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A Dynamic Model of the Firm with Cyclical Innovations and Production: Towards a Schumpeterian Theory of the Firm

von

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Abstract

In this paper we present a dynamic model of the firm with endogenous technical change. We take the model presented by Sato/Tsutsui (1984) and add inventory, but in contrast to them we do not distinguish between applied and basic knowledge. Local stability analysis of this model shows that it may exhibit complex dynamic behaviour near the equilibrium. So the model may be either stable in the saddle point sense with a monotonic or cyclical approach of the equilibrium or it may exhibit stable limit cycles. Application of the Hopf Bifurcation Theorem together with a numerical example shows that persistent oscillations occur for a certain parameter constellation.

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1 Introduction

The great economist Joseph A. Schumpeter has paid much attention to the significance of technical progress in the evolution of an economy. In his "Theory of Economic Development" he regarded the process of creative destruction, that is the creation of new conditions, such as new technologies, as *the* economic force that makes an economy grow. But in contrast to Keynes whose theory highly influenced economic thinking in the late sixties and seventies of this century, Schumpeter's thoughts were nearly completely disregarded at that time. This may partly result because Keynes' ideas can be brought into mathematical formulation without causing major difficulties, a fact which does not hold for Schumpeter's work. His ideas are characterized by discontinuities and by being dynamic, two features which are difficult to handle together with standard mathematical tools so that a lot of economists who favour exact mathematical theories were reluctant to occupy themselves with Schumpeter. Only recently, in the eighties, more and more attention is paid to Schumpeterian ideas leading Herbert Giersch to the statement that the fourth quarter of this century might become the age of Schumpeter (Giersch (1984)).

Now our goal in this paper is to present a microeconomic model of the firm which may be called Schumpeterian. The term Schumpeterian seems justified because of three reasons: first the model takes explicitely account of technical progress, second it allows for disequilibrium and third although not discontinuous the model may show a complex dynamic behaviour near the equilibrium as we shall see.

When modelling a theory of the firm with technical progress the deterministic approach is more or less clear (as long as product innovations are neglected one should add). In addition to the usual input factors, in general capital and labour, the stock of technical knowledge is added as third input. This factor may enter the production function explicitely as virtual input factor, see e. g. Rasmussen (1973), Shell (1973), Ramser (1986), Gort/Wall (1986) or it may be viewed as an efficiency parameter which influences the marginal product of capital and/or labour positively as in Sato/Nono (1982) or in Sato/Tsutsui (1984).

In particular the model we shall present consists of elements found in Sato/Tsutsui (1984), Ramser (1986) and Dockner/Feichtinger/Novak (1989). It will be seen that productivity of the production function for technical knowledge is a crucial point in determining the stability of the model. Necessary and sufficient conditions for the existence of a saddle point are derived where the trajectory leading to the steady state values may be either monotonic or cyclical. Moreover it is shown by means of the Hopf Bifurcation theorem and a numerical example that the model may also result in persistant oscillations of the state variables.

In the rest of the paper we will proceed as follows. In Section 2 a description of the model is presented and the modified Hamiltonian system is derived. In Section 3 we conduct local stability analysis at the steady state and present a numerical example to illustrate the possibility of stable limit cycles.

2 The Model

We consider a firm which produces a single output at the rate Q(t), where the production function for output depends on the stock of capital at t K(t), labour L(t) and the level of technical knowledge A(t). The function Q(t) = Q(K(t),L(t),A(t)) is assumed to be strictly concave in its arguments and to fulfill the following properties

$$Q(\cdot) > 0,\ Q_i > 0,\ i = K(t), L(t), A(t) \tag{1}$$

The evolution of the stock of technical knowledge is constrained as follows (cf. Ramser (1986), Sato/Tsutsui (1984))

$$\dot{A}(t) = g(A(t), R(t)) - \mu A(t),\ A(0) = A_0 \tag{2}$$

with A(t) stock of technical knowledge at t, R(t) R&D investment at t and μ depreciation rate.

$g(\cdot)$ is assumed to be concave in its arguments and

$$g(\cdot) > 0,\ g_A(\cdot) > 0,\ g_R(\cdot) > 0,\ g_{RR} < 0,\ g_{AR} \geq 0$$

The production function for technical knowledge implies that an increase in R&D raises the stock of technical knowledge but this increase diminishes as more and more is invested in R&D. Moreover the stock of technical knowledge itself influences its production positively but with non-increasing marginal returns. That states that technical knowledge is selfinforcing, or expressed in another way, a firm with a higher level of technical knowledge has a higher production of new technology. Finally it is assumed that a certain amount of technology per period is lost because it grows old for example, a fact which is taken into account by the depreciation rate μ.

In addition we assume that the firm may sell its product on the market or put on inventory. The reason behind this assumption is that there may be rationing on the market. Consumers are rationed if their demand cannot be completely fulfilled which causes a decline of the level of inventory, the firm is rationed if it cannot sell the whole production in time t leading to a higher level of inventory. The state equation for the inventory level is given by

$$\dot{X}(t) = Q(t) - d(t), \; X(0) = X_0 \tag{3}$$

where d(t) represents the level of demand which is assumed to be constant.

It is clear that carrying an inventory of produced goods causes costs for the firm. For the inventory cost function h(X) we use a function presented by Dockner/Feichtinger/Novak (1989) and Nagatani (1981, pp. 118/119) which satisfies

$$h(X) > 0, \; h'(X) >=< 0 \text{ for } X >=< \overline{X}, \; h''(X) > 0 \tag{4}$$

This specification shows that it is a strictly convex, U-shaped function with its inflection point at $X = \overline{X}$ and states that for a level of inventory lower than $\overline{X}$ managing a certain level of sales means a "high rush-order cost" (cf. Nagatani (1981) p. 119) which declines as the level of inventory rises. As in Dockner/Feichtinger/Novak (1989) we will set $\overline{X} = 0$. Moreover if demand exceeds production and inventory is exhausted the shortage is backlogged and the resulting costs are given by h(X). When X is greater than $\overline{X}$ the virtual costs of carrying inventory like warehouse rents prevail so that they rise with a higher level of inventory.

From the production function $Q(\cdot)$ of the firm we can derive its minimum cost function C(Q,A,c,w) by static optimization, with c cost of capital and w wage rate which are assumed to be constant over time. From the assumption of a strictly concave production function we get a strictly convex cost function. Furthermore we assume

$$C(\cdot) > 0, \; C_Q > 0, \; C_A < 0, \; C_{QA} < 0 \tag{5}$$

The decision problem of the firm can now be formulated as

$$\max_{Q(t),R(t)} \int_0^\infty e^{-rt}[-C(Q(t),A(t),c,w) - sR(t) - h(X(t))]dt$$

subject to (2), (3)

where r denotes the discount rate and s is the cost of a unit of research and development activity. Like c and w, r and s are constant over time. For economic reasons accumulated sales are assumed to exceed the minimum of accumulated total costs. Otherwise production is stopped.

In the following we consider only interior solutions which may be justified by imposing Inada type conditions on the functions (2) and (5).

To solve this problem we formulate the current value Hamiltonian which gives (suppressing time arguments)

$$H = -C(Q,A,c,w) - sR - h(X) + \gamma_1[g(A,R) - \mu A] + \gamma_2[Q - d]$$

where γ_1 and γ_2 are the current value costate variables.

Then necessary conditions for a maximum are given by:

$$H_Q = -C_Q + \gamma_2 = 0 \quad (6)$$
$$H_R = -s + \gamma_1 g_R = 0 \quad (7)$$
$$\dot{A} = g(A,R) - \mu A \quad (8)$$
$$\dot{X} = Q - d \quad (9)$$
$$\dot{\gamma_1} = r\gamma_1 + C_A - \gamma_1(g_A - \mu) \quad (10)$$
$$\dot{\gamma_2} = r\gamma_2 + h'(X) \quad (11)$$

The limiting transversality conditions which guarantee sufficiency are

$$\lim_{t\to\infty} e^{-rt}[\gamma_1(t)A(t) + \gamma_2(t)X(t)] = 0$$

The concavity respectively convexity assumptions of functions (2), (3), (4) and (5) assure that the necessary conditions are also sufficient (see e. g. Seierstad/Sydsaeter (1987), pp. 234/235).

From (6) and (7) we get $Q = Q(A,\gamma_2,c,w)$ and $R = R(A,\gamma_1,s)$ so that the canonical system of differential equations describing the evolution of the state and costate variables can be rewritten as

$$\begin{aligned}
\dot{A} &= g(A, R(A,\gamma_1,s)) - \mu A && (12)\\
\dot{X} &= Q(A,\gamma_2,c,w) - d && (13)\\
\dot{\gamma_1} &= r\gamma_1 + C_A(A, Q(A,\gamma_2,c,w)) - \gamma_1(g_A(A,R(A,\gamma_1,s)) - \mu) && (14)\\
\dot{\gamma_2} &= r\gamma_2 + h'(X) && (15)
\end{aligned}$$

It can easily be seen that the system (12) - (15) possesses a unique solution where $\dot{A} = \dot{X} = \dot{\gamma_1} = \dot{\gamma_2} = 0$. This follows from the concavity respectively convexity of the functions (2), (3), (4) and (5).

To get insight in the dynamic behaviour of the model we conduct local stability analysis around the steady state values.

3 Behaviour near the equilibrium

In order to determine the stability of our model we linearize the system (12) - (15) around the steady state values and compute the eigenvalues of the corresponding Jacobian matrix. The Jacobian matrix turns out to be

$$J = \begin{bmatrix} g_A - \mu + g_R R_A & 0 & g_R R_{\gamma 1} & 0 \\ -(C_{AQ}/C_{QQ}) & 0 & 0 & 1/C_{QQ} \\ \psi & 0 & \theta & C_{AQ}/C_{QQ} \\ 0 & h'' & 0 & r \end{bmatrix},$$

with $\psi \equiv C_{AA} + C_{AQ}Q_A - \gamma_1(g_{AA} + g_{AR}R_A)$ and $\theta \equiv r - g_A + \mu - \gamma_1 g_{AR} R_{\gamma 1}$

The roots of this matrix are computed according to

$$\lambda_{1,2,3,4} = \frac{r}{2} \pm \sqrt{(\frac{r}{2})^2 - \frac{K}{2} \pm \sqrt{(\frac{K}{2})^2 - detJ}}$$

where K is defined as

$$K = a_{11}a_{33} - a_{13}a_{31} + a_{22}a_{44} - a_{24}a_{42} + 2a_{12}a_{34} - 2a_{32}a_{14}$$

with a_{ij} element of the i-th row and j-th column of J (see Feichtinger/Hartl (1986), pp. 134/135). In this model the constant K is given by

$$K = -a + A_1 + A_2,$$

where

$$
\begin{aligned}
a &= -(g_A - \mu + g_R R_A)(r - g_A + \mu - \gamma_1 g_{AR} R_{\gamma 1}) \\
A_1 &= -g_R R_{\gamma 1}[C_{AA} + C_{AQ} Q_A - \gamma_1 (g_{AA} + g_{AR} R_A)] \\
A_2 &= -(h''/C_{QQ})
\end{aligned}
$$

Note that $A_1 < 0$ (as $C(\cdot)$ is strictly convex in its arguments and $g(\cdot)$ is concave in its arguments) and $A_2 < 0$ (as $h'' > 0$ and $C_{QQ} > 0$). The determinant of J can be written as

$$detJ = A_2(A_1 - a) + h''(C_{AQ}/C_{QQ})^2 g_R R_{\gamma 1}$$

Looking at the formula for the eigenvalues of J we can derive a first result. We see that two of the eigenvalues have negative real parts and two of them have positive real parts if $a > 0$, because then K is negative and det J is positive, so that the steady state is stable in the saddle point sense. Whether the equilibrium is approached monotonically or cyclically depends on the imaginary parts of the eigenvalues. So if $0 < detJ \leq (\frac{K}{2})^2$ all eigenvalues are real and we get a monotonic path leading to the steady state. If $detJ > (\frac{K}{2})^2$ all eigenvalues are complex and the trajectory shows oscillations until it reaches the equilibrium. Economically this means that if the marginal product of A in the production process for technical knowledge at the steady state is lower than the depreciation rate the model is stable in the saddle point sense. We will refer to this case as the unproductive production process for technical knowledge. If the production process is productive at the steady state the model is again stable in the saddle point sense if the discount rate r is smaller than the marginal product of A in the production process for technical knowledge at the steady state. Whether the optimal path is monotonic or cyclical cannot be determined without further specification of the functions. But this is beyond our interest. Instead we will investigate what may happen if $a < 0$.

In this case we see that the constant K may be positive and det J, too, which might give rise to two purely imaginary eigenvalues and thus to a Hopf Bifurcation, with limit cycles as result. (For a description of the Hopf Bifurcation Theorem see e. g. Guckenheimer/Holmes (1983) or Hassard/Kazarinoff/Wan (1981)).

The economic meaning of stable limit cycles is obvious. Persistant oscillations of the stock of technical knowledge state that there are up- and downswings of knowledge over time. The decline may be caused by rising obsolescence of the technique employed by the firm. This process continues until a new production technique is introduced by the firm which makes technical knowledge rise in the beginning up to a certain point of time from which on technical knowledge declines again. From a Schumpeterian point of view such a new innovation might be called a basic innovation. In the same way production which is stimulated by a new cost-reducing innovation and thus the level of inventory fluctuate over time. But notice that the shadow price γ_2 influences production, too.

Up to now we have only derived a necessary condition for a stable limit cycle. Below a numerical example shows that such oscillations may indeed occur. But, before we summarize the results obtained so far in the following proposition:

- Unproductivity of the production process for technical knowledge at the steady state is a sufficient condition for saddle point stability. The optimal trajectory may be monotonic or cyclical. The same holds for a productive production process if the discount rate is lower than the marginal product of A in the production process for technical knowledge at the steady state.

- Productivity of the production process for technical knowledge together with a discount rate higher than the marginal product of A in the production process for technical knowledge at the steady state is a necessary condition for limit cycles.

Next we present a numerical example which shows persistant oscillations[1].

For the production function of output we suppose a Cobb-Douglas technology of the form

$$Q = K^a L^b A^l$$

which is strictly concave for $a, b, l > 0$, $a + b + l < 1$.

The minimum cost function derived is specified as

$$C = Q^{10/6} A^{-1/2}$$

[1] I thank Markus Hierl, Andreas Novak and especially Volker Schulz for their help in doing the numerical calculations.

for $a = b = l = 0.3$ and $c \cdot w = 0.25$.

The evolution of the stock of technical knowledge follows

$$\dot{A} = A^e R^f - kA^i - \mu A$$

which is concave for $e, f > 0$, $e + f \leq 1$, $i \leq 0$ and $k \geq 0$ (sufficient conditions).

The cost function of inventory is

$$h(X) = hX^2$$

For the example we take the following parameter values e = 0.5, f = 0.5, i = -0.5, k = 0.3, $\mu = 0.1775$, and d = 1.2, h = 0.15, s = 0.5.

r serves as bifurcation parameter and the critical value at which two of the eigenvalues are purely imaginary is $r_{crit} = 1.885057$. The equilibrium values for these parameters are given by

A = 0.819583, X = -13.063, $\gamma_1 = 0.5818262$, $\gamma_2 = 2.078929$, Q = 1.2, R = 0.2774466.

In order to show the occurence of a Hopf Bifurcation and the existence of stable limit cycles we used the code "BIFDD" (for a description of the related code "BIFOR2" see Hassard/Kazarinoff/Wan (1981)).

For a Hopf Bifurcation to occur it is necessary that besides two purely imaginary eigenvalues the derivative of the real part of the eigenvalue with respect to the bifurcation parameter does not equal zero at the point of bifurcation.

In the example this value is computed as

$$Re\ \lambda_1'(r_{crit}) = 0.1565468$$

The sign of the coefficients β_2 and μ_2 of the so-called normal form of the differential equations on the center manifold which give the stability of the limit cycles and the direction of bifurcation are given by $\beta_2 = -1.10159$, $\mu_2 = 3.518406$ (for a detailed description see Hassard/Kazarinoff/Wan (1981)). As $\beta_2 < 0$ the limit cycles are stable[2].

For representation of the optimal trajectories and the limit cycle in the (A-Q) - phase diagram (see Appendix) we used the boundary value problem solver "VOLFIT" (see Schulz (1990)) and the value r = 1.97.

[2]The computations were done on a PC with a 286 processor and a 287 math-coprocessor.

4 Conclusion

It goes without saying that this model is too simple to describe completely the behaviour of a firm in reality nor can it sufficiently represent Schumpeterian thoughts. But even with such a simple standard model it could be shown that a more complex dynamic behaviour of the firm with persistent oscillations may result from an intertemporal optimization process. Thus this paper may be seen as a first attempt to formalize some of Schumpeter's ideas on the microeconomic level of economic theory. But whereas the appearence of cyclical basic innovations on the macroeconomic level seems justified and empirically supported (see Kleinknecht (1990)) it may be doubted if the same holds for the microeconomic level of economic theory. So in a static optimization model a catastrophy theoretic model in which basic innovations do not occur regularly, but only as sudden changes which show up as discontinuities in mathematical formulation would be to prefer (see e. g. Ursprung (1984) for a static catastrophy model with technical progress). A dynamic theory of the firm which tries to explain innovations should contain erratic behaviour of the state variables to describe the unregular and not predictable appearence of innovations at the microeconomic level of the firm.

Appendix

Caption of figure 1, figure 2 and figure 3

Figure 1 shows the optimal trajectories of the stock of technical knowledge (A), the level of inventory (X), the costate variables (γ_1, γ_2) and production (Q) over time, with the parameter values from page 7/8.

Figure 2 shows the limit cycle in the (A-Q) - phase diagram.

Figure 3 shows how the optimal path approaches the limit cycle in the (A-Q) - phase diagram when it starts in the interior of the cycle. For this purpose we changed the parameter value of μ and took $\mu = 0.15$ with all other parameter values and the boundary conditions unchanged. In this case the equilibrium values, r_{crit} and the coefficients β_2 and μ_2 are also slighly altered.

Figure 1

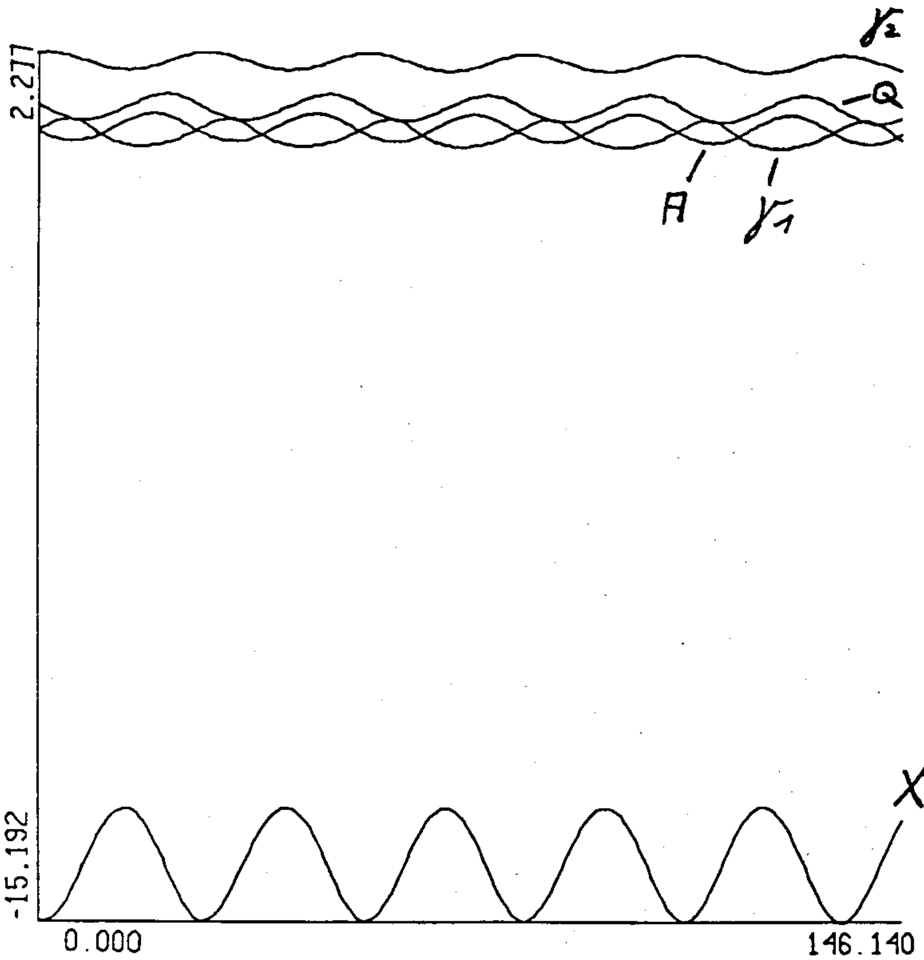
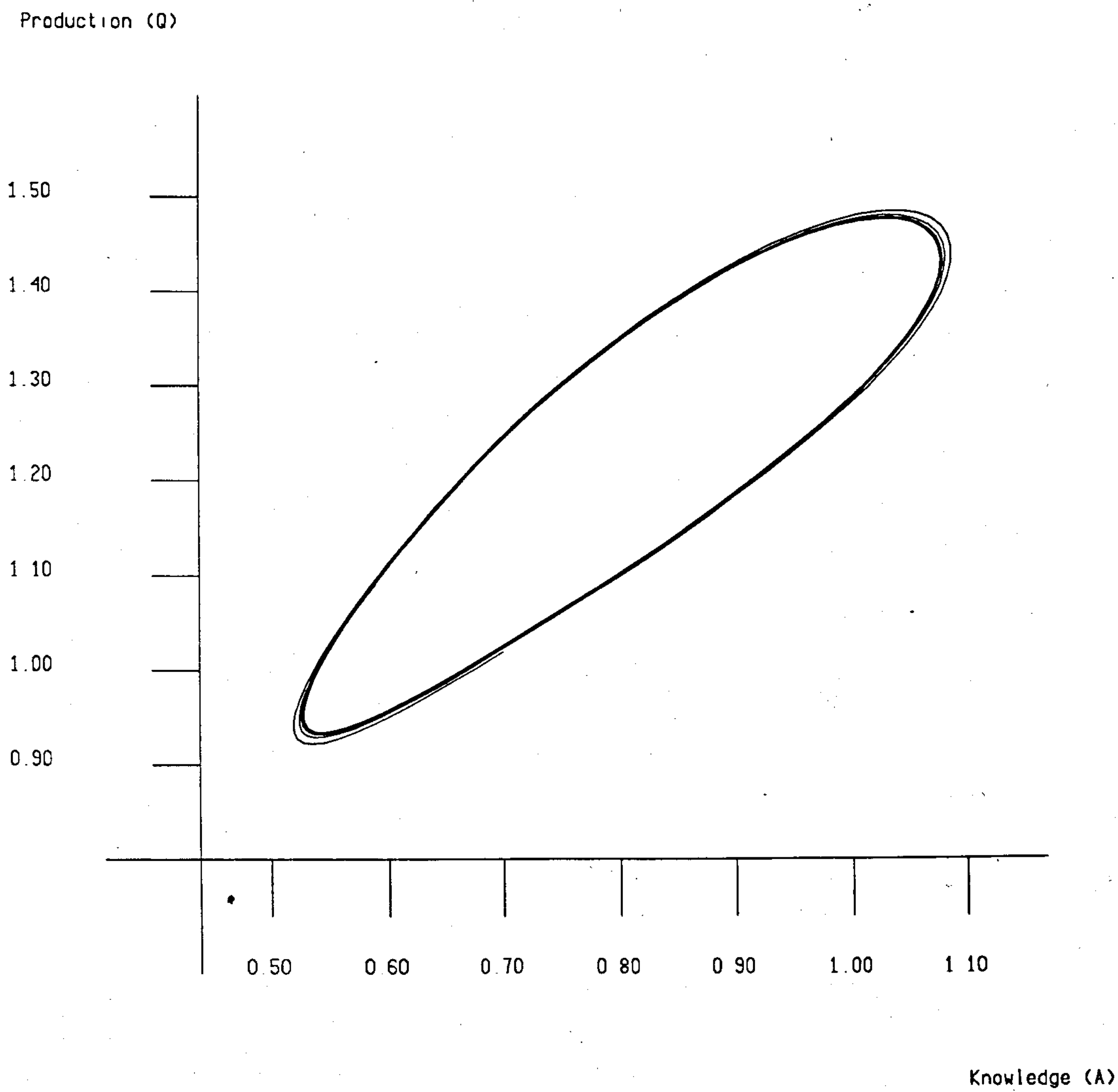
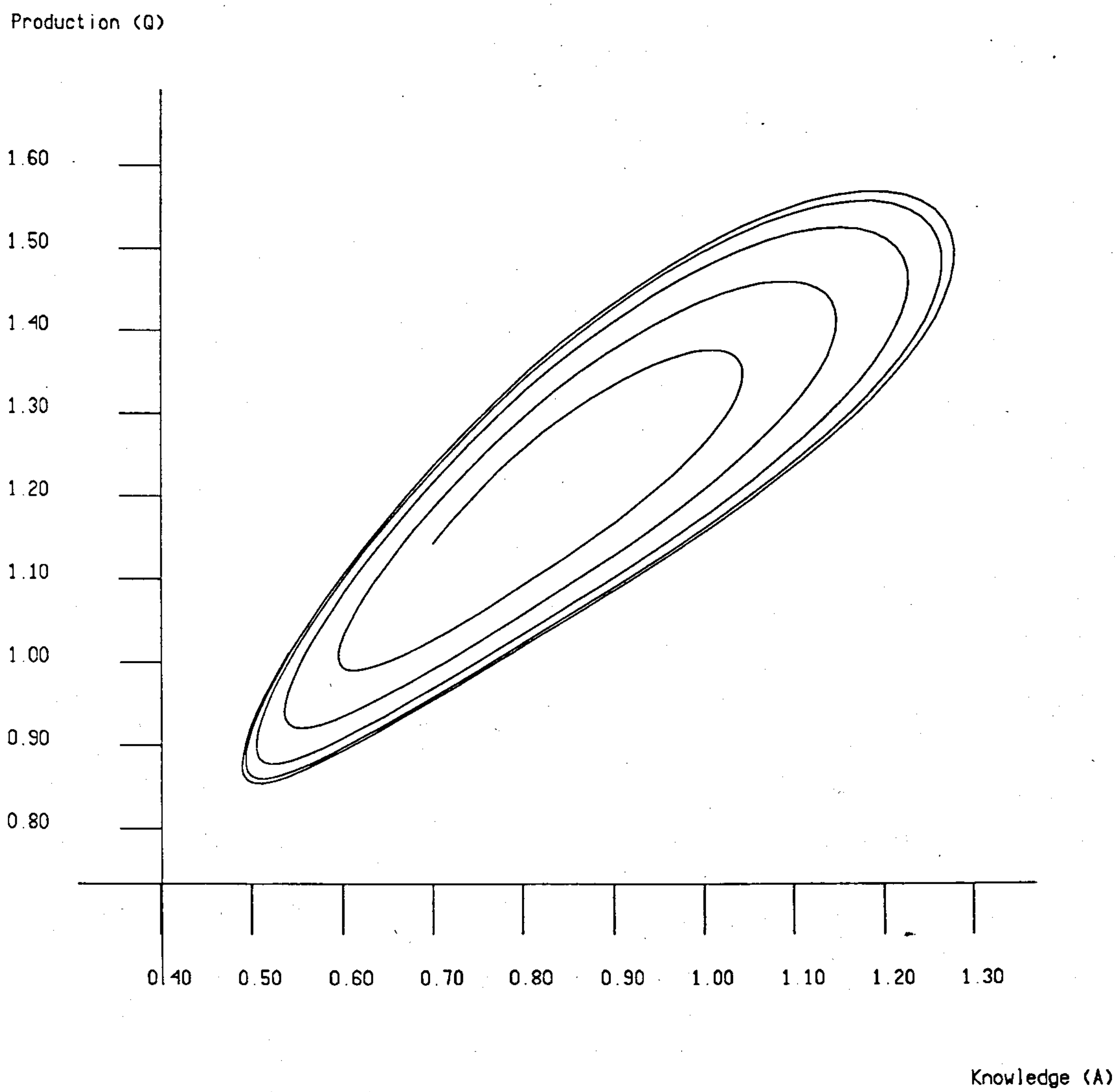


Figure 2



Production (Q)
1.50
1.40
1.30
1.20
1 10
1.00
0.90
0.50
0 60
0.70
0 80
0 90
1.00
1 10
Knowledge (A)

Figure 3


Production (Q)
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1.10
1.20
1.30
Knowledge (A)

References

[1] Dockner, E.J., Feichtinger, G., Novak, A. (1989) On Cyclical Production and Marketing Decisions: An Application of Hopf Bifurcation Theory. Forschungsbericht Nr. 123, TU Wien

[2] Feichtinger, G., Hartl, R.F. (1985) Optimal pricing and production in an inventory model. European Journal of Operational Research, Vol. 19

[3] Feichtinger, G., Hartl, R.F. (1986) Optimale Kontrolle ökonomischer Prozesse. De Gruyter Verlag, Berlin, New York

[4] Giersch, H. (1984) The Age of Schumpeter. American Economic Association, Papers and Proceedings, Vol. 74

[5] Gort, M., Wall, R.A. (1986) The Evolution of Technologies and Investment in Innovation. The Economic Journal, Vol. 96

[6] Guckenheimer, J., Holmes, P. (1983) Nonlinear Oscillations, Dynamical Systems, and Bifurcations of Vector Fields. Springer Verlag, New York, Berlin, Heidelberg, Tokyo

[7] Hassard, B.D., Kazarinoff, N.D., Wan Y-H. (1981) Theory and Applications of Hopf Bifurcation. Cambridge University Press, Cambridge, London, New York, New Rochelle, Melbourne, Sydney

[8] Jaeger, K. (1986) Die analytische Integration des technischen Fortschritts in die Wirtschaftstheorie. In Bombach, G., Gahlen, B., Ott, A.E. (edts.) Technologischer Wandel - Analyse und Fakten. J.C.B. Mohr (Paul Siebeck), Tübingen

[9] Kleinknecht, A. (1990) Are there Schumpeterian waves of innovations? Cambridge Journal of Economics, Vol. 14

[10] Nagatani, K. (1981) Macroeconomic Dynamics. Cambridge University Press, Cambridge

[11] Rahmeyer, F. (1989) The Evolutionary Approach to Innovation Activity. Journal of Institutional and Theoretical Economics (JITE) 145

[12] Ramser, H.J. (1986) Schumpeter'sche Konzepte in der Analyse des technischen Wandels. In Bombach, G., Gahlen, B., Ott, A.E. (edts.) Technologischer Wandel - Analyse und Fakten. J.C.B. Mohr (Paul Siebeck), Tübingen

[13] Rasmussen, J.A. (1973) Applications of a Model of Endogenous Technical Change to US Industry Data. Review of Economic Studies, Vol. 40

[14] Sato, R., Nono, T.N. (1982) A Theory of Endogenous Technical Progress: Dynamic Böhm-Bawerk Effect and Optimal R&D Policy. Zeitschrift für Nationalökonomie (Journal of Economics), Vol. 42

[15] Sato, R., Tsutsui, S. (1984) Technical Progress, the Schumpeterian Hypothesis and Market Structure. Zeitschrift für Nationalökonomie, Journal of Economics, Suppl. 4

[16] Schulz, V. (1990) Ein effizientes Kollokationsverfahren zur numerischen Behandlung von Mehrpunktrandwertproblemen in der Parameteridentifizierung und optimalen Steuerung. Diploma thesis, University of Augsburg, Augsburg

[17] Schumpeter, J.A. (1935) Theorie der wirtschaftlichen Entwicklung. 4.Aufl., Duncker & Humblot, München, Leipzig

[18] Seierstad, A., Sydsaeter, K., (1987) Optimal Control Theory with Economic Applications. North Holland, Amsterdam, New York, Oxford, Tokyo

[19] Shell, K. (1973) Inventive activity, Industrial Organization and Economic Growth. In Mirrlees, J.A., Stern, N.H., (edts.) Models of Economic Growth., Macmillan Press Ltd., London, Basingstoke

[20] Ursprung, U. (1984) Schumpeterian Entrepreneurs and Catastrophe Theory or a new Chapter to the Foundation of Economic Analysis. Zeitschrift für Nationalökonomie, Journal of Economics, Suppl, 4

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