads(0 3) lrwindow(3) westerlund	✔	✔	0.0000	0.065	0.0000	0.0130	reject null hypothesis of no coin-tegration	2.5 and 1.67
tobin's q-log natural output (centered moving average with 3 interval)	lags(1 3) leads(0 3) lrwindow(3) westerlund	✔	✔	0.0000	0.0000	0.0000	0.0000	reject null hypothesis of no coin-tegration	2.25 and 2.5

From the above table on can see that tobin's q is cointegrated with all of the variables. Of special importance is the notion that there is clear evidence of cointegration between tobins'q and R&D.Thus, there exist evidence of the long run relationship between innovations and Tobin's q.

Next, in a table is presented augmented model with democracy related variables and economic variables. Model specification is as follows:

$$q_{it} = C + \beta_0 logR\&D_{it} + \beta_1 logR\&D_{i(t-1)} + \beta_2 FHPR_{it} + \beta_3 FHPR_{it(-1)} + \beta_4 FHCL_{it} + \beta_5 FHCL_{i(t-1)} + \beta_6 \pi_{it} + \beta_6 \pi_{i(t-1)} + \beta_7 logGY_{it} + \beta_8 logGY_{i(t-1)} + \varepsilon_{it} \quad (20)$$

Table 7 Democracy and economic variables related with Tobin's q

Dependent variable	Tobin's q	**Model 1** Coefficient (statistical significance)	**Model 2** Coefficient (statistical significance)
Dependent variables Lag(1)	0.554***	0.561***	
Logknowledge absorption	Logarithm of knowledge absorption (proxy for R&D)	0.152***	0.16***
Lag(1)		-0.036	-0.03
FH_PR	Freedom House political rights index	0.018***	-
Lag(1)		-0.010	-
FH_CL	Freedom house civil liberties index	-	0.005
Lag(1)		-	0.019*
π_{it}	Inflation (percentage change in prices)	-0.0009	-0.001
Lag(1)	0.0034	0.002	
$logGY_{it}$	Government consumption	0.028*	0.018
Lag(1)		-0.001	-0.001
C	Constant	-0.640	-0.575
Arellano-Bond test for AR(1) in first differences ;p-value		0.0331	0.0308
Arellano-Bond test for AR(2) in first differences ;p-value		0.2112	0.6947

*Note: *** statistical significance at all levels of significance;** statistical significance at 5%,*statistical significance at 10%.*

From the above table one can see that there exist positive association between q and Freedom house political rights on long run, thus on short run coefficient is insignificant. Freedom house civil liberties coefficient I positive and significant on short run. Inflation is insignificant in relation with Tobin's q.While coefficient on government consumption is positive and significant on long run. R&D i.e. logarithm of knowledge absorption variable, is positive and significantly associated with the Tobin's q in long run. Next, Tobin's q is presented in traditional Keynesian IS-LM form. Specification for this models is as follows:

$$\left(\frac{K_{it}-K_{i(t-1)}}{K_{i(t-1)}}\right) = C + \beta_0(q_{it} - \bar{q}_{i(t-1)}) + \beta_1 logR\&D_{i(t-1)} + \beta_2 m2_{it} + \beta_3 m2_{it(-1)} + \beta_4 i^r{}_{it} + \beta_5 i^r{}_{i(t-1)} + \varepsilon_{it} \quad (21)$$

Table 8 IS LM model framework for Tobin's q

Dependent variable	Investment (Percentage change in physical capital)	Model 1 (Coefficient significance)	Model 2(Coefficient significance)	Model 3(Coefficient significance)
Dependent variables		0.072	0.020	0.0118
Lag(1)				
qminusqhat	Residual tobins'q	0.318***	0.380***	0.388***
Lag(1)		-0.392	0.229***	0.070
lrgdphat	Natural output (fitted values)	0.806**	-	-
Lag(1)		-1.153***	-	-
lognatural outputma3	Natural output(centered moving average with 3 periods)	-	0.0006	-
Lag(1)		-	0.0010***	-
Lognatural outputma5	Natural output(centered moving average with 5 periods)	-	-	-0.00049
Lag(1)		-	-	0.00041**
M2	Money andquasimoney (M2) as % of GDP	-0.009***	-0.401***	-0.220***
Lag(1)		0.006**	0.162***	0.287***
i^r	Lending interest rate	-0.003***	-0.0019***	-0.003***
Lag(1)		0.001	0.0008	0.001
C	Constant	0.564***	0.820***	-0.059
Sargan test H_0: overidentifying restrictions are valid ;p-value		0.1224	0.0708	0.3517

*Note: *** statistical significance at all levels of significance;** statistical significance at 5%,*statistical significance at 10%.*

Dependent variable is percentage change in capital i.e. investment ,as for natural output here it has been used centered moving average of logarithm of real GDP with 3 and 5 periods. Resiual q is positively associated with investment, on long run and in short run when one controls for natural output with centered moving average with three periods. Money and quasi money are negatively associated with the investment on long run, though they are insignificant on short run. Money supply is positively and statistically significantly associated with investment when lagged once. Lending interest rate is negatively associated with the investment on long run and this result is statistically significant. Natural output is positively and statistically significantly associated with investment. Next Tobin's in IS-MP-IA framework has been tested. Specification Form is as follows:

$$logRGDP_{it} = C + \beta_0 q_{it} + \beta_1 q_{i(t-1)} + \beta_2 logGY_{it} + \beta_3 logGY_{it(-1)} + \beta_4 logCY_{it} + \beta_5 logCY_{i(t-1)} + \beta_6 \pi_{it} + \beta_6 \pi_{i(t-1)} + \beta_7 log\mathrm{ER}^{e}_{it} + \beta_8 \log\mathrm{ER}^{e}_{i(t-1)} + \beta_9 log\mathrm{R}^{W}_{it} + \beta_{10} \log\mathrm{R}^{W}_{i(t-1)} + \beta_{11} log\mathrm{Y}^{W}_{it} + \beta_{12} \log\mathrm{Y}^{W}_{i(t-1)} \varepsilon_{it} \quad (22)$$

Table 9 IS MP IA model and testing whether Ricardian equivalence holds

Dependent variable	log of Real GDP per capita ($logRGDP_{it}$)	Model 1(Coefficient significance)	Model 2(Coefficient significance)
Dependent variables Lag(1)		0.8013***	0.644***
q	Market value/replacement value	0.0223*	0.005
Lag(1)		0.0114	0.005
$logGY_{it}$	Log of government consumption	-0.1048***	-0.092***
Lag(1)		-0.0078	0.047***
$logCY_{it}$	Log of private consumption	-	0.515***
Lag(1)		-	-0.297***
$Log\pi^{e}_{it}$	Log of expected inflation	-0.0341	-0.034*
Lag(1)		-0.0354	0.001
$logER^{e}_{it}$	Expected exchange rate, log	-0.0156	-0.010
Lag(1)		0.0520*	0.075***
R^{W}	World interest rate = US federalfundsrateminus PPI	-0.0020***	-0.001
Lag(1)		-0.0014***	-0.001***
Y^{W}	World output, log	0.8536***	0.247*
Lag(1)		-0.6041***	-0.096
Constant		-0.5363	-3.634
Sargan test H_0: overidentifying restrictions are valid ;p-value		0.0000	0.0315

*Note: *** statistical significance at all levels of significance;** statistical significance at 5%,*statistical significance at 10%.*

Romer (2000)[58], proposed an alternative to the IS-LM model and AS-AD model. This model makes assumption that Central banks in the world follow interest rate rule rather than targeting money supply. This model is known as AD-IA, or aggregate demand inflation adjustments model. So this model uses expected inflation ,that is inflation lagged once, when one makes inflation adjustment. In the Romer's approach aggregate demand relates to output and inflation. According to Romer (2000), target rate equals to last period inflation .This assumption also means that inflation rises when output is above its own natural rate, and inflation falls when output is below its natural rate. Dependent variable in the IS-MP-IA model is logarithm of Real GDP. Tobin's q is positively and statistically significantly associated with the logarithm of real GDP when private

58) Romer, D.,(2000),*Keynesian macroeconomics without the LM curve*, JournalofEconomicPerspectives—Volume 14, Number 2—Spring 2000—Pages 149

consumption is not in the model. Government consumption is negatively associated with the logarithm of real GDP, which means that for these countries fiscal prudence is needed. Expected exchange rate is positively associated with logarithm of real GDP lagged once (on short run).World interest rate is negatively associated with the logarithm of real GDP. Lagged once coefficient is even more significant for this variable. World out is positively associated with the logarithm of real GDP on long run, and lagged once is negatively associated, though in the second models is insignificant. Expected inflation is negatively an statistically significantly associated with the logarithm of real GDP in the second model on long run. Government consumption is not insignificant in the presence of private consumption, so one can conclude that for these countries Ricardian equivalence does not hold. For a graphical depiction of these models see Appendix 2[59].

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[60]. The small size of the coefficient is being interpreted as evidence in support of the hypothesis that Tobin's q is being influenced by the increase of physical capital more than by investment in intangible capital or R&D which consists mainly of expenditures on the wages of scientists. This is one of important conclusion from this paper. Second, conclusion is that on average higher level of democracy does induce more positive stock market outcomes. This means that higher level of democracy thus induce higher ratio of Tobin's q. Government consumption is positively associated with the average tobin's q. Cointegration tests by country prove the positive association between R&D investment and Tobin's q for 6 countries. Also, panel cointegration tests prove that Tobin's does have long run relationships with the following variables: R&D, logarithm of M2 , Freedom house political rights and civil liberties, investment, and logarithm of natural output. Tobin's q was tested in the IS-LM framework and in the more recent IS-MP-IA model and the results were as expected. From the results in the IS MP IA model also, relatively low world real interest rates and the expected world economic recovery would help increase real GDP whereas expected real depreciation of the national currencies of the countries in the panel would have negative effect on the real GDP. The estimation results suggest that the change of the effective exchange rate affects output positively (lagged once), while the change of the world interest rate affects output negatively or it does not affect the output at all, i.e. that variable is insignificant.

Appendix 1 Definitions on some of the variables used in the models

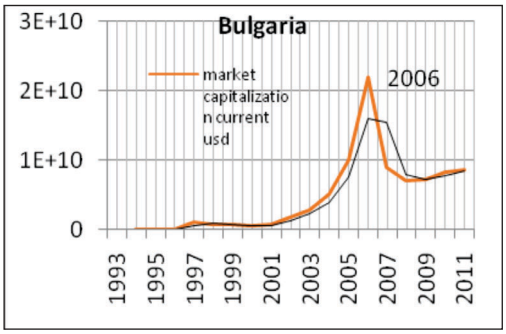
Name of the variable	Variable label
Market capitalization of listed companies (current US$) (also known as market value)	Market capitalization (also known as market value) is the share price times the number of shares outstanding. Listed domestic companies are the domestically incorporated companies listed on the country's stock exchanges at the end of the year. Listed companies does not include investment companies, mutual funds, or other collective investment vehicles. Data are in current U.S. dollars.
Adjusted savings: consumption of fixed capital (current US$) (Replacement value)	Consumption of fixed capital represents the replacement value of capital used up in the process of production.

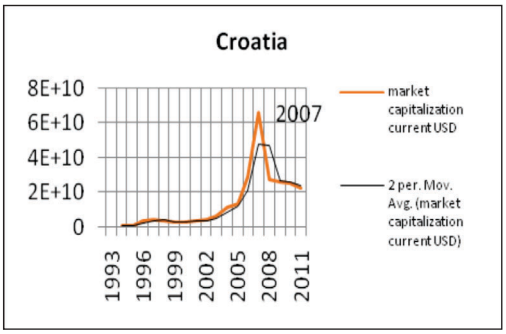
59) Appendix 3 R&D and Tobins'q ,democracy and Tobins's q and IS-LM model

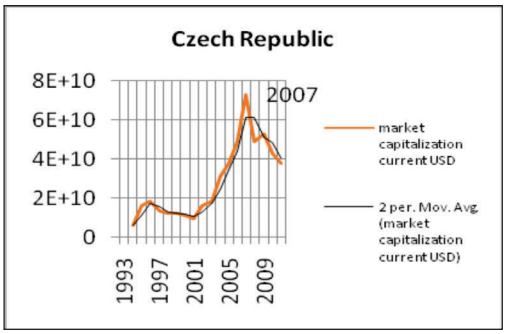
60) http://www.globalinnovationindex.org/gii/

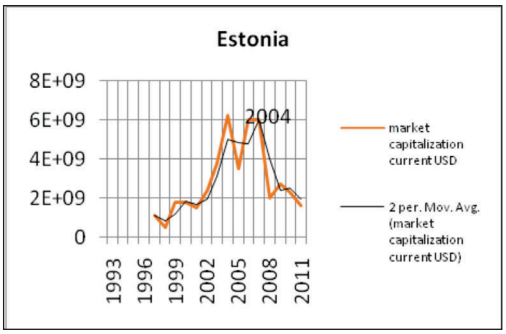
Royalty and license fees, payments (BoP, current US$) (knowledge absorption)-(R&D)	Royalty and license fees are payments and receipts between residents and nonresidents for the authorized use of intangible, nonproduced, nonfinancial assets and proprietary rights (such as patents, copyrights, trademarks, 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.
Freedom house political rights (FH_PR)	Since 1972 (1978 in book form), Freedom House publishes an annual report, Freedom in the World, on the degree of democratic freedoms in nations and significant disputed territories around the world, by which it seeks to assess the current state of civil and political rights on a scale from 1 (most free) to 7 (least free).
Freedom house political rights (FH_PR)	Since 1972 (1978 in book form), Freedom House publishes an annual report, Freedom in the World, on the degree of democratic freedoms in nations and significant disputed territories around the world, by which it seeks to assess the current state of civil and political rights on a scale from 1 (most free) to 7 (least free).
Government consumption (gov.cons) (% of GDP)	General government final consumption expenditure (formerly general government consumption) includes all government current expenditures for purchases of goods and services (including compensation of employees). It also includes most expenditures on national defense and security, but excludes government military expenditures that are part of government capital formation.
Inflation (annual %)	Inflation as measured by the annual growth rate of the GDP implicit deflator shows the rate of price change in the economy as a whole. The GDP implicit deflator is the ratio of GDP in current local currency to GDP in constant local currency.
World interest rate	World interest rate is derived when US Federal funds rate is subtracted by the Producer Price Index in US manufacturing, which proxies for US inflation. This variables proxies for monetary policy conditions, same as exchange rate does. Data on US federal funds rate and US Producer Price Index for all commodities (which served for world interest rate derivation) are obtained by the FRED (Federal Reserve Bank of St.Louis) data base
World output	World output production of world GDP

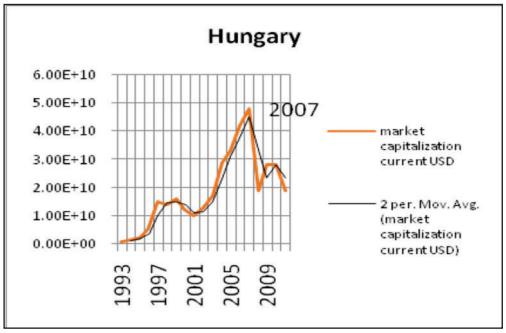
Appendix 2 Market capitalization of firms in stock markets in CESEE countries

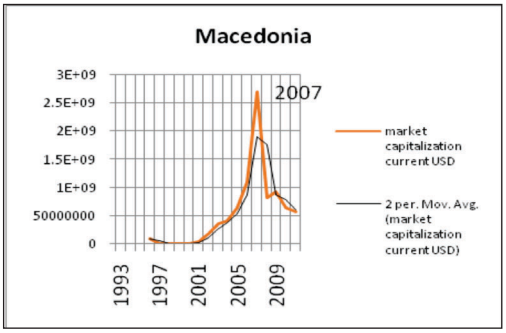


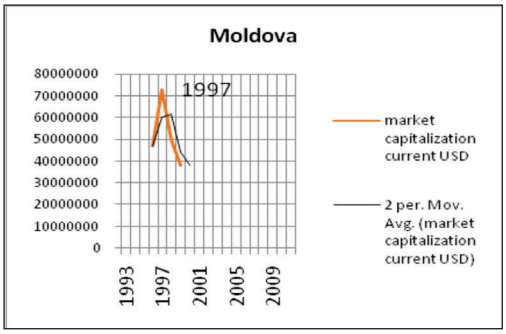


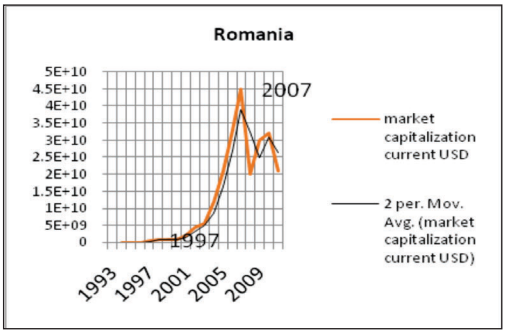


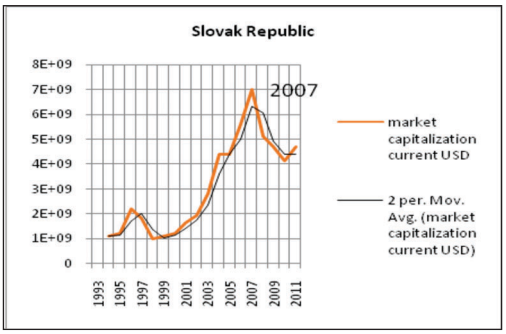


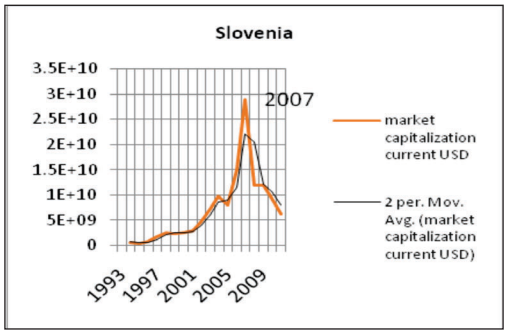




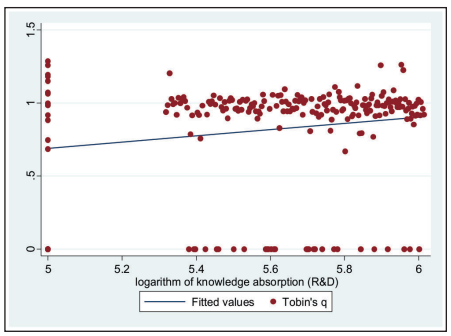


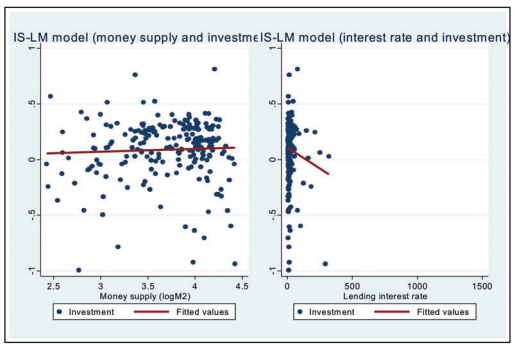


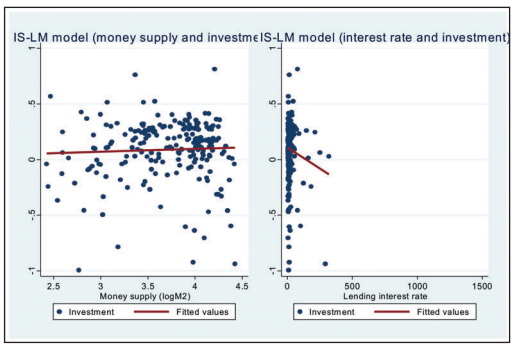




Appendix 3 R&D and Tobins'q, democracy and Tobins' q and IS-LM model







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