EUI WORKING PAPERS IN ECONOMICS

EUI Working Paper ECO No. 94/1

Cooperatives With Privately Optimal Price Indexed Debt Increase Membership When Demand Increases

ROBERT WALDMANN

European University Institute, Florence

Please note
As from January 1990 the EUI Working Paper Series is divided into six sub-series, each sub-series is numbered individually (e.g. EUI Working Paper **LAW** No. 90/1).

EUROPEAN UNIVERSITY INSTITUTE, FLORENCE

ECONOMICS DEPARTMENT

EUI Working Paper **ECO** No. 94/1

Cooperatives With Privately Optimal Price Indexed Debt Increase Membership When Demand Increases

ROBERT WALDMANN

BADIA FIESOLANA, SAN DOMENICO (FI)

Printed in Italy in January 1994
European University Institute
Badia Fiesolana
I – 50016 San Domenico (FI)
Italy

Cooperatives With Privately Optimal Price Indexed Debt Increase Membership When Demand Increases

Robert Waldmann
European University Institute

Abstract: In a simple model of a cooperative, an increase in the price offered for the cooperative's product causes a reduction in membership and production. This perverse response called the Ward effect is often proposed as an explanation of why cooperatives are rare. When the model is augmented by allowing the cooperative to issue debt instruments which pay an arbitrary continuous function of the price of their product the Ward effect is reversed, that is, the cooperative has an upward sloping supply curve. In the model presented below, this results from the privately optimal decisions of a core group which is not concerned about efficiency or employment.

This note is the continuation of joint research between Stephen Smith and myself. I would like to thank him for stimulating conversations and for teaching me about the economics of labour managed firms. The usual caveat applies. Our collaboration was supported by funds of the Research Council of the European University Institute.

I. Introduction

If cooperatives are financed with conventional debt paying a fixed interest rate and are controlled by workers whose continued membership is not in doubt, the cooperative will reduce membership and output when the price they are offered for their product increases (Ward 1958, Domar 1966, Ireland and Law 1982, Bonin and Fukuda 1986). This perverse optimal response, known as the Ward effect, is widely considered to be one of the principal reasons that cooperatives are rare. It is driven by the fact that price suprises create quasi rents and that current members of the cooperative benefit if they share speculative losses with new members and do not share speculative profits. Speculative losses and profits are privately undesirable, since risk averse members would benefit if the risk were born by investors with diversified portfolios. The interests of members and investors are better served by bonds indexed to the price of output, which enable investors to sell insurance to the cooperative. This paper notes that the use of such assets can reverse the Ward effect and cause an upward sloping supply response.

Below it is shown in some generality that cooperatives which have access to debt instruments which pay an arbitrary continuous function of the price of their product, will choose a financial strategy which makes upward sloping supply privately optimal. An earlier paper shows that this reversal of the Ward effect occurs if the class of instruments is arbitrarily restricted and if the members are sufficiently risk averse (Waldmann and Smith 1992). Other proposed solutions to the risk diversification problem have not been shown to reverse the Ward effect when voluntarily implemented by cooperatives controlled by members who care only about the members share (see e.g. McCain 1977, Thomson 1982, Guesnerie and Laffont 1984, Suvakovic-Olgin 1992). The result presented below is at least somewhat novel, since complete freedom and selfishness of members of the cooperative is assumed and a robust reversal of the Ward effect is obtained.

This paper has four sections the first of which is this introduction. The second is a fairly simple example which illustrates the claim above. The third is a more general proof. The fourth draws conclusions.

II. A Model

There is a cooperative with some small number of members. It is required to pay present and future members equal shares of value added minus interest payments. Current members decide on financial and productive decisions in order to maximise their own expected utility. The current members are certain that they will continue to be members of the cooperative. Admitting new members can create a positive externality, benefiting new members if the share they receive is greater than the going wage. This presumably makes membership decisions inefficient. In particular if the cooperative is self financed or financed with ordinary debt, an increase in the price of its product will cause it to reduce output. This is the well known Ward effect.

Assume the cooperative can issue debt instruments which pay any continuous function of the price of their product. Assume that this price is set on competitive markets and that price risk is diversifiable. The privately optimal financing and output choices give an upward sloping supply curve. The existence of such assets would reverse the Ward effect if the members of cooperatives were rational utility maximisers. This theoretical result holds for fairly general production and utility functions and price distributions. the proof is by contradiction. Given any cooperative which has chosen a financial strategy that implies downward sloping supply a strictly preferable strategy with upward sloping supply can be described. Therefore the optimal strategy must involve upward sloping supply.

A simple model illustrating the above claims follows. There are two time periods. In period zero the cooperative issues liabilities which require them to pay investors a function of the price of the product in period 1 equal to $h(p)$. The cooperative invests the proceeds in productive capital K. In period 1 the price of output p is revealed and the cooperative chooses membership L and produces and sells output $F(L,K)$ pays $h(p)$ and divides the rest among its members giving each share.

$$s = \left[F(L,K) - h(p)\right]/L \tag{1}$$

The cooperative chooses h and, after p is revealed, L in order to maximise the expected utility of its members $U(s)$. F is twice differentiable increasing in L and K and concave. $F(0,K) = 0$. U is monotonically increasing in s and as noted is a function only of s. To shorten long equations define $L(p)$ to be the optimal membership given K, price p and optimal payments to investors $h(p)$. Define $s(p)$ to be the resulting share.

If $h(p)$ is less than or equal to zero, s is maximised at $L = 0$ making nonsense of the assumption that decisions are made by members of the cooperative whose continued membership is not in doubt. Therefore it is assumed that $h(p)$ is positive for every p. Similarly it is assumed as is standard in the literature that the cooperative can always attract new members no matter how low s is. If the members of the cooperative are not very risk averse, it is possible that, for optimal plans, s will sometimes be zero. Clearly a minimum membership and minimum share should be defined. Fortunately, the proofs below show that any plan with downward sloping supply is inferior to another plan with the same distribution of membership and shares. This means that no such plan can be optimal with (or without) constraints on membership or shares.

To close the model it is necessary to decide how much investors are willing to pay in period zero for income $h(p)$ in period one. This must be equal to K. The analysis below is valid if investors are risk neutral and care only about the expected value of $h(p)$. Similarly it is valid if investors are risk averse but have consumption in period one independent of p. If so the risk in $h(p)$ is diversifiable and investors care only about the expected value of $h(p)$. Investors are assumed to care only about the expected value of $h(p)$.

I will first present a fairly simple model in which p takes a finite number n of values each with equal probability. This simplifies the proof considerably, but is absolutely not necessary for the result.

The remainder of this section is a proof by contradiction that the cooperatives optimal financial and membership decisions give an upward sloping supply curve. Assume not, that for the optimal financial scheme h that there are prices p_1 and p_2 with $p_1 < p_2$ such that membership at price p_1 is greater than or equal to membership at price p_2. In symbols

$$L_1 = L\big(h(p_1), K, p_1\big) \geq L_2 = L\big(h(p_2), K, p_2\big). \tag{2}$$

define s_1 as the share of each member when price is p_1 and s_2 as the share when price is p_2. Now consider a change in the cooperatives behavior so they have L_1 members each of whom gets share s_1 when the price is p_2 and have L_2 members each of whom gets share s_2 when the price is p_1. This clearly increases investors expected income by $(p_2-p_1)[F(L_1,K)-F(L_2,K)] \geq 0$. It clearly has no effect on members expected utility which depends only on the univariate distribution of s. It is not yet clear how this improvement can be achieved if employment decisions are made unilaterally by the cooperative.

Now consider a new financing scheme in which the cooperative pays investors $h^{\sim}(p)$ where

$$h^{\sim}(p_1) = p_1 F(L_2,K) - L_2 s_2 - (p_2-p_1)[F(L_1,K)-F(L_2,K)] \tag{3}$$

$$h^{\sim}(p_2) = p_2 F(L_1,K) - L_1 s_1$$

$$h^{\sim}(p) = h(p) \text{ otherwise}$$

$E(h(P)) = E(h^{\sim}(p))$ so investors will supply K in either case. Assume the cooperative has L_1 members at price p_2 and L_2 members at price p_1 and the same number of members as before for other prices. If so the distribution of s is the same as with the original scheme except for a $1/n$

probability that it will be increased by $(p_2-p_1)[F(L_1,K)-F(L_2,K)]/L_2$. If L_1 is strictly greater than L_2, $h^\sim$ is clearly a better financing scheme than h. For optimally chosen membership expected utility is at least as great as with the arbitrary membership assumed above and is therefore greater than that under the original scheme. For L_1 equals L_2, $h^\sim$ is an improvement unless the arbitrary membership happens to be optimal. It is not optimal as is shown below, so $h^\sim$ gives higher expected utility than h.

Consider s as a function of L given K and h and p

$$s = [pF(L,K) - h(p)]/L \tag{4}$$

this gives the derivative

$$ds/dL = [pLF_L(L,K) - pF(L,K) + h(p)]/L^2 = [pLF_L(L,K) - s]/L^2 \tag{5}$$

since L_1 was optimally chosen given p_1 and $h(p_1)$ the first order condition equation 6 holds.

$$p_1L_1F_L(L_1,K) - s_1 = 0 \tag{6}$$

This means that for $h^\sim$, at price p_2 and employment L_1, $s = s_1$ so the derivative of s with respect to L is given by equation 7.

$$ds/dL = [p_2L_1F_L(L_1,K) - s_1]/L_1^2 = (p_2-p_1)[L_1F_L(L_1,K)/L_1^2 > 0. \tag{7}$$

This means that L_1 is not the optimal employment level at price p_2 with liabilities equal $h^{\sim}(p_2)$. Therefore the expected utility of members of the cooperative is greater if they use $h^{\sim}(p)$ instead of $h(p)$, so $h(p)$ is not optimal.

This proves by contradiction that employment increases in the price of output if the cooperative uses optimal financial instruments which give liabilities as a function of p and if investors are risk neutral or can diversify the resulting risk away.[1].

III. A More General Proof

The assumption that p takes only a finite number of values each with equal probability simplifies the proof, but is not necessary at all. A proof for a more general distribution of p can be constructed using the same logic. This section presents a proof based on weaker smoothness and continuity assumptions.

First assume that p is distributed according to the cumulative distribution function G which is continuous and strictly monotonic at every possible value of p. That is assume that p has an atomless distribution with connected support. Assume that F is twice differentiable and quasi-concave with F_L and F_K positive and F_{LL} and F_{KK} strictly negative. Assume that the cooperative attempts to maximise the expected value of $U(s)$ for U strictly concave and that investors are risk neutral. Finally assume that cooperatives can issue any asset which pays $h(p)$ continuous in p. The final assumption is particularly troublesome as it confines the allowed strategies of the cooperative not tastes or technology.

All these assumptions make it possible to reproduce the simple proof of section two for neighbourhoods of single points. Again I will

[1]Note that with the strong assumptions about the distribution of p, the only assumption about F used in the proof are that it is monotonically increasing in L and once differentiable with respect to L. The only assumption about U(s) is that it is increasing in s.

derive a contradiction by assuming that with optimal liabilities $H(p)$ there is a p_1 and p_2 with $p_1 < p_2$ and $L_1 \geq L_2$. Again the basic idea will be to switch high and low membership levels and shares. First assume $L_1 > L_2$ — membership is greater at the lower price. The total derivative of the first order condition for membership implies that optimal membership is a continuous function of p and h. The assumption that h is continuous implies that membership is a continuous function of p given $h(p)$. This means that there is an e so small that employment is higher for all p in $[p_1, p_1+e]$ than in any point in $[p_2 - e, p_2]$. Let d be the lesser of $G(p_1+e) - G(p_1)$ and $G(p_2) - G(p_2 - e)$. By the assumption that the support of G is connected, d must be positive. Define e_1 as $G^{-1}(G(p_1)+d) - p_1$ and e_2 as $p_2 - G^{-1}(G(p_2)-d)$. Since G is monotonic and continuous G^{-1} exists and is monotonic and continuous. For p between p_1 and $p_1 + e_1$ define

$$y(p) = G^{-1}\{G(p_2) + G(p_1) - G(p)\} \quad (8)$$

y maps points near p_1 to points near p_2 and maps a range of prices which occurs with probability d to a region which appears with probability d. Since G and G^{-1} are continuous, y is continuous. It makes it possible to define and improved financing scheme $h^{\sim}$.

$$\text{if } p_1 < p < p_1+e_1 \quad h^{\sim}(p) = pF(L(y(p),K) - L(y(p)s(y(P)) - q \quad (9)$$

$$\text{if } p_2 - e_2 < p < p_2 \quad h^{\sim}(p) = pF(L(y^{-1}(p),K) - L(y^{-1}(p))s(y^{-1}(p)) - q$$

$$\text{otherwise} \quad h^{\sim}(p) = h(p) - q$$

for $q = \int_{p_1}^{p_1+\varepsilon_1} (y(p)-p)[F(L(p),K)-F(L(y(p)),K)]g(p)dp$

and $g(s) = G'(s)$.

As in the previous example the modified scheme gives the same expected return to investors as the original scheme and gives higher expected utility to members of the cooperative. The resulting function $h^{\sim}$ is continuous in p since $L(p)$, $s(p)$, $F(L,K)$, y and y^{-1} are continuous in p.

The change is very similar to the change described in section II. The only difference from the earlier example is that the benefits are distributed to the cooperative equally for all prices. This is done to make $h^{\sim}$ continuous. Again the improvement proves by contradiction that the optimal financing scheme makes employment L and supply non–decreasing in price.

Again it is easy to prove that supply is strictly increasing in price. Assume for optimal h there are p_1 and p_2 with $p_1 < p_2$ and $L(p_1) = L(p_2)$. Since $L(p)$ is non-decreasing membership must be constant for all p between p_1 and p_2. Define $h^{\sim}$ as above for $\delta = (G(p_2)-G(p_1))/2$. In words switch the workers shares for low and high p between p_1 and p_2. As in section 2 this has no effect on investors return or on the expected utility of members if employment is chosen as it would be for liabilities $h(p)$. Again, these employment levels are not optimal so expected utility is higher for $h^{\sim}$ and optimal employment. This proves by contradiction that with optimal liabilities that are a continuous function of price, employment and supply are strictly increasing in the price of output and the Ward effect is reversed.

IV. Conclusions and Directions for Further Research

In the model presented above a cooperative is allowed to issue debt which pays an arbitrary continuous function of the price of their product. A core of members (founders) of the cooperative is assumed to be guaranteed continued membership and to make all financing decisions in order to maximise some concave function of the share per member. Then, when the price is revealed they are assumed to choose membership in order to maximise the share given the restriction that the share must be equal for all members. This separation of control and reward might be expected to cause inefficient behavior and indeed, in simple models where only debt paying a fixed return is allowed, the cooperative reduces membership and production when the price of its product increases. This perverse response is reversed when debt which pays an arbitrary continuous function of the price is allowed. The result that a new financial instrument eliminates an inefficiency which seemed to follow directly from an unrelated institutional restriction is very striking. The conclusion that with a little financial innovation cooperatives might be able to survive in market economies is very appealing.

Some final caveats are required however. First and most importantly I assumed that the price of the cooperatives product is observable and exogenous. If the cooperative is part of an imperfectly competitive industry, it could influence the price and therefore its price indexed debt obligations. Even if the price can't be manipulated, price indices by industry are generally difficult to calculate and are calculated with delay. This limits the potential application of the proposed instrument to cooperatives in competitive industries which produce a homogenous product.

I assumed that the risk in the price paid for the cooperatives product is fully diversifiable. If investors require higher expected returns for price indexed bonds than for regular bonds, the optimal amount of hedging will be reduced. I assumed that the debt instruments must pay a continuous function of the price of output. If the cooperative can influence the price at all this is clearly necessary to prevent manipulation. Finally I considered a two period model. In practice a sluggish response of membership to demand may be caused by the firing costs implied by membership rights. Would current members of cooperatives use price indexed bonds to hedge such costs and eliminate their effect on membership decisions ? The evaluation of the effect of new financial instruments on dynamic labour demand of imperfectly competitive cooperatives is a direction for future research.

The simple model of this paper was chosen to illustrate the most extreme form of perverse behavior of cooperatives proposed in the literature. The fact that privately optimal financial innovation can eliminate such behavior is very striking.

References

Bonin, J. and Fukuda, W. (1986) "The Multi-Factor Illyrian Firm Revisited." *Journal of Comparative Economics* vol 10 pp. 171–80.

Domar, E. (1966) "The Soviet Collective Farm as a Producer Cooperative," *American Economic Review* vol 56 pp. 734–57.

Guesnerie, R. and Laffont, J. J. (1984) "Indirect Public Control of Self–Managed Monopolies," *Journal of Comparative Economics* vol 8 pp. 139–58.

Ireland, N. J. and Law, P. J. (1982) *The Economics of Labor-Managed Enterprises,* New York: St. Martin's Press.

McCain, R. (1977) "The Optimum Financial Environment for Worker Cooperatives," *Zeitschrift fur Nationalokonomie* vol 37 pp. 355–84.

Suvakovic-Olgin, D (1992) "Simulating Codetermination in a Cooperative Economy," *European University Institute Working Paper* # 92/92.

Thomson, W. (1982) "Information and Incentives in Labor–Managed Economies," *Journal of Comparative Economics* vol 6 pp. 248–68.

Waldmann, R. and Smith, S. (1992) "A Partial Solution to the Financial Risk and Perverse Response Problems of Labour Managed Firms: Industry Average Performance Bonds," *European University Institute Working Paper* # 92/64.

Ward (1958) "The Firm in Illyria: Market Syndicalism," *American Economic Review* vol 48 pp. 566–89.

EUI WORKING PAPERS

EUI Working Papers are published and distributed by the European University Institute, Florence

Copies can be obtained free of charge – depending on the availability of stocks – from:

The Publications Officer
European University Institute
Badia Fiesolana
I-50016 San Domenico di Fiesole (FI)
Italy

Please use order form overleaf

Publications of the European University Institute

To The Publications Officer
European University Institute
Badia Fiesolana
I-50016 San Domenico di Fiesole (FI) – Italy
Telefax No: +39/55/573728

From Name . . . .
Address. . . . .
. . . .
. . . .
. . . .
. . . .

p Please send me a complete list of EUI Working Papers
p Please send me a complete list of EUI book publications
p Please send me the EUI brochure Academic Year 1994/95
p Please send me the EUI Research Review

Please send me the following EUI Working Paper(s):

No, Author . . . .
Title: . . . .
No, Author . . . .
Title: . . . .
No, Author . . . .
Title: . . . .
No, Author . . . .
Title: . . . .

Date . . . .

Signature . . . .

Working Papers of the Department of Economics Published since 1993

ECO No. 93/1
Carlo GRILLENZONI
Forecasting Unstable and Non-Stationary Time Series

ECO No. 93/2
Carlo GRILLENZONI
Multilinear Models for Nonlinear Time Series

ECO No. 93/3
Ronald M. HARSTAD/Louis PHLIPS
Futures Market Contracting When You Don't Know Who the Optimists Are

ECO No. 93/4
Alan KIRMAN/Louis PHLIPS
Empirical Studies of Product Markets

ECO No. 93/5
Grayham E. MIZON
Empirical Analysis of Time Series: Illustrations with Simulated Data

ECO No. 93/6
Tilman EHRBECK
Optimally Combining Individual Forecasts From Panel Data

ECO NO. 93/7
Víctor GÓMEZ/Agustín MARAVALL
Initializing the Kalman Filter with Incompletely Specified Initial Conditions

ECO No. 93/8
Frederic PALOMINO
Informed Speculation: Small Markets Against Large Markets

ECO NO. 93/9
Stephen MARTIN
Beyond Prices Versus Quantities

ECO No. 93/10
José María LABEAGA/Angel LÓPEZ
A Flexible Demand System and VAT Simulations from Spanish Microdata

ECO No. 93/11
Maozu LU/Grayham E. MIZON
The Encompassing Principle and Specification Tests

ECO No. 93/12
Louis PHLIPS/Peter MØLLGAARD
Oil Stocks as a Squeeze Preventing Mechanism: Is Self-Regulation Possible?

ECO No. 93/13
Pieter HASEKAMP
Disinflation Policy and Credibility: The Role of Conventions

ECO No. 93/14
Louis PHLIPS
Price Leadership and Conscious Parallelism: A Survey

ECO No. 93/15
Agustín MARAVALL
Short-Term Analysis of Macroeconomic Time Series

ECO No. 93/16
Philip Hans FRANSES/Niels HALDRUP
The Effects of Additive Outliers on Tests for Unit Roots and Cointegration

ECO No. 93/17
Fabio CANOVA/Jane MARRINAN
Predicting Excess Returns in Financial Markets

ECO No. 93/18
Iñigo HERGUERA
Exchange Rate Fluctuations, Market Structure and the Pass-through Relationship

ECO No. 93/19
Agustín MARAVALL
Use and Misuse of Unobserved Components in Economic Forecasting

ECO No. 93/20
Torben HOLVAD/Jens Leth HOUGAARD
Measuring Technical Input Efficiency for Similar Production Units: A Survey of the Non-Parametric Approach

ECO No. 93/21
Stephen MARTIN/Louis PHLIPS
Product Differentiation, Market Structure and Exchange Rate Passthrough

ECO No 93/22
F. CANOVA/M. FINN/A. R. PAGAN
Evaluating a Real Business Cycle Model

ECO No 93/23
Fabio CANOVA
Statistical Inference in Calibrated Models

ECO No 93/24
Gilles TEYSSIÈRE
Matching Processes in the Labour Market in Marseilles. An Econometric Study

ECO No 93/25
Fabio CANOVA
Sources and Propagation of International Business Cycles: Common Shocks or Transmission?

ECO No. 93/26
Marco BECHT/Carlos RAMÍREZ
Financial Capitalism in Pre-World War I Germany: The Role of the Universal Banks in the Financing of German Mining Companies 1906-1912

ECO No. 93/27
Isabelle MARET
Two Parametric Models of Demand, Structure of Market Demand from Heterogeneity

ECO No. 93/28
Stephen MARTIN
Vertical Product Differentiation, Intra-industry Trade, and Infant Industry Protection

ECO No. 93/29
J. Humberto LOPEZ
Testing for Unit Roots with the k-th Autocorrelation Coefficient

ECO No. 93/30
Paola VALBONESI
Modelling Interactions Between State and Private Sector in a "Previously" Centrally Planned Economy

ECO No. 93/31
Enrique ALBEROLA ILA/J. Humberto LOPEZ/Vicente ORTS RIOS
An Application of the Kalman Filter to the Spanish Experience in a Target Zone (1989-92)

ECO No. 93/32
Fabio CANOVA/Morten O. RAVN
International Consumption Risk Sharing

ECO No. 93/33
Morten Overgaard RAVN
International Business Cycles: How much can Standard Theory Account for?

ECO No. 93/34
Agustín MARAVALL
Unobserved Components in Economic Time Series

ECO No. 93/35
Sheila MARNIE/John MICKLEWRIGHT
"Poverty in Pre-Reform Uzbekistan: What do Official Data Really Reveal?"

ECO No. 93/36
Torben HOLVAD/Jens Leth HOUGAARD
Measuring Technical Input Efficiency for Similar Production Units: 80 Danish Hospitals

ECO No. 93/37
Grayham E. MIZON
A Simple Message for Autocorrelation Correctors: DON'T

ECO No. 93/38
Barbara BOEHNLEIN
The Impact of Product Differentiation on Collusive Equilibria and Multimarket Contact

ECO No. 93/39
H. Peter MØLLGAARD
Bargaining and Efficiency in a Speculative Forward Market

***

ECO No. 94/1
Robert WALDMANN
Cooperatives With Privately Optimal Price Indexed Debt Increase Membership When Demand Increases