Endogenous dynamic academic research culture

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ENDOGENOUS DYNAMIC ACADEMIC RESEARCH CULTURE

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Abstract

This paper models a dynamic scholar's allocation of time between academia and professional activities outside academia, given the academic labor market and social interactions. The model shows how particularly in less developed countries business and political networks may have large negative externalities for academic research culture and then for university system performance. The conclusion part of the paper offers a brief discussion on policy recommendations to stimulate academic research productivity.

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1. Introduction

The new economy, also called knowledge economy, is a creative destruction period characterized by economic instability, technological innovations and globalization (Brock and Evans, 1989; Carlsson, 1992; Acs and Audretsch, 1993). The role of universities as providers of human capital, technology and know-how has been increasingly recognized as essential for the growth of the modern economy. Human capital and technology creation generate spinouts, and one of the mains externalities essential for the modern economy is academic entrepreneurship (e.g., Nicolaou, and Birley, 2003a). As universities provide public goods and generate positive externalities, the majority of them, at least in poor countries, are public institutions. In order to make them more capable to face current challenges emphasis has been put in increasing its efficiency, especially making them more managerial (e.g., Hood, 1991, 1995) through the introduction of incentives for faculty, increasing assessment and evaluation through public agencies and more university autonomy (OECD, 2003).

The literature on university performance and efficiency generally takes into account how some inputs such as faculty, infra-structure and financial resources produce outputs such as graduate students, publications, patents, and grants. Research done on universities in the UK (Johnes and Johnes, 1993), Australia (Madden et al., 1997), USA (Thursby, 2000; Moreno and Tadepali, 2002), Turkey (Koksal and Nalcaci, 2006) and Italy (Agasisti et al., 2011) for example, assess whether the university resources are being used efficiently. Besancenot and Vranceanu (2008), Besancenot et al. (2009), and Besancenot and Faria (2010) examine how efforts to improve efficiency in academia, such as the incentives for publications in business schools, can have undesirable and unpleasant consequences in teaching, student recruitment and publication standards.

Universities produce three important goods and services: 1) Human capital, through teaching Universities develop human capital; 2) Technology, through pure and applied

research they produce new techniques and know-how; and 3) Consultancies and New firms, as spinoffs of research, and patents. The creation of Human capital through teaching is well-regulated and relatively fixed as compared to the other two, being less affected by the allocation of resources.

Human capital and academic research [1) and 2)] are associated with scientific networks. Scientific networks are social networks, defined as a collection of people, each of whom is acquainted with some subset of the others (Newman, 2001). Scientific networks are characterized by Faria (2002) as networks that create incentives for scholars to produce, present, evaluate and reward their scientific work under strict criteria (e.g. Van Dalen, 1999; Faria et al, 2011). Examples of scientific networks are academic journals (Goel and Faria, 2007), links between journal editors (Baccini and Barabesi, 2010), and exchange of PhDs among academic departments (Burris, 2004).

Research, consultancy work and creation of firms [items 2) and 3)] are associated with research and technology transfer activities, and have common grounds since whenever new knowledge is produced by research; it has to find channels to affect society. These channels are related to business and political networks. According to Faria (2002) business and political networks include all networks of a scholar outside academia, linking the scholar to the rest of the society. These networks create incentives for scholars to use their knowledge and expertise to explore commercial opportunities and/or pursuing a political career. The response to these incentives can compromise the public character of science, through privatization of knowledge (Stephan and Levin, 1996).

Regarding business networks, a brand new literature on entrepreneurial activity within academia (e.g., Nicolaou, and Birley, 2003b) has dealt with the business spinout of universities and examined issues such as trade-off between publications and patents (Looy et

al., 2006), and differences between research-driven entrepreneurship and overall academic entrepreneurship (Goel and Grimpe, 2011).

As per political networks, Frey and Eichenberger (1992, 1993) explain the differences in academic productivity between American and European economists (e.g., Frey and Pommerehne, 1988) arguing that American economists emphasize academic publications, while Europeans rather participate in local and national affairs. Faria (2005) argues that economists outside north-America have incentives to publish in domestic journals to maximize their value in their home countries, either to obtain additional income doing consultancies for private business, or increase their political influence. Of course such behavior can lead to rent-seeking in academia (e.g., Tullock, 1993).

This paper examines, in an endogenous growth type model, how business and political networks may have large negative externalities for academic research culture and then for university system performance. This is particularly troubling for poor countries, where the universities may not be functioning as engines of growth as expected, but rather as typical public institutions, inefficient and socially costly.

2. A Simple Model

The representative scholar is a scientist who has clear identity à la Akerlof and Kranton (2010), she/he (he hereafter) is producer of Knowledge , but can allocate his labor supply by working in academia and in other professional activities. So he has two different sources of real income. The income from academia includes his wage, scholarships, scientific prizes, and any other income from the academic industry (from books, conference presentations etc.). The income from other non-academic activities is the income received from outside academic

industry. It includes the scholar's income from consulting to the government, trade unions, civil societies, private firms, international organizations and so on.

In academia the scholar has to teach and do some academic research. Outside academia he does consulting. We suppose that under a regime of a fixed time of teaching τ, the scholar spends $r(t)$ units time in efforts-producing knowledge or human capital-ideas, and, $l(t)$ units of time in consulting activities, therefore the time constraint (normalized) is given by :

$$\tau + r(t) + l(t) = 1 \quad \forall t \tag{1}$$

In LDC (and even in developed countries) countries the time of teaching τ is regulated or fixed and our salary function may be written as :

$$Y^A = \beta Log(\tau[\omega h(t) + (1-\omega)H(t)]) = \beta Log(\tau) + \beta Log(\omega h(t) + (1-\omega)H(t))$$

Now we can set $\beta Log(\tau) = w_0$ yielding the following salary function:

$$Y^A = w_0 + \beta Log(\omega h(t) + (1-\omega)H(t)) \tag{2}$$

Where w_0 is a fixed wage, ω is the weight given to the individual human capital performance. For example for $\omega = 0$ the wage depends only on the average human capital performance, such case may emerge in the institutions which can't measure the individual performance (lack of incentives systems of publications and so on), for instance in the less developing countries. Finally, the parameter ω may be a good measure of the organization of *Formal Extrinsic Incentives*.

The income from the academia institution for a fixed academic working time is given by:

$$Y^A\big(h(t)\big) = W\big(h(t), H(t)\big) + P\left(\frac{h(t)}{H(t)}\right) \tag{3}$$

Where $h(t)$ is the human capital level at time t of the representative scholar, $H(t)$ is the average human capital of total scholars (of unitary measure), $W\big(h(t), H(t)\big)$ is the direct

wage received which depends on combination of $h(t)$ and $H(t)$. Indeed, $H(t)$ acts like positive externality in any Mincerian wage function.

The other part of scholar's income is derived from $P\left(\frac{h(t)}{H(t)}\right)$, this increasing function is a proxy of Social Prestige (status) for the representative scholar. Indeed, higher status (prolific scholar) may generate further revenues from scholarships, scientific prizes, and any other income from the academic industry (from books, conferences presentations and so forth). Other justification of this function may be related to Social Admiration, Fame, or relative *Intrinsic Reward* .

Hence, our academic compensation function is:

$$Y^A\big(h(t)\big) = w_0 + \beta Log(\omega h(t) + (1-\omega)H(t)) + P\left(\frac{h(t)}{H(t)}\right) \qquad (3')$$

Equation (3) is flexible enough to more interpretations.

The income from other non-academic activities is the income received from outside academic institution. It includes the scholar's income from consulting to the government, trade unions, civil societies, private firms, international organizations and so on. This income is given by the following explicit function:

$$Y^C\big(h(t)\big) = s_0 + \alpha Log\big(l(t)h(t)\big) \qquad (4)$$

Where s_0 is a fixed salary of consulting normalized to zero, while the variable part is given by $\alpha Log\big(l(t)h(t)\big)$ for $l(t)$ hours (time) work in consulting activities for a scholar type $h(t)$, and finally the parameter α may be interpreted as an index of consulting demand intensity (in a growing economy-starting modernization). Observe this outside salary depend on human capital level of the scholar.

Hence the global income for the representative scholar h type is given by:

$$Y(h(t)) = Y^C\big(h(t)\big) + Y^A\big(h(t)\big) \qquad (5)$$

The representative scholar maximizes his inter temporal global income under (scarce) time constraint and dynamic formation of his human capital:

Regarding Eq.(1) if we denote the available time $T = 1 - \tau$ then the time constraint becomes:

$$T = r(t) + l(t) \qquad \forall t$$

Lastly the dynamic of accumulation of human capital or Knowledge is built following Lucas (1988)' insights on knowledge externalities:

$$\dot{h}(t) = \phi(T - l(t))h(t)^{\vartheta}H(t)^{1-\vartheta} \qquad (7)$$

Where ϕ is parameter which represents degree of institutional efficiency of organizing research structure (Infrastructure-seminars- reviews-libraries- and so on) and the ability of assimilating new ideas, while $(1-\vartheta)$ measures the elasticity of the extent of externalities in generating human capital or knowledge within scientific networks-community. These externalities are very important in presence of social interactions.

Therefore, under a decentralized regime (no coordinated) the representative academic scholar maximizes his inter temporal social preferences under dynamic equation of human capital formation , hence he solves the following optimal control:

$$Max\ \mathcal{B} = \int_0^{+\infty} \left(w_0 + \beta Log(\omega h(t) + (1-\omega)H(t)) + P\left(\frac{h(t)}{H(t)}\right) + \alpha Log\big(l(t)h(t)\big) \right) e^{-t} dt$$

s.t: $\dot{h}(t) = \phi(T - l(t))h(t)^{\vartheta}H(t)^{1-\vartheta}$ (9)

$h(t) = H(t),\ l(t) = L(t)\ \forall t$ ex post

where ρ is the scholar's subjective rate of time preference.

3. Private Equilibrium Allocation of Academic Research

The Hamiltonian for the representative academic scholar's problem is:

$$\mathcal{H} = w_0 + \beta Log(\omega h(t) + (1-\omega)H(t)) + P\left(\frac{h(t)}{H(t)}\right) + \alpha Log\big(l(t)h(t)\big)$$

$$+ \lambda(t)\big(\phi(T-l(t))h(t)^{\vartheta}H(t)^{1-\vartheta}\big)$$

where $\lambda(.)$ is the costate variable for h(.).

The first order conditions are :

$$\frac{\alpha}{l(t)} = \lambda(t)\phi h(t)^{\vartheta}H(t)^{1-\vartheta} \qquad (10)$$

$$\dot{\lambda}(t) = \rho\lambda(t) - \frac{\beta\omega}{\omega h(t)+(1-\omega)H(t)} - \frac{P'\left(\frac{h(t)}{H(t)}\right)}{H(t)} - \frac{\alpha}{h(t)} - \vartheta\lambda(t)\phi(T-l(t))h(t)^{\vartheta-1}H(t)^{1-\vartheta}$$

(11)

At equilibrium we have: $l(t) = L(t), h(t) = H(t)$ (12)

Then Eq (10) and (12) become at equilibrium :

$$\frac{\alpha}{l(t)} = \lambda(t)\phi h(t) \qquad (13)$$

$$\dot{\lambda}(t) = \rho\lambda(t) - \frac{\beta\omega}{h(t)} - \frac{P'(1)}{h(t)} - \frac{\alpha}{h(t)} - \vartheta\lambda(t)\phi(T-l(t)) \quad (14)$$

As it is shown in the literature, the equilibrium level of $l(t)$ is constant $(t) = l \ \forall t$, therefore $\frac{\alpha}{l}$ from (13) is constant and we have :

$$\frac{\dot{\lambda}(t)}{\lambda(t)} = -\frac{\dot{h}(t)}{h(t)} \qquad (15)$$

By using : $\frac{\alpha}{l(t)} = \lambda(t)\phi h(t)$ we obtain:

$$\frac{1}{\lambda(t)h(t)} = \phi\frac{l}{\alpha} \qquad (16)$$

Thus

$$\frac{\dot{\lambda}(t)}{\lambda(t)} = \rho - \phi l\frac{(\beta\omega+P'(1)+\alpha)}{\alpha} - \vartheta\phi(T-l) \qquad (17)$$

Then equation (15) becomes:

$$\rho - \phi l \frac{(\beta\omega + P'(1) + \alpha)}{\alpha} - \vartheta\phi(T - l) = -\phi(T - l) \quad (18)$$

From this relation we have our first result.

Proposition 1

Given the incentives from the formal institutions, the aggregated decentralized level of consulting activities is given by:

$$L = \frac{\rho + (1 - v)T\phi}{(1 - v)\phi + \phi \,.\frac{(\beta\omega + P'(1) + \alpha)}{\alpha}}$$

Proof: It is obtained from equation (18) with at equilibrium $l = L$:

$$\rho - \phi l \frac{(\beta\omega + P'(1) + \alpha)}{\alpha} - v\phi(T - l) = -\phi(T - l) \quad (18)$$

Having characterized the aggregated non coordinated level of academic consulting-outside activities, we can easily show it main determinant factors as follows.

Corollary 1

We have the following comparative statics:

$\frac{dL}{d\rho} > 0$, the consulting always emerge for a positive discount time , higher discount time (aged professors) lowers the academic research.

$\frac{dL}{dT} > 0$, denotes that for large time available (less teaching or free ride on it in Morocco professors absent for instance) may encourage the outside activities..

$\frac{dL}{d(1-v)} > 0$, the larger are the externalities in accumulating knowledge, the larger are incentives for the consulting since the scholar may Free ride..

$\frac{dL}{d\phi} < 0$, in presence of efficient infrastructure (physical-social), we may observe less consulting, since this infrastructure (libraries, laboratories, seminars, etc) facilitates knowledge assimilation and accumulation.

$\frac{dL}{d\alpha} > 0$, in presence of growing demand of consulting (emergent economies), the temptation by scholars is higher..

$\frac{dL}{d\omega} < 0$, *formal incentives* (extrinsic) foster research spirit and help to build an academic research culture. Indeed we observe that the institutions which compensate the publications and the visibility of their scholars by instituting an observable incentive scheme: salary may depend on individual productivity, have higher academic performance.

$\frac{dL}{dP'(1)} < 0$, finally this last result shows the importance of the informal incentives or intrinsic since theses social (recognition) incentives tend to decrease outside activities and helps creating an academic research culture.

Proof: Given that :

$$L = \frac{\rho + (1-v)T\phi}{(1-v)\phi + \phi\,.\frac{(\beta\omega + P'(1) + \alpha)}{\alpha}}$$

All comparative statics are obtained by simple derivatives, but for the following result :

$\frac{dL}{d(1-v)} > 0$, We have in fact :

$$Sign\left(\frac{dL}{d(1-v)}\right) = Sign(T\phi\frac{(\beta\omega + P'(1) + \alpha)}{\alpha} - \rho)$$

We suppose that $T\phi\frac{(\beta\omega+P'(1)+\alpha)}{\alpha} - \rho \geq 0$

Indeed in order to have at equilibrium a positive growth of knowledge:

$$\frac{\dot{h}(t)}{h(t)} = \phi(T - L)$$

The condition :

$$T\phi\frac{(\beta\omega + P'(1) + \alpha)}{\alpha} - \rho \geq 0$$

must hold which it is intuitive since the incentives (extrinsic and intrinsic given by $\beta\omega + P'(1)$), the infrastructure (given by ϕ) and the available time (less teaching) T are enough sufficient to sustain a positive accumulation of scientific knowledge.

4. Endogenous Academic Long term Performance

Having characterized the non coordinated level of the scholar consulting, we are able to characterize the evolution or the rate of accumulation of the knowledge of our representative economy (university system).

Indeed we know that the rate of knowledge is given by the following equation:

$$g = \frac{\dot{h}(t)}{h(t)} = \phi(T - L)$$

Or we know that at equilibrium we have :

$$L = \frac{\rho + (1 - \upsilon)T\phi}{(1 - \upsilon)\phi + \phi \,.\frac{(\beta\omega + P'(1) + \alpha)}{\alpha}}$$

Then the rate of knowledge performance is given by the following result.

Proposition 2

The long term performance of the representative academic research is given by it rate of accumulation of knowledge which is as follows:

$$g = \frac{\dot{h}(t)}{h(t)} = \frac{T.\phi\frac{(\beta\omega + P'(1) + \alpha)}{\alpha} - \rho}{(1 - \upsilon) + \frac{(\beta\omega + P'(1) + \alpha)}{\alpha}}$$

Proof: Simple and it is obtained by substituting the consulting level:

$$g = \frac{\dot{h}(t)}{h(t)} = \phi\left(T - \frac{\rho + (1 - \upsilon)T\phi}{(1 - \upsilon)\phi + \phi \,.\frac{(\beta\omega + P'(1) + \alpha)}{\alpha}}\right)$$

And simple calculus gives us the announced result.

In order to interpret easily our main finding given by the growth rate of knowledge :

$$g = \frac{\dot{h}(t)}{h(t)} = \frac{T.\phi \dfrac{(\beta\omega + P'(1) + \alpha)}{\alpha} - \rho}{(1 - v) + \dfrac{(\beta\omega + P'(1) + \alpha)}{\alpha}}$$

Let the term:

$$I = \frac{(\beta\omega + P'(1) + \alpha)}{\alpha}$$

be interpreted as an index of the relative supply of academic incentives, formal and informal. Indeed, $\beta\omega + P'(1)$ are the global incentives within the academic community while α represente the intensity of temptation of the outside activities given by growing demand of consulting. Hence we can rewrite our rate of growth of knowledge as follows:

$$g(I) = \frac{\dot{h}(t)}{h(t)} = \frac{T.\phi.I - \rho}{(1-v)+I}$$

From this finding we have the following corollary:

Corollary 2

The Universities which offer higher formal and informal Incentives tend to have the larger academic performances:

$$\frac{dg(I)}{dI} = \frac{T.\phi(1 - v) + \rho}{(1 - v + I)^2} > 0$$

The large are the uncoordinated externalities lower is the rate of knowledge accumulation:

$$\frac{dg(I)}{d(1 - v)} = -\frac{T.\phi.I - \rho}{(1 - v + I)^2} < 0$$

Hence our result says that in face of larger knowledge externalities, the planner (social benevolent planner) must coordinate the optimal implementation of academic allocations. This coordination requires larger formal and informal incentives and the appropriate infrastructure.

Finally, our model may be useful to characterize the endogenous salaries for scholars. In fact, in less developing countries we observe low incentives, i.e., low salaries, which generates a vicious path dependency.

5. Endogenous Scholars Wages

The global income for the representative scholar h type at instant t and for given time of teaching is given by :

$$Y(h(t)) = Y^C\big(h(t)\big) + Y^A\big(h(t)\big)$$

Where the academic global wage is:

$$Y^A\big(h(t)\big) = w_0 + \beta Log(\omega h(t) + (1-\omega)H(t)) + P\left(\frac{h(t)}{H(t)}\right)$$

And the salary from consulting is given by:

$$Y^C\big(h(t)\big) = s_0 + \alpha Log\big(l(t)h(t)\big)$$

With $s_0 = 0$. At equilibrium we have the identity:

$$h(t) = H(t) \quad \forall t \qquad \text{and}$$

$$L = \frac{\rho + (1-\upsilon)T\phi}{(1-\upsilon)\phi + \phi\,.\dfrac{(\beta\omega + P'(1) + \alpha)}{\alpha}}$$

Therefore we obtain the endogenous wages at equilibrium as follows:

$$Y^A(t) = w_0 + \beta Log(H(t)) + P(1)$$

And $\quad Y^C(t) = \alpha Log\big(L\big) + \alpha Log(H(t))\big)$

Where $\quad H(t) = H(0)e^{gt}$

Thus we have :

$$Y^A(t) = w_0 + \beta Log(H(0)) + \beta g.t + P(1)$$

Or

$$Y^A(t) = w_0 + \beta Log(H(0)) + \beta \frac{T.\phi \frac{(\beta\omega + P'(1) + \alpha)}{\alpha} - \rho}{(1-v) + \frac{(\beta\omega + P'(1) + \alpha)}{\alpha}}.t + P(1)$$

And

$$Y^C(t) = \alpha Log(H(0) + \alpha Log(\frac{\rho + (1-v)T\phi}{(1-v)\phi + \phi.\frac{(\beta\omega + P'(1) + \alpha)}{\alpha}}) + \alpha \frac{T.\phi \frac{(\beta\omega + P'(1) + \alpha)}{\alpha} - \rho}{(1-v) + \frac{(\beta\omega + P'(1) + \alpha)}{\alpha}}.t$$

In conclusion, the structure of endogenous wages is directly related to the formal informal incentives-Institutions. Hence, if the wages are low, this reflects the low incentives which lead to lower knowledge performance and to a vicious path dependency.

6. Conclusion

The main aim of this paper is to explain the lower academic performance particularly in developing countries. Indeed it is shown the existence of Lower Performance Trap, and only a "Big Push " policy : incentives to hire good scholars which may help to set up a standard of academic research culture …..

This paper may be extended to include the formal and informal Institutions (social norms) which help to coordinate the optimality of the academic research, further also the existence of pure game of rent seeking within the academia may harm or distort the incentives these extensions are our ongoing works..

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