Research in Economics (2002) **56**, 187–198
doi:10.1006/reec.2001.0274
Available online at http://www.idealibrary.com on IDEAL®

Scientific, business and political networks in academia

João Ricardo Faria

School of Social Sciences, University of Texas at Dallas, P.O. Box 830688, Richardson, TX 75080-0688, U.S.A. Phone: +1-972-883 6402; Fax: +1-972-883 2735; E-mail: jocka@utdallas.edu

(*Received 20 November 2000, accepted 4 September 2001*)

Summary

This paper models a scholar's allocation of time between academia and professional activities outside academia, given the academic labour market and networks incentives. Under feasible conditions scientific networks have positive externalities, while business and political networks have negative externalities for academic productivity. The final part of the paper brings a brief discussion on policy recommendations to stimulate academic productivity.

J.E.L. Classification: A19; C62; D19; J22.
Keywords: economics of science, network externalities, rent-seeking.

1. Introduction

There is a consensus that human capital, science and technology play an essential role in economic growth (e.g. Adams, 1990; Aghion and Howitt, 1998). A substantial part of the human capital, science and technology is produced in universities by scholars. The study of scholars' behaviour is essential to understand the path of human capital formation, and the creation of scientific theories and technology. Governments aiming at fostering economic growth should take into account the behaviour of scholars when formulating their policies.

The economic analysis of academia has addressed issues concerning the scholars' labour market and the determination of teaching/research levels. On the one hand, the labour market studies cover topics such as job mobility (Skeels and Fairbanks,

1090–9443/02/020187 + 12 $35.00/0

1968/1969), wage determination (Hammermesh *et al*., 1982) and tenure positions (Carmichael, 1988). On the other hand, the literature on research and teaching has emphasized the conditions for teaching and research quality (e.g. Becker, 1975; Stigler, 1982), the role of departmental management on scholars' performance (Borooah, 1994; Faria, 1998), government grants and other incentives for research (Graves *et al*., 1982; Fox and Milbourne, 1999; Thursby, 2000).

This paper focuses on the effect of networks on academic productivity. The paper analyses how different types of networks, academic, business and political, affect the behaviour of scholars. Academic (scientific) networks comprise the academic industry as a whole. They include the scientific circle of the scholar, his links with other researchers, technical journals, academic societies and conferences, his students, department and university. Scientific networks create incentives for scholars to produce, present, evaluate and reward their scientific work under strict criteria (e.g. Van Dalen, 1999).

Business and political networks include all links of the scholar outside academia. Basically they consist of the scholar's links with the rest of the society. The business and political networks create incentives for scholars to use their knowledge and expertise to explore commercial opportunities through consulting and/or pursuing a political career.† An important possible outcome of this process is that university researchers can become too responsive to economic incentives linked to these externalities, compromising the public character of science by trying to privatize knowledge (Stephan and Levin, 1996). One by-product of these non-scientific networks is the emergence of rent-seeking behaviour in academia (e.g. Diamond, 1993; Tullock, 1993).

The major purpose of this investigation is to draw attention to the network externalities on scholars. By analysing the incentives faced by a typical scholar, the paper shows the negative impact of the business and political networks on research productivity. In particular, the role of the government is emphasized. The study provides some policy recommendations to increase academic productivity.

The paper is structured as follows. The basic model is introduced in the next section. The stability analysis of the model appears in Section 3. The qualitative results of the model are presented in Section 4. Policy suggestions derived from the model are shown in Section 5. Finally, Section 6 brings the concluding remarks.

† See Frey and Eichenberger (1993).

2. The model

The representative scholar is a scientist who can allocate his labour supply by working in academia and in other professional activities. So he has two different sources of real income: $Y = Y(A, P)$. The income from academia (A) 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 (P) 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.

The academic output of the scholar (F) consists of scientific publications in peer-reviewed journals. Hence F represents the academic productivity.† The change in the stock of scientific publications, $\dot{F}$, indicates the creation of scientific knowledge. This depends on the academic labour market—captured by the academic environment and the opportunities outside of academia—and scientific networks. $\dot{F}$ increases with the scholar's satisfaction with the academic environment, which is reflected by his academic income (A). The opportunities outside academia, represented by P and by the output of the scholar outside academia (D), decrease the change in the stock of scientific publications, $\dot{F}$. Finally, there are substantive costs to the researcher to publish his output, since scientific papers submitted to academic journals are subject to formal rules of review and critical evaluation. Scientific networks provide a forum for discussion, co-authorship‡ and critical analysis of a scholar's output, which increase the chances of publication and academic success.§ Hence, scientific networks (z) minimize the production costs of scientific creation:

$$\dot{F} = f(A, P, z, D, F),\ f_A > 0, f_P < 0, f_z > 0, f_D < 0, f_F < 0, f_{FF} < 0 \tag{1}$$

In order to simplify the analysis below it is assumed that $f_A > 0, f_P < 0, f_z > 0, f_D < 0$, are constants.¶ The non-linearity of function f is given by the terms: $f_F < 0, f_{FF} < 0$, this is in accordance with the evidence that, on average, scientists become less productive as they age (see Levin and Stephan, 1991).

† Another measure of academic output often used is the number of citations in professional journals.

‡ See Beckmann (1994).

§ See, for instance, the interview with Granger (1997).

¶ This can be contrasted with van Dalen's (1998) findings that institutional incentives matter for economists' accumulation of knowledge. He shows that economists with business and political links tend to concentrate on applied literature, while economists with academic links concentrate on advanced theory. One way to relate his findings with the present model is by assuming that the applied work is less likely to appear as peer-review publication.

The output of the scholar outside academia (D), includes consulting and technical reports for the government, trade unions, international organizations, private firms, and the like. It is assumed that this work does not appear as publication in peer-review journals—since it does not meet the high standards for publication in peer-review journals.†

The scholar has to build up a good reputation as a researcher to attract the attention outside academia and be invited to give consultancies. The academic reputation (R) increases with F, and depends on a threshold level of academic achievements, which depends on z and A:‡

$$R = R(F, zA), R_F > 0, R_z < 0, R_A < 0, R_{zA} < 0$$

The academic reputation is expected to increase the change in the stock of the scholar's output outside academia, $\dot{D}$. In addition, $\dot{D}$ is affected by business and political networks (x). Nevertheless, business and political networks have ambiguous effects on $\dot{D}$, since on the one hand, a larger x attracts more invitations for future consulting, which increases $\dot{D}$. On the other hand, it encourages the scholar to develop strategies for self-promotion, requiring more time spent socializing and increasing personal contacts, which decreases $\dot{D}$. If rent-seeking is pervasive, the negative effect of x in $\dot{D}$ is dominant:

$$\begin{aligned}\dot{D} &= D(R(F, zA), x, D) = g(zA, x, D, F),\\ &g_F > 0, g_A < 0, g_z < 0, g_{zA} < 0, g_x < 0, g_D > 0, g_{DD} = 0 \quad (2)\end{aligned}$$

Where, $g_x < 0, g_F > 0, g_D > 0$, are constants.

Considering a constant rate of time preference, $r > 0$, the scholar solves the following maximization problem:

$$\begin{aligned}&\max_{A,P} \int_0^\infty U(A, P)e^{-rt}dt, U_A(A), U_p(P) > 0,\\ &U_{AA}(A), U_{PP}(P) < 0, U_{AP} = 0§\end{aligned}$$

† One can argue that consulting and research might be complimentary, since consultancies can have a positive spillover effect on research by providing new problems, and suggesting new methods, techniques and ideas to the researcher, see for instance Krugman (1993).

‡ According to Johnson (1997) there is a strong positive relationship between scholar's reputation and academics citation, which can be associated with z and A.

§ The separability of A and P in the utility function is made in order to simplify the analysis. The results do not depend strongly on this assumption, however, it seems plausible that higher scientific income (A) lowers the marginal utility of external income (P) and vice versa, this effect is explored in Faria (2001).

subject to equations (1) and (2).†

One could argue that the representative scholar's problem presented above is too restrictive and does not capture the entire role of reputation in the scientist's decisions. Reputation seeking as an end in itself seems to be one of the main incentives in doing science (see Samuelson, 1995). Thus one would expect the introduction of reputation in the utility function. Another way to think of reputation is that it allows the researcher to work in better environments, with better colleagues, libraries, laboratories, and therefore it influences the academic output. In this sense reputation leads to more academic productivity, and so again to more reputation as in a virtuous cycle. Both are valid points, and the model can, indeed, be extended in these directions. However such modeling strategy is extremely costly in mathematical terms, since the model becomes too complex to provide clear-cut results. Moreover, the way reputation appears in the present model (see equation (2)) represents the idea stressed by Stephan (1996) that a reward system based on reputation provides a mechanism for capturing the externalities of scientific discovery, which brings more rewards in terms of income.

The Hamiltonian of the optimal problem is:

$$H = U(A,P) + \theta f(A,P,z,D,F) + \lambda g(zA,x,D,F)$$

where θ and λ denote, respectively, the costate variables for F and D.

The first-order conditions are:

$$U_A(A) + \lambda z g_A + \theta f_A = 0 \Rightarrow A = A(\lambda,\theta,z)$$

$$A_\theta = \frac{-f_A}{U_{AA}} > 0, A_\lambda = \frac{-g_A}{U_{AA}} < 0,$$

$$A_z = \frac{-\lambda(z g_{zA} + g_A)}{U_{AA}} < 0 \tag{3}$$

$$U_P(P) + \theta f_P = 0 \Rightarrow P = P(\theta), P_\theta = \frac{-f_P}{U_{PP}} < 0 \tag{4}$$

$$\dot{\theta} - r\theta = -\theta f_F - \lambda g_F \tag{5}$$

$$\dot{\lambda} - r\lambda = -\lambda g_D - \theta f_D \tag{6}$$

Plus the transversality conditions.

This framework allows the investigation of networks' impact (i.e. the impact of x and z) on academic productivity. However, to

† One can think of the functional as a typical utility function. The scholar derives utility from a composite consumption good (C): $V(C)$. Normalizing its price to the unity, the scholar consumes all his income at every point in time: $C = Y(A,P)$, therefore: $V(C) = V(Y(A,P)) = U(A,P)$.

examine the existence of internal solutions and the workings of this model through the comparative statics analysis, it is necessary to assess its stability properties at a given steady state solution.

3. Stability analysis

The first step for the local stability analysis of the model is the substitution of the optimal controls given by equations (3) and (4) into the state and costate differential equations (1), (2), (5) and (6). Notice that this step decreases the dimension of the dynamical system, since by substituting the control variables A and P into the system, it reduces the number of endogenous variables from 6 to 4. The remaining endogenous variables are: D, F, θ and λ. The substitution results in the canonical equations below:

$$\dot{F} = f(A(\theta, \lambda, z), P(\theta), D, F) \tag{7}$$

$$\dot{D} = g(zA(\theta, \lambda, z), x, D, F) \tag{8}$$

$$\dot{\theta} = \theta(r - f_F) - \lambda g_F \tag{9}$$

$$\dot{\lambda} = \lambda(r - g_D) - \theta f_D \tag{10}$$

At this point, it is important to stress that the equations of motion for D and F (equations (7) and (8)), depend on the impact of network externalities (x and z) on A and P. That is, in contrast with equations (1) and (2), one should note that beyond the direct effect of scientific (z) and business and political (x) networks, it is necessary to assess their indirect effect through the academic (A) and non-academic (P) income in the dynamics of F and D.

The local stability properties of a hyperbolic system (equations 7–10) (i.e. if all eigenvalues of the Jacobean below have real parts different from zero) follow from an analysis of the linearized system. The Jacobean of the dynamic system (equations 7–10) is:

$$J = \begin{bmatrix} f_F & f_D & f_A A_\theta + f_P P_\theta & f_A A_\lambda \\ g_F & g_D & z g_A A_\theta & z g_A A_\lambda \\ -\theta f_{FF} & 0 & r - f_F & -g_F \\ 0 & 0 & -f_D & r - g_D \end{bmatrix}$$

The eigenvalues of J evaluated at a steady state equilibrium determine the local stability properties.

The eigenvalues $E(i)$, $i = 1$ to 4, can be calculated using a formula derived in Dockner (1985):

$$E(i) = r/2 \pm \sqrt{\frac{r^2}{4} - \frac{M}{2} \pm \frac{1}{2}\sqrt{M^2 - 4\det J}}, \; i = 1 \text{ to } 4.$$

Where det J denotes the determinant of the Jacobean J:

$$\det J = [(f_D g_F - f_F g_D) - r(r - g_D - f_F)](f_D g_F - f_F g_D) + \theta f_{FF} \{(r - g_D)[g_D(f_A A_\theta + f_P P_\theta) - z f_D g_A A_\theta] - f_D A_\lambda (z f_D g_A - f_A g_D)\} \quad (11)$$

The coefficient M is defined as the sum of the principal minors of J of dimension 2:

$$M = f_F(r - f_F) + (r - g_D)g_D + \theta f_{FF}(f_A A_\theta + f_P P_\theta) - 2 f_D g_F \quad (12)$$

Dockner (1985) has proved that the necessary and sufficient conditions for the local stability in optimal control problems with two-state variables are the following:

$$(i)\, M < 0,$$
$$(ii)\ \det J \in (0, M^2/4].$$

Conditions (i) and (ii) guarantee the existence of two eigenvalues which are either negative or with negative real parts.†

Let us consider a steady state equilibrium (F^*, D^*, θ^*, λ^*) of the system (equations 7–10):

$$\dot{F} = f(A(\theta^*, \lambda^*, z), P(\theta^*), z, D^*, F^*) = 0 \quad (13)$$

$$\dot{D} = g(zA(\theta^*, \lambda^*, z), x, D^*, F^*) = 0 \quad (14)$$

$$\dot{\theta} = \theta^*(r - f_F(F^*)) - \lambda^* g_F = 0 \quad (15)$$

$$\dot{\lambda} = \lambda^*(r - g_D) - \theta^* f_D = 0 \quad (16)$$

Notice that from equation (16) follows:

$$\theta^* = \frac{\lambda^*(r - g_D)}{f_D} \quad (17)$$

By substituting equation (17) into equation (15) we have:

$$\frac{\lambda^*(r - g_D)}{f_D}(r - f_F(F^*)) = \lambda^* g_F \Rightarrow \lambda^* = \bar{\lambda} \text{ constant} \quad (18)$$

The steady state equilibrium given by equations (13), (14), (17) and (18) provides the equilibrium values (denoted by an asterisk) of D, F, θ and λ in implicit form. It is clear that the endogenous variables, F^*, D^*, θ^*, λ^*, depend on the behaviour of the exogenous variables x and z. In order to study the impact of network

† That is, a two-dimensional manifold is associated with the two eigenvalues with negative real parts. This manifold characterizes the stable motions in the four dimensional space of states and costates such that for any given initial condition (F_0, D_0) the corresponding initial conditions of the costate variables are uniquely determined.

externalities (x and z) on F^* and D^* through the comparative static analysis, this equilibrium must be locally stable.

This equilibrium is locally stable if the following inequalities are satisfied:

$$(1)\, r > g_D$$

$$(2)\, 0 < g_D(f_A A_\theta + f_P P_\theta) < z f_D g_A A_\theta$$

$$(3)\, f_F(r - f_F) + \theta f_{FF}(f_A A_\theta + f_P P_\theta) < 2 f_D g_F - (r - g_D) g_D$$

Inequalities (1) and (2) yield a positive det J,† while inequality (3) leads to a negative M. These are sufficient conditions for the local stability of the system presented above. Now we can address the qualitative implications of the model.

4 Qualitative results

In order to assess the impact of networks in the model, consider the steady state equilibrium (which is locally stable) given by equations (13), (14), (17) and (18). Substituting equations (17) and (18) into (13) and (14) yields:

$$f\left(A\left(\bar{\lambda}\left[\frac{r-g_D}{f_D}\right], \bar{\lambda}, z\right), P\left(\bar{\lambda}\left[\frac{r-g_D}{f_D}\right]\right), z, D^*, F^*\right) = 0 \quad (13')$$

$$g\left(zA\left(\bar{\lambda}\left[\frac{r-g_D}{f_D}\right], \bar{\lambda}, z\right), x, D^*, F^*\right) = 0 \quad (14')$$

total differentiation of this system gives (notice that $d\bar{\lambda} = 0$):

$$\begin{bmatrix} f_F & f_D \\ g_F & g_D \end{bmatrix} \begin{bmatrix} dF \\ dD \end{bmatrix} = \begin{bmatrix} -[f_A A_\theta + f_P P_\theta]\dfrac{\bar{\lambda}}{f_D} dr - [f_A A_z + f_z] dz \\ -z g_A A_\theta \dfrac{\bar{\lambda}}{f_D} dr - g_x dx - [z g_A A_z + A g_z] dz \end{bmatrix} \quad (19)$$

From equation (19) by using the Cramer rule one can assess the impact of exogenous variables x and z into the endogenous variables F and D.

Business and political networks (given by x) decrease academic productivity, and increase the output of the scholar outside academia:‡

$$\frac{dF}{dx} = \frac{f_D g_x}{f_F g_D - f_D g_F} < 0 \quad (20)$$

† Note that (18) holds when $f_D g_F - f_F g_D = r(r - g_D - f_F) > 0$.
‡ Notice that according to footnote 11, the denominator is negative.

$$\frac{dD}{dx} = \frac{-f_F g_x}{f_F g_D - f_D g_F} > 0 \tag{21}$$

The role of business and political networks is determined by the impact of x on function g. As discussed before, the effect can be negative or positive. However, when rent-seeking becomes dominant, the effect is negative, which drives the qualitative results in equations (20) and (21). The important message here is that the presence of rent-seeking leads to a negative impact of business and political networks on research productivity.

Scientific networks (given by z) affect the academic productivity and the output of the scholar outside academia according to the following equations:

$$\frac{dF}{dz} = \frac{f_D[Ag_z + zg_A A_z] - [f_z + f_A A_z]g_D}{f_F g_D - f_D g_F} \tag{22}$$

$$\frac{dD}{dz} = \frac{f_F[Ag_z + zg_A A_z] - [f_z + f_A A_z]g_F}{f_F g_D - f_D g_F} \tag{23}$$

The signs of equations (22) and (23) depend on the impact of scientific network (z) on the functions f and g. An inspection of equations (13) and (14) shows that z has direct and indirect effects on both functions. The indirect effect works through the function A. It is important to stress that the effect of z on academic activities (A) is negative, because it captures the scholar's effort in building up his reputation. As argued before, the scholar is assumed to cross a threshold level—which depends on z—to achieve reputation. The better the reputation the greater are the opportunities to work outside academia, therefore the less the scholar works in academia.

The critical point in our analysis is the comparison between the indirect and the direct effects of scientific networks on academic and non-academic output. For function f, the direct effect is positive, while the indirect effect is negative. Conversely, for function g, the direct effect is negative and the indirect effect is positive. A feasible condition is given by the case in which scientific networks have an overall positive effect on functions f and g is:

$$f_z + f_A A_z > 0 \Rightarrow f_z > -f_A A_z > 0 \tag{24}$$

$$Ag_z + zg_A A_z > 0 \Rightarrow zg_A A_z > -Ag_z > 0 \tag{25}$$

If inequalities (24) and (25) hold, the direct effect dominates the indirect effect for function f, while for function g, the indirect effect dominates the direct effect. These imply, by equations (22) and (23), that the impact of scientific networks on academic productivity is positive, $\frac{dF}{dz} > 0$, while the impact on non-academic output is negative, $\frac{dD}{dz} < 0$. At this point, it is important to stress that inequalities (24) and (25) are simply general feasible sufficient conditions and cannot be taken for granted. In fact, these inequalities are essentially an open empirical question and should be tested accordingly for each specific country. Therefore, the positive effect of scientific networks on academic productivity and negative impact on non-academic output remains an empirical problem as well.

5. Policy recommendations

Policy recommendations derived from the model are quite simple. It is well known that the government can affect the business-political and scientific networks. In most countries research universities are public institutions linked to state or federal governments, and great part of research funding comes primarily from the government (see Stephan, 1996, for U.S. figures). Among the main government instruments affecting scientific networks are the research funding policies and labour market regulation in public universities. The government also affects the business and political networks through its demand for consultants, technical reports, participation of scholars in policy advisory boards, and hiring "specialists" in the formulation of public policies. So one can write the networks as being influenced by the government (G) in a positive way: $z = z(G)$, $z_G > 0$; $x = x(G)$, $x_G > 0$.

Therefore, if the government aims at increasing academic productivity:

$$\frac{dF}{dG} = \frac{\{f_D[Ag_z + zg_A A_z] - [f_z + f_A A_z]g_D\}z_G + f_D g_x x_G}{f_F g_D - f_D g_F} > 0 \Leftrightarrow$$
$$\{f_D[Ag_z + zg_A A_z] - [f_z + f_A A_z]g_D\}z_G < -f_D g_x x_G < 0$$

it should at least make the differential: $z_G > x_G$ as wide as possible. This is the key point in the policy recommendations derived from the present model: the impact of the government on scientific networks should be greater than its effect on business and political networks. The set of available policies to achieve this target is huge, among them the government can (i) develop a competitive academic labour market (by affecting, for example, the rules for tenure in public universities); (ii) increase research funding; (iii) decrease the demand for technical advice from scholars by increasing the average quality of public servants. This last recommendation implies in the investment in human capital of public servants.

6. Concluding remarks

The production of science, technology and human capital is in the heart of modern economic growth. The main agent behind this process is the scholar associated with academic institutions. In order to understand the creation of knowledge through academic research, it is necessary to understand how scientists behave. This paper examines how academic and business and political networks affect research productivity. It presents a model in which a representative scholar decides how to allocate his time between academia and professional activities outside academia, subject to the incentives given by the academic labour market and the networks.

The model presents an intertemporal maximization problem for the representative scholar. He is assumed to maximize his income flow from academic and non-academic activities, subject to the way his scientific and non-academic output changes. On the one hand, the dynamics of academic output depends on his academic and non-academic income and output, and scientific networks. On the other hand, the dynamics of non-academic output depends on the scholar's reputation and his business and political networks. The solution of the model shows that the income from both activities reflects the network externalities, which also affect the dynamics of academic and non-academic output. That is, scientific and business-political networks affect academic and non-academic output directly and indirectly via the scholar's income.

The results of the model concerning academic output are quite appealing. Under feasible conditions, scientific networks have positive externalities in scientific research, while business and political networks have negative impact on academic productivity. The policy recommendations to stimulate academic productivity include: the development of a competitive labour market in academia; the increase in research funding; the reduction in the government demand for technical advice from scholars.

Acknowledgements

I would like to thank, without implicating, Joaquim P. Andrade, Nadima El-Hassan, Amnon Levy, Marcos J. Mendes and an anonymous referee for useful comments.

References

Adams, J. (1990). Fundamental stocks of knowledge and productivity growth. *Journal of Political Economy*, **98**, 673–702.

Aghion, P. & Howitt, P. (1998). *Endogenous Growth Theory*. London: MIT Press.

Becker, W.E., Jr. (1975). The university professor as a utility maximizer and producer of learning, research and income. *Journal of Human Resources*, **10**, 107–115.

Beckmann, M.J. (1994). On knowledge networks in science: collaboration among equals. *Annals of Regional Science*, **28**, 233–242.

Borooah, V.K. (1994). Modelling institutional behaviour: a microeconomic analysis of university management. *Public Choice*, **81**, 101–124.

Carmichael, H.L. (1988). Incentives in academics: why is there tenure?. *Journal of Political Economy*, **96**, 453–472.

Diamond, A.M., Jr. (1993). Economic explanations of the behaviour of the universities and scholars. *Journal of Economic Studies*, **20**, 107–133.

Dockner, E. (1985). Local stability analysis in optimal control problems with two state variables. In G. Feichtinger, ed., *Optimal Control Theory and Economic Analysis 2*. Amsterdam: North-Holland, pp. 89–103.

Faria, J.R. (1998). The economics of witchcraft and the big eye effect. *Kyklos*, **51**, 537–546.

Faria, J.R. (2001). Rent seeking in academia: the consultancy disease (2001). *American Economist*, **45**, 69–74.

Fox, K.J. & Milbourne, R. (1999). What determines research output of academic economists? *Economic Record*, **75**, 256–267.

Frey, B.S. & Eichenberger, R. (1993). American and European economics and economists. *Journal of Economic Perspectives*, **7**, 185–193.

Granger, C. (1997). The ET interview: professor clive granger. *Econometric Theory*, **13**, 253–303.

Graves, P.E., Marchand, J.R. & Thompson, R. (1982). Economics departmental rankings: research incentives, constraints, and efficiency. *American Economic Review*, **72**, 1131–1141.

Hamermesh, D.S., Johnson, G.E. & Weisbrod, B.A. (1982). Scholarship, citations and salaries: economic rewards in economics. *Southern Economic Journal*, **49**, 472–481.

Johnson, D. (1997). Getting noticed in economics: the determinants of academic citations. *American Economist*, **41**, 43–52.

Krugman, P. (1993). How I work. *American Economist*, **37**, 25–31.

Levin, S.G. & Stephan, P.E. (1991). Research productivity over the life cycle: evidence for academic scientists. *American Economic Review*, **81**, 114–132.

Samuelson, P.A. (1995). In P.A. Samuelson, W. Breit & R.W. Spencer, eds, *Lives of the Laureates*. Cambridge: MIT Press.

Skeels, J.W. & Fairbanks, R.P. (1968/1969). Publish or perish: an analysis of the mobility of publishing and nonpublishing economists. *Southern Economic Journal*, **35**, 17–25.

Stephan, P.E. & Levin, S.G. (1996). Property rights and entrepreneurship in science. *Small Business Economics*, **8**, 177–188.

Stephan, P.E. (1996). The economics of science. *Journal of Economic Literature*, **34**, 1199–1235.

Stigler, G.J. (1982). The literature of economics: the case of the kinked oligopoly demand curve. In *The Economist as Preacher and Other Essays*. Chicago: The University of Chicago Press, pp. 223–243.

Thursby, J.G. (2000). What do we say about ourselves and what does it mean? yet another look at economics department research. *Journal of Economic Literature*, **38**, 383–404.

Tullock, G. (1993). Are scientists different? *Journal of Economic Studies*, **20**, 90–106.

Van Dalen, H.P. (1998). Accumulating knowledge over the economist's lifetime. *Kyklos*, **51**, 359–378.

Van Dalen, H.P. (1999). The golden age of Noble economists. *American Economist*, **43**, 19–35.