A GROWTH MODEL OF FINANCIAL REFORMS AND R&D INVESTMENT

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OUTLINE

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INTRODUCTION AND MOTIVATION

- The role of finance in long run output is widely regarded in recent growth literature. Theoretical approaches about the positive role of well-functioning financial sector on economic growth can be found well back to Tobin and Brainard (1963).

- From a theoretical point of view an effective financial system:

  (a) Leads to a better allocation of the resources as it improves the monitoring ability of financial intermediaries and even risky investment projects can receive loans at the appropriate interest rates.

  (b) At firm level reduces the cost of external finance, which in turn reduces existing market frictions. This allows more entry opportunities for new dynamic firms.

- Empirical verifications of the positive impact of financial development on economic growth at aggregate level have been provided among others by King and Levine (1993), Rajan and Zingales (1998), Beck et al. (2000) and Christopoulos and Tsionas (2004) while at the micro level see for example the papers of Levine (2002) and Demirguc-Kunt and Maksimovic (2002).

INTRODUCTION AND MOTIVATION

- The most developed countries have high innovation rates (number of patents) which promote the technological frontier of a country. It is important to check what factors may enhance innovation.

- There are few theoretical and empirical papers analyzing how the financial system promotes R&D.

- In this line of research Blackburn and Hung (1998) have developed a theoretical model which shows that a highly repressed financial environment weakens the role of financial intermediation in monitoring risky investments and therefore less loans are given to R&D (risky investment).

- Aghion et al. (2005) and Aghion and Howitt (2009) claim from a theoretical point of view that financial reforms can enhance the financing of R&D accelerating technological deepening and knowledge creation.

INTRODUCTION AND MOTIVATION

- There is also theoretical literature which proposes that financial liberalization may be an obstacle for the innovation process:

(a) More financial liberalization according may discourage savings: Stiglitz (1994).

(b) More financial liberalization may increase financial instability: Kaminsky and Reinhart (1999) and Stiglitz (2000) among others.

(c) Reallocation of talent from technology sector to financial sector: Murphy et al. (1991) and Acemoglu (1995).

- Empirically, Bandiera et al. (2000) reveal empirically a negative effect of financial liberalisation on savings.

- Ang (2011) found that financial liberalization exerts a negative influence on firms' R&D activities.

INTRODUCTION AND MOTIVATION

- All these papers, both theoretical and empirical ones, ignore the fact that financial reforms do not induce a symmetric effect on all those factors that are crucial for growth.

- For example a more liberalized financial system with less entry restrictions ensures competition in the financial market with an efficient allocation of resources at the lowest possible cost of lending while removal of credit controls might discourage investment in demanding long-term R&D activities while promote the distribution of resources towards activities with quick returns and high short term profitability .

CONTRIBUTION

- Our paper offers a new methodological perspective by developing a unified framework within which innovation output (patents) is driven by R&D investment while allows financial reforms to carry a non-monotonic effect.

- We disintegrate reforms into micro and macro reforms to address both theoretical and empirical ambiguities as per our previous discussion. This approach goes beyond the existing literature of Bandiera et al. (2000) and Ang (2011) in understanding the role of financial reforms on innovation as it captures the existence of heterogeneous policy effects in R&D spending.

THEORETICAL MODEL

FIRMS

- We have three type of firms (Y=final output, I=intermediate goods, Ω=ideas), households who accumulate human (H) capital and put deposits (D) into the banks and a banking sector which compete a la' Cournot for deposits and determine the mark-up between the interest rate for loans r^L relative to the interest rate for deposits r^d by taking as given the different types of financial policy rules.

- The final output firms use human capital and buy intermediate goods. The production of final output is:

$$Y_t = H_{Yt}^{1-\alpha} \int_0^{\Omega_t} (x_{it})^{\alpha} di, \quad \alpha \in (0,1) \tag{1}$$

- The maximization of final output profits determine the inverse demand function for the intermediate inputs:

$$p_{it} = \alpha H_{Yt}^{1-\alpha} x_{it}^{\alpha-1}, \quad \forall i \in [0, \Omega_t], \quad \Omega_t \in [0,\infty) \tag{2}$$

THEORETICAL MODEL

FIRMS

- By following Grossman and Helpman (1991, Ch. 3) the production function of the generic *i*-th intermediade good is one-to-one technology in human capital:

$$x_{it} = h_{it}, \qquad \forall i \in [0, \Omega_t], \qquad \Omega_t \in [0, \infty) \tag{3}$$

- A firm in order to operate in the intermediate sector needs to buy at a fixed price one patent from the R&D sector. Once the intermediate inputs have produced, they provide monopolistic power for ever.

- The price elasticity of the *i*-th intermediate is equal to $1/(1-\alpha)$ and coincides with the elasticity of substitution between two generic varieties of intermediate goods which are used in the production of the final good.

- The assumption of the symmetric equilibrium implies that the total amount of human capital used in the intermediate sector at time *t* (H_{It}) is:

$$\int_0^{\Omega_t} (x_{it})\, di = \int_0^{\Omega_t} (h_{it})\, di \equiv H_{it} \tag{4}$$

THEORETICAL MODEL

FIRMS

- Profit maximization of the generic *i-th* firm's leads to the following mark-up rule:

$$p_{it} = \frac{w_{It}}{\alpha} = \frac{w_t}{\alpha} = p_t, \quad \forall i \in [0, \Omega_t] \tag{5}$$

- High substitutability between intermediate goods (high α) leads into a lower mark-up.

- The R&D firm employs a research technology similar to Jones (1995) (diminishing returns in each input- no scale effects) and Avila (2008) (banking resources F_Ω used as input for facilitating the work of researchers). Ω is the total stock of society's knowledge.

- Moreover, every R&D firm produces one idea without knowing in advance for the success of the production of the idea. The probability of success in production of a new idea is constant over time and equal to $\phi \in (0,1)$. The total accumulation of the stock of ideas in the economy is produced according to:

$$\dot{\Omega}_t = \phi H_\Omega^{\beta} F_\Omega^{\gamma} \Omega^{\delta} \tag{6}$$

THEORETICAL MODEL

FIRMS

- H_{Ω} is the amount of human capital (researchers) employed in R&D activity.
- with $\beta+\gamma=1$ and $\beta<1$ {Kortum (1993) confirms empirically the diminishing returns of researchers in the production of new ideas}.
- If $\delta<0$ the rate of innovation declines when new ideas are discovered (*fishing-out effect*)
- If $\delta>0$ the old discoveries improve the production of new ideas (*standing-on-shoulders effect*)
- If $\delta=0$ the rate of current innovation is independent from the stock of knowledge.
- Because of the assumption of perfect competition in the R&D sector, the market value of the *i-th* patent, which is useful for the production of the intermediate input, will be equal to the flow of the instantaneous profits of the intermediate sector:

THEORETICAL MODEL

FIRMS

$$V_{\Omega t} = \int_{t}^{\infty} \pi_{I\tau} e^{-\int_{t}^{\tau} r^{d}(s)ds} d\tau, \qquad \tau > t \tag{7}$$

- In the above expression, $V_{\Omega t}$ is the price at time t of the *i-th* patent, π_{It} is the instantaneous profit of the *i-th* intermediate input and r^{d} is the interest rate for deposits used as a discount factor of the profits.

- The profit maximization of a representative R&D firm will be:

$$\pi_{\Omega} = \dot{\Omega} V_{\Omega} - w_{\Omega} H_{\Omega} - r^{L} F_{\Omega} \tag{8}$$

- The first order conditions from the profit maximization are:

$$w_{\Omega} = \beta \phi H_{\Omega}^{\beta-1} F_{\Omega}^{\gamma} \Omega^{\delta} V_{\Omega} \tag{9}$$

$$r^{L} = \gamma \phi H_{\Omega}^{\beta} F_{\Omega}^{\gamma-1} \Omega^{\delta} V_{\Omega} \tag{10}$$

THEORETICAL MODEL

HOUSEHOLDS

- The size of the housholds is of mass one and there is no population growth. Moreover, households gain utility by consuming the consumption good from the final output firms.

- The wealth of the housholds equals the aggregate value of the intermediate firms:

$$A_t = \Omega_t V_{\Omega t} \tag{11}$$

- Eq. (11) connects the saving behavior of households with the structure in the production sectors.

- The representative household can accumulate human capital in the formal education system according to Lucas (1988):

$$\dot{H}_t = \sigma(1-u_t)H_t, \quad \sigma>0 \tag{12}$$

- with the parameter σ representing the efficiency of the education sector and $1-u_t \in (0,1)$ is the fraction of human capital which is used for accumulation human capital and the remaining fraction u_t is allocated endogenously in the three production sectors H_Y, H_I, H_Ω.

THEORETICAL MODEL

HOUSEHOLDS

- Finally, the household can deposit its wealth in the banking sector for receiving interest rate r^d. Therefore the equation for the accumulation of the households' wealth takes the following form:

$$\dot{A}_t = r_t^d A_t + \pi_B + wuH_t - C_t \tag{13}$$

- Finally, the representative agent of households is solving the following problem:

$$\underset{\{C_t,u_t,H_t,A_t\}_{t=0}^{+\infty}}{\text{Max}} U \equiv \int_0^{+\infty} \left[\frac{C_t^{1-\theta}-1}{1-\theta}\right] e^{-\rho t} dt, \quad \rho > 0, \quad \theta > 1 \tag{14}$$

$$s.t.: \quad \dot{A}_t = r_t^d A_t + \pi_B + wuH_t - C_t \tag{15}$$

$$\dot{H}_t = \sigma (1 - u_t) H_t \tag{16}$$

- The parameter θ is the inverse of the intertemporal elasticity of substitution of consumption. Blundell et al. (1994) and Attanasio and Browning (1995) find empirically at country level that θ is close to unity. Other papers such as Evans (2004) and Percoco (2008) which are based on surveys find θ is closer to 1.5.

THEORETICAL MODEL

BANKING SECTOR

- The structure of the banking sector is close to the paper of Berthelemy and Varoudakis (1996) but without having monitoring technology in the banking sector and by adding financial reforms which are imposed to the banking sector by the government.

- The first policy instrument is referred as micro financial reform and determines the level of the competition in the banking sector. More precisely, the number of banks is indexed by *n* and after the micro financial reforms the number of banks is increasing until the bank's profits to be zero.

- The second policy instrument is called macro financial reform and has to do with credit controls. More precisely, from the deposits that each bank receives can lend only a fraction $\eta \in (0,1)$ and the rest $1-\eta \in (0,1)$ is used as reserve requirements.

- Since the R&D projects face some risk, in order the deposits to be protected we assume that the banks buy some deposit insurance as it is proposed by Boyd and De Nicolo (2005).

THEORETICAL MODEL
BANKING SECTOR

- We assume that the amount of deposits which can be given for loans is ηD_j and there is another fraction $z(\eta)D_j$ which is used for paying the deposit insurance companies with $z(\eta) \in (0,1)$ and $z'(\eta) > 0$. This assumption captures the idea of Calomiris et al. (2015) that if the reserve requirements are low (high η) then the insurance cost of deposits is high. (We do not implement endogenous insurance sector for simplicity).

- The net amount of deposits available for loans is $(\eta - z(\eta))D_j$. We assume that $\eta > z(\eta)$ in order the amount to be given for loans to be positive.

THEORETICAL MODEL

BANKING SECTOR

- Banks compete a la Cournot for deposits and they set up a mark up between the interest rate for loans and deposits. The higher the mark up the more expensive is the cost of borrowing for the R&D firms which leads into a reduction of R&D expenditure.

- The mark up between the interest rate for loans and deposits is:

$$r^{L} = (1 + i) r^{d} \tag{17}$$

- The total demand for loans is $L = F_{\Omega}$ and by assuming symmetry between banks, the loans provided to R&D firms from bank j are $L_j = F_{\Omega} / n$.

- The deposits to each bank under symmetry is:

$$D_{j} = \frac{A}{n} \tag{18}$$

- There is equality between the loans given to R&D firms and the deposits which are permitted to be given for loans:

$$(\eta - z(\eta)) D_j = L_j \equiv \frac{F_{\Omega}}{n} \tag{19}$$

THEORETICAL MODEL

BANKING SECTOR

- Another important condition is that the part of deposits which is paid to the insurance companies is enough to cover the loss of deposits due to the defaulted loans:

$$z(\eta)D_j = (1-\phi)L_j \equiv (1-\phi)\frac{F_\Omega}{n} \tag{20}$$

- where $1-\phi$ is the fraction of the R&D projects which were not successful.

- The present value of *j*'s bank profits where banks seek to maximize is the following:

$$\pi_j^B = \frac{r^L \phi L_J - r^d D_j}{r^d} \tag{21}$$

- ϕL_J are the successful R&D projects for which the banks will receive back the loans they have provided.

- By substituting in Eq. (21), Eqs. (19) and (20) the discounted profits of the bank *j* are:

$$\pi_j^B = (1+i)\left[\eta - 2z(\eta)\right]D_j - D_j \tag{22}$$

THEORETICAL MODEL
BANKING SECTOR

- Because of the banking competition for deposits, we assume as in Berthelemy and Varoudakis (1996) that banks take into account the fact that the total savings react with response to changes of the interest rate of deposits. Therefore, the elasticity of the total deposits with respect to the interest rate of deposits is: $\frac{dD}{dr^d}\frac{r^d}{D}=\frac{1}{\varepsilon}>0$.

- The equilibrium mark up between the two interest rates (for deposits and loans) is:

$$\frac{r^L}{r^d}=(1+i)=\frac{1}{\left[\eta-2z(\eta)\right]\left[1-\frac{\varepsilon}{n}\right]} \tag{23}$$

- The economy internalizes the risk of the R&D sector through the existence of insurance of deposits.

THEORETICAL MODEL
GENERAL EQUILIBRIUM AND BGP ANALYSIS

- In equilibrium the following equalities must hold:

$$u_t H_t = H_{\Omega t} + H_{It} + H_{Yt} \tag{24}$$

$$w_{Yt} = w_{It} = w_{\Omega t} = w \tag{25}$$

$$\dot{V}_{\Omega t} = r_t^d V_{\Omega t} - \pi_{it} \tag{26}$$

- The no-arbitrage equation suggests that the return on the value of the *i-th* intermediate firm $\left(r_t^d V_{\Omega t}\right)$ at equilibrium must equal the sum of the instantaneous monopoly profit accruing to the *i-th* input producer (π_{it}) and the capital gains/losses matured on V_Ω during the time interval *dt* ($\dot{V}_{\Omega t}$).

- **DEFINITION**: Balanced Growth Path (BGP) Equilibrium

A BGP equilibrium in this economy is a situation in which: (i) *All variables depending on time grow at constant (possibly positive) exponential rates and* (ii) *The sectorial shares of human capital* ($s_j \equiv H_j / H$, $j = Y,\ I,\ \Omega$) *are constant. Along, the BGP, the fraction of human capital employed in the different production sectors is constant* $(u_t = u,\ \forall t \geq 0)$.

THEORETICAL MODEL
GENERAL EQUILIBRIUM AND BGP ANALYSIS: PROPOSITION 1

$g_Y = g_C = g_A = \frac{(\sigma-\rho)\left[1-\delta+(1-\gamma)(1-\alpha)\right]}{(1-\alpha)\left[\theta(1-\gamma)-1\right]+\theta(1-\delta)}$	(27)
$g_H = \frac{(\sigma-\rho)\left[1-\delta-\gamma(1-\alpha)\right]}{(1-\alpha)\left[\theta(1-\gamma)-1\right]+\theta(1-\delta)}$	(28)
$g_\Omega = \frac{(\sigma-\rho)}{(1-\alpha)\left[\theta(1-\gamma)-1\right]+\theta(1-\delta)}$	(29)
$g_{F\Omega} = \frac{(\sigma-\rho)\left[(1-\beta)(1-\delta)+\beta\gamma(\delta-\alpha)\right]}{\gamma\left\{(1-\alpha)\left[\theta(1-\gamma)-1\right]+\theta(1-\delta)\right\}}$	(30)
$u = \frac{\sigma(\theta-1)\left[1-\delta+(1-\alpha)(1-\gamma)\right]+\rho\left[1-\delta-(1-\alpha)\gamma\right]}{\sigma\left\{(1-\alpha)\left[\theta(1-\gamma)-1\right]+\theta(1-\delta)\right\}}$	(31)
$s_y = \left[(1-\alpha)(u-s_\Omega)\right]/\left(1-\alpha+\alpha^2\right)$	(32)
$s_I = \left[\alpha^2(u-s_\Omega)\right]/\left(1-\alpha+\alpha^2\right)$	(33)
$s_\Omega = \frac{(1-\alpha)\alpha\beta g_\Omega u}{\left[r^d-g_H+\alpha g_\Omega\right]\left(1-\alpha+\alpha^2\right)+(1-\alpha)\alpha\beta g_\Omega}$	(34)
$r^d = \frac{(\sigma-\rho)(1-\alpha)+\sigma\left\{(1-\alpha)\left[\theta(1-\gamma)-1\right]+\theta(1-\delta)\right\}}{(1-\alpha)\left[\theta(1-\gamma)-1\right]+\theta(1-\delta)}$	(35)
$r^L / r^d = 1/\left[\left(\eta-2z(\eta)\right)\left(1-(\varepsilon/n)\right)\right]$	(36)
$\left(H^\beta F_\Omega^\gamma\right)/N^{1-\delta} = g_\Omega / s_\Omega^\beta$	(37)

THEORETICAL MODEL
GENERAL EQUILIBRIUM AND BGP ANALYSIS: PROPOSITION 2

For $\sigma > \rho,\ \theta > 1,\ \alpha > \delta, \eta - 2z(\eta) > 0$ and $1-(\varepsilon / n) > 0$ or for

$\sigma > \rho,\ \theta > 1,\ \delta > \alpha,\ 1-(\varepsilon / n) > 0$ and $1-\delta-(1-\alpha)\gamma > 0$ the following results hold:

$g_Y = g_C = g_A > 0,\ g_H > 0, g_\Omega > 0, g_{F\Omega} > 0, V_\Omega > 0, r^d > 0, r^L > 0, u \in (0,1), s_j \in (0,1), j=\{Y,H,\Omega\}$ and

$u > s_j,\ j=\{Y,H,\Omega\}$.

Proof: It comes immediately by solving the results in Proposition 1 and imposing the following parameter values: $\{\alpha = 0.6, \beta = 0.7, \gamma = 0.3, \delta \in [0.4, 0.8], \varepsilon \in [0.1, 0.5], \sigma = 0.12, \rho = 0.01, \theta = 1.5\}$.

THEORETICAL MODEL
GENERAL EQUILIBRIUM AND BGP ANALYSIS: PROPOSITION 3

	n	η	ε
$\frac{r^L}{r^d}$	-	+/-	+

Proof: It comes immediately by differentiating Eq. (36) with respect to the parameters. The effect of macro financial reforms on the interest rate of loans might be positive or negative depending on the sign of the following condition $2z'(\eta)-1$. If the previous condition is positive the cost of borrowing is increasing and it implies that the insurance companies increase harshly the insurance cost of deposits in case of a reduction of the reserve requirements.

THEORETICAL MODEL
GENERAL EQUILIBRIUM AND BGP ANALYSIS: PROPOSITION 4

- It can be proven: $\frac{\partial g_{\Omega}}{\partial F_{\Omega}} > 0$ and $\frac{\partial F_{\Omega}}{\partial r^{L}} < 0$.

- The combination of the results in Proposition 3 and 4 leads into the following sum up: the micro financial reforms increase the banking competition, which leads into a reduction to the loan interest rate. This in turn reduces the cost of borrowing for the R&D firms and they can undertake R&D expenditure which is something helpful for the production of new ideas. The second deduction we can make is that the macro financial reforms lead into a reduction of the reserve requirements that banks are obliged to keep. Therefore, the insurance cost of deposits will rise. If the rise is high, then this will lead into an increase in the loan interest rate which increases the cost of borrowing for the R&D firms.

EMPIRICAL PART
METHODOLOGY

- The following empirical model is estimated:

$$\Delta \ln P_{i,t} = \beta_0 + \beta_{P_0} P_{i,0} + \beta_{Risk} RiskP_{i,t} + \beta_{RD} RD_{i,t} + \beta_H H_{i,t} + \beta_{RD}^{MIC} \left(RD_{i,t} \times MIC_{i,t} \right) + \beta_{RD}^{MAC} \left(RD_{i,t} \times MAC_{i,t} \right) + e_{i,t} \quad (36)$$

P_{it} is the per capita stock of USPTO patents in country *i* at time *t*. (for patent stock we applied the perpetual inventory method assuming a depreciation rate δ at 10%.)

P_{i0} is the initial patent stock.

RD_{it} is the ratio of R&D expenditure to GDP.

H_{it} is human capital measured by the average years of tertiary schooling.

MIC_{it} is the Micro reform of barriers to entry in the financial market.

MAC_{it} is the Macro reform of credit control requirements.

$RiskP_{it}$ is the risk associated with R&D investments

EMPIRICAL PART
METHODOLOGY

- Equation (36) is subject to endogeneity problems as R&D and *H* are highly correlated. Countries with high R&D shares are also well-endowed with human capital while the invention of new patents leads to monopolistic rents that enhance profitability, which can in turn be used to stimulate R&D expenditure.
- OLS estimation could lead to biased results.
- A Two Stage Least Squares Estimator (2SLS) regression with the use of appropriate instruments is employed. As instruments we use country specific effects, the lags of the right hand variables as we all as merchandise trade (% of GDP), Foreign direct investment, net inflows (% of GDP), domestic credit to private sector (%GDP), Manufacturing, value added (% of GDP), and Crude oil and NGL production. These instruments are correlated with the endogenous regressors and uncorrelated with the error term e_{it} .

EMPIRICAL PART
METHODOLOGY

- Since the existence of strong instruments is always an ambiguous task in country level studies we use additionally to 2SLS estimator the copula method (Park and Cupta 2012). In these models the correlation between the endogenous variables and the error term and the values obtained are used to provide consistent estimates independent from the use of instruments.

- The Copula model considers that $x_{it}^{*}=\Phi^{-1}[F_x(x_{it})]$ and $e_{it}^{*}=\Phi^{-1}[F_e(e_{it})]$ variables have continuous marginal distribution functions F_x and F_e respectively. Φ^{-1} stands for the standard normal CDF. The generated x_{it}^{*} variables are included as additional regressors in equation (36) and OLS estimates are free from endogeneity bias.

EMPIRICAL PART
DATA

- We use country annual data (1997-2005) for 25 OECD countries.
- P_{it} data comes from OECD Patent statistics.
- The R&D share comes from OECD-R&D Statistics
- H: Tertiary education is taken from the Barro-Lee (2013) educational data base.
- MIC_{it}- the Micro reform of barriers to entry in the financial market and MAC_{it} –and the Macro reform of credit control requirements are taken from Abiad et al. (2010).
- Definitions of MIC_{it} and MAC_{it} follows Bandiera et al. (2000) and Pina (2012).These indices take values from 0 to 3. 0: fully repressed system, 1: partially repressed system, 2: partially liberalized system, 3: fully liberalized system.
- A Garch-E model is employed to estimate the $RiskP_{it}$ variable.

EMPIRICAL RESULTS

Table 1: Dep. Variable: Grant growth rate

Variables	OLS	2SLS	COPULA
$RD_{it} \times CreditContr_{it}$	**-0.016** (0.001)	**-0.029** (0.001)	**-0.014** (0.002)
$RD_{it} \times Entry_{it}$	0.006 (0.152)	**0.019** (0.001)	**0.007** (0.070)
RD_{it}	**0.157** (0.001)	**0.123** (0.001)	**0.066** (0.049)
H_{it}	**0.042** (0.002)	**0.077** (0.001)	**0.072** (0.001)
$(PGR)_{i0}$	-0.001 (0.277)	0.019 (0.247)	**-0.003** (0.038)
$Risk_{it}$	0.0003 (0.590)	**-0.0009** (0.002)	**-0.004** (0.483)
Constant	**-0.112** (0.001)	**-0.134** (0.001)	**-0.299** (0.001)
RD_{it}^{*}			**-0.098** (0.001)
H_{it}^{*}			**0.103** (0.001)
Schwarz B.I.C	-708.997		-719.931
$F(6,469)$ endogeneity test		**105.142**	
SSR		0.735	
Nobs	622	392	622

Note: Boldfaced values show statistical significance at conventional statistical significance levels. The critical value for the $F-$distribution at 5% statistical level is 2.11. In parentheses are the p-values. Fixed effects estimates are not reported here to save space.

INTERPRETATION

- The F-test shows that both variables are endogenous and thus standard OLS estimator produce biased estimates.

- The interaction term of R&D with the Micro reform is positive and statistically significant.

- The interaction term of R&D with the Macro reform has a negative and statistically significant coefficient both with IV and Copula method.

- This means that R&D expenditure combined with the Macro reforms exerts a negative influence on patent growth rate while R&D expenditure combined with the Micro reforms affects positively the patent growth rate. Both results are compatible to the main proposition of the patent growth model developed in theoretical section.

INTERPRETATION

- Human capital associates a positive sign both with IV and Copula method. The higher the average years of tertiary schooling the greater the patent growth rates.

- The initial value of patent stock (P_{i0}) has a negative sign (see column 3). The presence of a negative value implies that patent growth rate differentials have been reduced over time among countries.

- The $RiskP_{it}$ associates a negative sign, see column 3. This means the higher the risk the lower the growth rate of patents.

- The empirical findings lend support to the theoretical predictions that a more liberalized environment with free entry of new financial competitors impacts positively on the evolution of patents while relaxing credit control restrictions have deleterious effects on innovation.

CONCLUSIONS

- In this paper we try to investigate how the liberalization of the banking system affects the efficiency of the innovation process.
- Ang (2011) finds negative effect of the financial liberalization on the growth rate of patents by using an aggregate index of financial liberalization.
- Financial liberalization is consisted of many different indices which are quite heterogeneous and perhaps they may have a differential effect on the growth rate of patents.
- We distinguish in two types of financial reforms as it is proposed by Bandiera et al (2000) and Pina (2012).
- The first type is the so called micro reform which mainly has to do with the degree of competition in the banking sector. (number of banks)

CONCLUSIONS

- The second reform is the so called macro reform which has to do with credit controls and in general with fewer restrictions in the way the banks make use of the deposits. (reserve requirements held by banks)
- Our intuition is that the banking competition reduces the mark up between interest rate for loans and interest rate for deposits which makes borrowing less costly and R&D firms increase R&D expenditure for facilitating the work of researchers through banking loans.
- Banks need to buy insurance for deposits since to lend risky R&D firms can put into danger the deposits of the savers.
- Contrary to micro reforms, the macro financial reforms by letting banks to keep less reserve requirements may increase the cost of deposit insurance and pushing up the mark up between the interest rates which in turn makes loans more costly.

CONCLUSIONS

- For capturing our idea, we build an endogenous growth model with horizontal differentiation in accumulation of patents, with human capital accumulation and with a banking system which competes a la Cournot for deposits by taking as given the two types of policy instruments which determine the micro and the macro financial reforms. The banks react in changes on the financial reforms.
- We then use data for checking empirically the main assumptions of the theoretical model.
- We estimate the model by using OLS, IV and the Copula method for controlling for endogeneity issues.
- The empirical part verifies the assumptions of the theoretical model and our results are robust by checking the results of the different econometric methods.

THANK YOU - ΕΥΧΑΡΙΣΤΩ!