Empirical Examinations of the Information Sets of Economic Agents

Gottfries, Nils and Torsten Persson

Working Paper No. 90
June 1987

University of Rochester
EMPIRICAL EXAMINATIONS OF THE
INFORMATION SETS OF ECONOMIC AGENTS

by

Nils Gottfries

and

Torsten Persson

Working Paper No. 90

June 1987
EMPIRICAL EXAMINATIONS OF THE INFORMATION SETS OF ECONOMIC AGENTS

Nils Gottfries and Torsten Persson

Abstract

We show theoretically how one can derive coefficients that measure, in a natural way, the information advantage of decision-makers with rational expectations over an information set formulated by the econometrician. We discuss econometric estimation of the information advantage coefficients, and show how to use the estimates to test the hypothesis that agents have no better information than the econometrician or the hypothesis that agents have perfect information. Finally, we present results from an empirical application of the methodology, where estimates of information advantage coefficients are used to test for significant lags in portfolio revision and associated buffer stock behavior in money demand.

We are grateful for comments by an anonymous referee and by seminar participants at the Institute for International Economic Studies and at the University of Rochester.
I. Introduction

There is growing consensus that rational expectations is the most appealing assumption about how agents form their expectations. According to the rational expectations assumption agents use their available information efficiently. Theory offers little guidance as to what information agents rely on when forming their expectations, however, above vague references to the costs and benefits of gathering information. Empirical applications of rational expectations models therefore tend to rely on fairly arbitrary assumptions about agents' information sets. In some applications the econometrician postulates an information set for the economic agents whose behavior is being modeled and assumes that this is their true information set; see Pagan [1984] and references therein. But much research explicitly assumes that the agents typically have more information than the econometrician; see Mishkin [1983] and the references therein.¹

This paper suggests a simple way of testing hypotheses regarding the information sets of decision-makers with rational expectations. Specifically, we show how one can test the hypothesis that agents have no information advantage over the econometrician, as well as the hypothesis that agents have perfect information. Such tests may be of interest in themselves as a diagnostic on the informational assumption in an empirical model. The tests may also be of interest as a means of investigating other economic phenomena. In particular, if agents make decisions at intervals that are finer than the intervals at which the econometrician samples data, a test for perfect information may be equivalent to a test for whether there exist (significant) decision and information lags.
In Section II we demonstrate theoretically how to derive a coefficient that measures rational expectation agents' information advantage over the econometrician in a natural way. We show how to estimate the information advantage coefficient empirically and how to test the hypothesis that agents have no better information than the econometrician, as well as the hypothesis that agents have perfect information. Section III reports on an application of the suggested methodology. We present empirical estimates of information advantage coefficients from a Swedish money demand function which is estimated jointly with relevant forecasting equations. The estimates can be used to test for significant decision lags in the private sector's portfolio revisions. Such lags may give rise to buffer stock effects in money demand. Section IV concludes.

II. Derivation and Estimation of Information Advantage Coefficients

Consider some agents who attempt to forecast the random variable $y$. These agents have an identical information set that includes $x$ and $z$, two (row) vectors of random variables. The econometrician has a more limited information set that includes only $x$. The conventional approach, when forming a guess about agents' true expectations $x$, would be to approximate $P(y|x,z)$ with the linear projection $P(y|x)$. This is in fact the econometrician's best guess about $P(y|x,z)$ given $x$, because the law of iterated projections -- see Sargent [1979, p. 208], for example -- says $P[P(y|x,z)|x] = P(y|x)$.

However, relying on the conventional approach, the econometrician disregards information that is typically available to him, namely the ex post outcome of $y$. Exploiting this information results in an alternative and better guess about $P(y|x,z)$: $P[P(y|x,z)|x,y]$, the properties of which we
will exploit in the following. To simplify the subsequent exposition, let us adopt the shorthand notation $y^e \equiv P(y|x,z)$ for agents' true expectations, $\tilde{y}^e \equiv P(y|x)$ for the conventional guess, and $\hat{y}^e \equiv P[P(y|x,z)|x,y]$ for our alternative guess. Define the associated error terms by

\begin{align*}
(1a) \quad & \varepsilon \equiv y - y^e, \\
(1b) \quad & \tilde{\varepsilon} \equiv y^e - \tilde{y}^e, \\
(1c) \quad & \hat{\varepsilon} \equiv y^e - \hat{y}^e,
\end{align*}

where $E(y^e\varepsilon) = E(\tilde{y}^e\tilde{\varepsilon}) = E(\hat{y}^e\hat{\varepsilon}) = 0$ by the orthogonality properties of linear projections. We can think of $\varepsilon$ and $\hat{\varepsilon}$ as "measurement errors" for two different measures, $y^e$ and $\hat{y}^e$, of agents' true expectations. Agents' true forecast error $\varepsilon$, would also be a measurement error if we measured their expectations by $y$. The properties of our proposed guess about agents' expectations can then be summarized in the following proposition:

**Proposition**  The linear projection of $y^e$ on $x$ and $y$ satisfies

\begin{align*}
(P1) \quad & \hat{y}^e = (1-m)\tilde{y}^e + my,
\end{align*}

where the weight $m$ is given by

\begin{align*}
(P2) \quad & m = \frac{\text{Var} \tilde{\varepsilon}}{\text{Var} \varepsilon + \text{Var} \hat{\varepsilon}}.
\end{align*}

We first prove (P1). Project $y^e$ recursively on $x$ and $z$ -- see Sargent [1979, pp. 206-208] -- to get

\begin{align*}
(2) \quad & \hat{y}^e = P(y^e|x) + P[y^e - P(y^e|x)|y - P(y|x)].
\end{align*}

Because of the law of iterated projections $P(y^e|x) = P(y|x) = \tilde{y}^e$. But then we may rewrite (2) as

\begin{align*}
(3) \quad & \hat{y}^e = \tilde{y}^e + P(y^e - \tilde{y}^e|y - \tilde{y}^e) = \tilde{y}^e + m(y - \tilde{y}^e),
\end{align*}

which is the desired result. To verify (P2), we need to determine the unknown projection coefficient in (3). From (1) it follows that
\[ P(y^e - \tilde{y}^e | y - \tilde{y}^e) = P(\tilde{e} | \epsilon + \tilde{\epsilon}), \text{ so that } m = \frac{\text{Cov}(\tilde{e}, \epsilon + \tilde{\epsilon})}{\text{Var}(\epsilon + \tilde{\epsilon})}, \text{ but since } E(\tilde{e}\tilde{\epsilon}) = 0 , \] (P2) follows.

The formula (P2) bears out the close analogy between our approach and the standard signal-extraction problem. We have two noisy "signals", \( y \) and \( \tilde{y}^e \), from which we are trying to forecast \( y^e \) optimally by forming a weighted average of the two signals. In that sense, our approach combines the conventional approach with the approach -- suggested by McCallum [1976], for example -- of using the realization of a variable as a measure of the rational expectation of that variable. ²

The \( m \)-coefficient measures the agents' information advantage over the econometrician in a natural way. To see this clearer, use (1) to rewrite (P2) as

\[ (4) \quad m = \frac{\text{Var}(y^e - \tilde{y}^e)}{\text{Var}(y - \tilde{y}^e)}. \]

Thus, \( m \) measures the fraction of the variation in \( y \) which is unpredictable to the econometrician but predictable to the agents. Notice that the value of \( m \) rises from zero when \( \text{Var} \tilde{\epsilon} = 0 \) -- that is, when knowing \( z \) does not improve the forecast of \( y \) given \( x \) -- to unity when \( \text{Var} \epsilon = 0 \) -- that is, when knowing \( z \) allows agents to forecast \( y \) perfectly.

Let us next discuss estimation. When \( y^e \) is unobservable, we cannot estimate the \( m \)-coefficients directly. Suppose, however, that we have a behavioral relation in the form of a simple decision rule:

\[ (5) \quad \nu = \beta y^e + \eta, \]

where \( \eta \) is a shock to tastes or technology. We assume that \( \eta \) is white noise and that \( \text{Cov}(\epsilon, \eta) = 0 \). Next, we substitute \( \hat{y}^e + \hat{\epsilon} = (1 - m)\tilde{y}^e + m\epsilon + \tilde{\epsilon} \) for \( y^e \) in (5), and express \( \tilde{y}^e \) as \( \tilde{y}^e = x\tilde{\alpha} \), where \( \tilde{\alpha} \) is a (column) vector of projection coefficients. This yields the system
(6a) \[ v = \beta (1 - m) x \tilde{a} + \beta y + (\beta \hat{e} + \eta). \]

(6b) \[ y = x \tilde{a} + (\hat{\varepsilon} + \varepsilon). \]

This system can be estimated by, for example, non-linear multivariate least squares, with the restriction imposed that the \( \tilde{a} \)-coefficients be equal across the equations. Since \( y^e \) is an imperfect measure of the true value of \( y^e \), one might suspect to get biased estimates due to an errors-in-variables problem. This is not the case, however, because the measurement error, \( \hat{\varepsilon} \), is uncorrelated with the measure, \( (1 - m)y^e + my \), by construction. In fact, \( \hat{\varepsilon} \) is orthogonal to the whole vector \( (x, y) \). Also, the error term in (6b) is correlated with \( y \), which enters as an explanatory variable in (6a). But since \( E[\hat{\varepsilon}(y - x \tilde{a})] = 0 \) by construction, the error terms in the two equations are uncorrelated. Therefore, estimation of (6) by multivariate least squares will produce consistent estimates of \( m, \beta \), and \( \tilde{a} \).

While our information advantage coefficient can be estimated easily if the underlying model is (5), other models may be less favorable for identifying information advantage coefficients. Suppose that we have a "surprise model" like

(7) \[ u = \gamma (y - y^e) + \mu; \]

a formulation common in the efficient markets literature as well as in the neutrality literature. Substitute \( y^e = \hat{y} + \hat{\varepsilon} \) into (7) to get

(8) \[ u = \gamma (1 - m)(y - \hat{y}^e) + (\mu + \gamma \hat{\varepsilon}). \]

Here, \( m \) cannot be identified unless we are willing to make an a priori assumption about \( \gamma \). Observe, however, that the converse is also true. Therefore the estimates of behavioral coefficients in conventionally estimated surprise models will be downward biased unless \( m = 0 \); that is, unless agents have no better information than the econometrician.
Let us finally mention a couple of generalizations of the methodology. First, suppose that agents try to forecast not a scalar but a vector \( y = (y_i) \) of random variables. It is easy to extend our Proposition to this case by deriving a corresponding vector of information advantage coefficients, \( m = (m_i) \). But for consistent estimation of these coefficients, we have to assume that the measurement error for each expected variable, \( \hat{\varepsilon}_i = y_i^e - \hat{y}_i^e \), is uncorrelated with the realizations of the other expected variables, \( y_j \) for all \( j \neq i \). Second, we have only covered the case when the variable forecasted by agents is strictly exogenous in the behavioral equation. We believe that one may be able to estimate information coefficients even when the model is simultaneous, although the interpretation of these coefficients would be slightly different. The information coefficients would then measure how good information agents have relative to a set of instruments specified by the econometrician. Such a measure of information availability may be of interest in a time-series context, when one may choose some of the instruments to be contemporaneous with the variable that agents attempted to forecast and thus unknown to agents at the time they make their forecast.³

III. An Application

In this section we report on an empirical application of our methodology, which shows how one can estimate information advantage coefficients in order to test whether there exist significant lags between agents decisions. Specifically, we try to identify significant lags in the portfolio revisions by private agents in Sweden that give rise to buffer stock effects in money demand. Our estimates are based on quarterly data from 1970 to 1982.⁴
To motivate the specification to follow, assume that time can be measured in elementary time periods of fixed length \( \theta \), where \( \theta \) measures the interval between the representative agent's decisions as well as the interval between the arrival of new information in his information set. Assume also that there are \( n \) elementary time periods in a quarter, where \( n \) is an integer. In each elementary time period agents decide how to split their financial wealth between planned holdings of money, \( M^p \), and holdings of other assets, \( K \). \( M \) includes currency and ordinary (demand and time) bank deposits, while \( K \) is an aggregate of other financial assets. Agents' financial portfolio is given by their net financial assets, \( W \), plus their bank loans, \( L \): we assume that agents are rationed in the loan market.

We assume that agents' plan at \( t-\theta \) for money holdings at \( t \) is

\[
\Delta M^p_t = \beta_0 + \beta_r (\Delta r^e_{mt} - \Delta r^e_{st}) Y_{t-1} + \beta_w \Delta W^e_t + \beta_L \Delta L^e_t + \beta_Y \Delta Y^e_t + \eta_t,
\]

where \( r^e_{mt} \) is the own interest rate on money, \( r^e_{st} \) is the interest rate on "special deposits" (taken to measure the opportunity cost of holding money), \( Y \) is national income, \( f^e_t \) denotes expectations at \( t-\theta \) about \( f \) at \( t \), and \( \eta \) is a white noise error term. Equation (9) is thus a conventional demand function for broad money on first difference form.

At \( t-\theta \) agents also choose their holdings of other assets at \( t \), \( K_t \) to satisfy the (expected) wealth constraint

\[
\Delta K_t = \Delta W^e_t + \Delta L^e_t - \Delta M^p_t.
\]

Any unexpected changes in \( W \) or \( L \) during the decision interval \( (t-\theta, t) \) are temporarily held in the form of money. Thus, actual money holdings, \( M \), at \( t \) satisfy

\[
\Delta M_t = \Delta M^p_t + (\Delta W_t - \Delta W^e_t) + (\Delta L_t - \Delta L^e_t),
\]

where the two last terms bring out the "buffer stock" role of money.
For each expected variable $f^e_t$ in (9), we formulated conventional forecasts $\hat{f}^e_t$ by projecting $f_t$ on variables in an information set containing variables dated $t-1$ and earlier. Following the approach in Section II, we then formed guesses about agents true expectations at $t-\theta$, $f^e_{t-\theta}$, as $\hat{f}^e_t = (1 - m_f)\hat{f}^e_t + m_ff_t$. Notice that a rejection of perfect information in this model — that is, a rejection of $m_f = 1$ — can be interpreted as evidence of significant lags in portfolio revision. With $m_f$ below unity, it is impossible that agents knew $f_t$ when deciding on $M^p_t$, as they would if the decision interval $\theta$ was arbitrarily short.

To obtain the final form of the money demand function, we inserted our guesses $\hat{f}^e_t + \hat{e}_{ft}$ for $f^e_t$ in (9), substituted the resulting expression into (10) and added seasonal dummies. This money demand function and the forecasting equations were estimated jointly with nonlinear multivariate least squares (using the TSP-package, Version 4.0). Table I reports the estimated information advantage coefficients — $m_{rm}$, $m_{rs}$, $m_w$ and $m_\gamma$ — and the parameters in the money demand function. All the $m$-coefficients except $m_{rm}$ are estimated fairly precisely. Furthermore, all the $m$-coefficients except $m_\gamma$ are significantly below unity. This strongly suggests that there is indeed significant decision and information lags in the private sector's portfolio revisions and buffer stock effects in money demand.

IV. Concluding remarks

We have shown how an econometrician can derive and estimate information advantage coefficients. These coefficients measure in a natural way how large an information advantage agents with rational expectations
have over the information set that the econometrician has specified. Our methodology can thus be used to diagnose how bad the specified information set is.

In Section III we gave an example of an application of our methodology, which went beyond a test of the information set per se. The major advantage of agents was that they sampled some variables more frequently than the econometrician. In that context, we showed that a test for perfect information could be interpreted as a test for significant lags in portfolio revision. One could easily think of other similar applications; for instance, tests for significant lags between price setting decisions by firms in particular industries. There may also be applications where one would want to test whether agents have access to information that is not known to the econometrician, quite apart from any advantage arising from more frequent sampling of information.

Finally, we would like to stress that our methodology yields an informed guess (\(\hat{y}^e\) above) about agents' true expectations (\(y^e\) above), where the resulting forecast error by definition has lower variance than the forecast error generated by the conventional guess (\(\tilde{y}^e\) above). If one is simply interested in generating an accurate guess about the representative agent's true expectations, our methodology would thus be preferable to the conventional approach.

Institute for International Economic Studies
References


Footnotes

1. Hansen and Sargent [1980] indeed take this information advantage to be one possible motivation for the presence of an error term in empirical rational expectations models; the other motivation they give is unobservable shocks to tastes or technology. Their work, as well as subsequent work by Hansen and Singleton [1982] among others, discusses econometric issues in the estimation of structural parameters in such models.

2. Wickens [1982] labels the conventional approach the "substitution method" and the approach where realizations are used to measure expectations the "errors-in-variables method". His paper compares the statistical properties of the two methods when estimating structural coefficients in a general context.

3. Suppose, to fix ideas, that \( y \) and \( \eta \) were correlated in the model given by (5) and that we still wanted to derive an information coefficient and estimate it. Let us choose the vector \( x \) to include only exogenous and predetermined variables. Further, suppose that we have another vector of exogenous variables, \( q \), that may or may not be known to agents. In a time series context \( x \) may include only predetermined variables, and \( q \) may include contemporaneous exogenous variables. Thus the full set of instruments we want to use is \( (x,q) \). Define \( \bar{y}^e = P(y^e|x,q) \). It is easy to show that \( P(y^e|x,\bar{y}^e) = (1 - m)P(y|x) + my^e = (1 - m)\bar{y}^e + my - m\bar{e} \), where \( \bar{e} = y - \bar{y}^e \). Here, \( m \) equals zero if agents have no better information than \( x \), and \( m \) equals unity if agents' information is equivalent to knowing \( (x,q) \). The error term \( \bar{e} \) is orthogonal to \( (x,q) \) by construction. But the "measurement error" \( P(y^e|x,\bar{y}^e) - y^e \) which corresponds to \( \hat{e} \) above, is not orthogonal to \( q \) in general. However, it is orthogonal to \( (x,\bar{y}^e) \) and since \( \bar{y}^e \) will be the
instrument for y in 3SLS, say, it seems that the measurement error should not lead to bias in the estimation.

4. The data is described in Gottfries, Palmer and Persson [1986].

5. A more sophisticated model would distinguish between decision and information lags and allow for staggered decision-making across agents.

6. During the estimation period the Swedish credit market was heavily regulated. The interest rate on deposits and many other interest rates were regulated, as well as the quantity of loans. These regulations make the assumption that the error term in (9) is uncorrelated with the explanatory variables less objectionable than in a market clearing model.

7. The model is formulated on first-difference form for data reasons. We believe that the data for changes in the financial portfolio is more reliable than the data for levels.

8. The money demand function is specified in nominal terms. We divided both sides of the equation by the CPI, however, since the variance of the error term is likely to increase with the price level.

9. The variables in the information set at t were specified to be: $r_{m,t-1}'$, $r_{s,t-1}'$, $\Delta W_{t-1}'$, $\Delta W_{t-4}'$, $L_{t-1}'$, $L_{t-4}'$, $Y_{t-1}'$, $Y_{t-4}'$, constant, and seasonal dummies.

10. The fact that $\beta_L$ is close to unity caused problems in the estimation of $m_L$ ($m_L$ is not identified if $\beta_L$ is unity). We therefore arbitrarily set $m_L$ to unity.

11. The estimates of the forecasting equations are not reported, but available on request from the authors. We had too few degrees of freedom to test the cross-equation restrictions.

13. In this respect our approach is related to the work, such as that by Hamilton [1985], that tries to uncover expectations from market behavior by help of Kalman Filtering techniques. There is a formal similarity in that our work relies on recursive projection, which is what underlies Kalman Filtering.
TABLE I


<table>
<thead>
<tr>
<th>$m_{rm}$</th>
<th>$m_{rs}$</th>
<th>$m_w$</th>
<th>$m_Y$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.135</td>
<td>0.302</td>
<td>0.751</td>
<td>0.917</td>
</tr>
<tr>
<td>(0.316)</td>
<td>(0.180)</td>
<td>(0.126)</td>
<td>(0.365)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$\beta_r$</th>
<th>$\beta_w$</th>
<th>$\beta_L$</th>
<th>$\beta_Y$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.045</td>
<td>0.369</td>
<td>0.742</td>
<td>0.377</td>
</tr>
<tr>
<td>(0.010)</td>
<td>(0.102)</td>
<td>(0.131)</td>
<td>(0.136)</td>
</tr>
</tbody>
</table>

Standard errors in brackets. Durbin-Watson: 2.44
Rochester Center for Economic Research
University of Rochester
Department of Economics
Rochester, NY 14627

1986-87 DISCUSSION PAPERS

WP#33 OIL PRICE SHOCKS AND THE DISPERSION HYPOTHESIS, 1900 - 1980
by Prakash Loungani, January 1986

WP#34 RISK SHARING, INDIVISIBLE LABOR AND AGGREGATE FLUCTUATIONS
by Richard Rogerson, (Revised) February 1986

WP#35 PRICE CONTRACTS, OUTPUT, AND MONETARY DISTURBANCES
by Alan C. Stockman, October 1985

WP#36 FISCAL POLICIES AND INTERNATIONAL FINANCIAL MARKETS
by Alan C. Stockman, March 1986

WP#37 LARGE-SCALE TAX REFORM: THE EXAMPLE OF EMPLOYER-PAID HEALTH
INSURANCE PREMIUMS
by Charles E. Phelps, March 1986

WP#38 INVESTMENT, CAPACITY UTILIZATION AND THE REAL BUSINESS CYCLE
by Jeremy Greenwood and Zvi Hercowitz, April 1986

WP#39 THE ECONOMICS OF SCHOOLING: PRODUCTION AND EFFICIENCY IN PUBLIC
SCHOOLS
by Eric A. Hanushek, April 1986

WP#40 EMPLOYMENT RELATIONS IN DUAL LABOR MARKETS (IT'S NICE WORK IF YOU
CAN GET IT!)
by Walter Y. Oi, April 1986

WP#41 SECTORAL DISTURBANCES, GOVERNMENT POLICIES, AND INDUSTRIAL OUTPUT IN
SEVEN EUROPEAN COUNTRIES
by Alan C. Stockman, April 1986

WP#42 SMOOTH VALUATIONS FUNCTIONS AND DETERMINANCY WITH INFINITELY LIVED
CONSUMERS
by Timothy J. Kehoe, David K. Levine and Paul R. Romer, April 1986

WP#43 AN OPERATIONAL THEORY OF MONOPOLY UNION-COMPETITIVE FIRM INTERACTION
by Glenn M. MacDonald and Chris Robinson, June 1986

WP#44 JOB MOBILITY AND THE INFORMATION CONTENT OF EQUILIBRIUM WAGES:
PART 1, by Glenn M. MacDonald, June 1986

WP#45 SKI-LIFT PRICING, WITH APPLICATIONS TO LABOR AND OTHER MARKETS
by Robert J. Barro and Paul M. Romer, May 1986, revised April 1987
WP#46 FORMULA BUDGETING: THE ECONOMICS AND ANALYTICS OF FISCAL POLICY UNDER RULES, by Eric A. Hanushek, June 1986

WP#48 EXCHANGE RATE POLICY, WAGE FORMATION, AND CREDIBILITY by Henrik Horn and Torsten Persson, June 1986

WP#49 MONEY AND BUSINESS CYCLES: COMMENTS ON BERNAKE AND RELATED LITERATURE, by Robert G. King, July 1986

WP#50 NOMINAL SURPRISES, REAL FACTORS AND PROPAGATION MECHANISMS by Robert G. King and Charles I. Plosser, Final Draft: July 1986

WP#51 JOB MOBILITY IN MARKET EQUILIBRIUM by Glenn M. MacDonald, August 1986

WP#52 SECRECY, SPECULATION AND POLICY by Robert G. King, (revised) August 1986

WP#53 THE TULIPMANIA LEGEND by Peter M. Garber, July 1986

WP#54 THE WELFARE THEOREMS AND ECONOMIES WITH LAND AND A FINITE NUMBER OF TRADERS, by Marcus Berliant and Karl Dunz, July 1986

WP#55 NONLABOR SUPPLY RESPONSES TO THE INCOME MAINTENANCE EXPERIMENTS by Eric A. Hanushek, August 1986

WP#56 INDIVISIBLE LABOR, EXPERIENCE AND INTERTEMPORAL ALLOCATIONS by Vittorio U. Grilli and Richard Rogerson, September 1986

WP#57 TIME CONSISTENCY OF FISCAL AND MONETARY POLICY by Mats Persson, Torsten Persson and Lars E. O. Svensson, September 1986

WP#58 ON THE NATURE OF UNEMPLOYMENT IN ECONOMIES WITH EFFICIENT RISK SHARING, by Richard Rogerson and Randall Wright, September 1986

WP#59 INFORMATION PRODUCTION, EVALUATION RISK, AND OPTIMAL CONTRACTS by Monica Hargraves and Paul M. Romer, September 1986

WP#60 RECURSIVE UTILITY AND THE RAMSEY PROBLEM by John H. Boyd III, October 1986

WP#61 WHO LEAVES WHOM IN DURABLE TRADING MATCHES by Kenneth J. McLaughlin, October 1986

WP#62 SYMMETRIES, EQUILIBRIA AND THE VALUE FUNCTION by John H. Boyd III, December 1986

WP#63 A NOTE ON INCOME TAXATION AND THE CORE by Marcus Berliant, December 1986
WP#64 INCREASING RETURNS, SPECIALIZATION, AND EXTERNAL ECONOMIES: GROWTH AS DESCRIBED BY ALLYN YOUNG, by Paul M. Romer, December 1986

WP#65 THE QUIT-LAYOFF DISTINCTION: EMPIRICAL REGULARITIES by Kenneth J. McLaughlin, December 1986

WP#66 FURTHER EVIDENCE ON THE RELATION BETWEEN FISCAL POLICY AND THE TERM STRUCTURE, by Charles I. Plosser, December 1986

WP#67 INVENTORIES AND THE VOLATILITY OF PRODUCTION by James A. Kahn, December 1986

WP#68 RECURSIVE UTILITY AND OPTIMAL CAPITAL ACCUMULATION, I: EXISTENCE, by Robert A. Becker, John H. Boyd III, and Bom Yong Sung, January 1987

WP#69 MONEY AND MARKET INCOMPLETENESS IN OVERLAPPING-GENERATIONS MODELS, by Marianne Baxter, January 1987

WP#70 GROWTH BASED ON INCREASING RETURNS DUE TO SPECIALIZATION by Paul M. Romer, January 1987

WP#71 WHY A STUBBORN CONSERVATIVE WOULD RUN A DEFICIT: POLICY WITH TIME-INCONSISTENT PREFERENCES by Torsten Persson and Lars E.O. Svensson, January 1987

WP#72 ON THE CONTINUUM APPROACH OF SPATIAL AND SOME LOCAL PUBLIC GOODS OR PRODUCT DIFFERENTIATION MODELS by Marcus Berliant and Thijs ten Raa, January 1987

WP#73 THE QUIT-LAYOFF DISTINCTION: GROWTH EFFECTS by Kenneth J. McLaughlin, February 1987

WP#74 SOCIAL SECURITY, LIQUIDITY, AND EARLY RETIREMENT by James A. Kahn, March 1987

WP#75 THE PRODUCT CYCLE HYPOTHESIS AND THE HECKSCHER-OHLIN-SAMUELSON THEORY OF INTERNATIONAL TRADE by Sugata Marjit, April 1987

WP#76 NOTIONS OF EQUAL OPPORTUNITIES by William Thomson, April 1987

WP#77 BARGAINING PROBLEMS WITH UNCERTAIN DISAGREEMENT POINTS by Youngsub Chun and William Thomson, April 1987

WP#78 THE ECONOMICS OF RISING STARS by Glenn M. MacDonald, April 1987

WP#79 STOCHASTIC TRENDS AND ECONOMIC FLUCTUATIONS by Robert King, Charles Plosser, James Stock, and Mark Watson, April 1987
WP#80  INTEREST RATE SMOOTHING AND PRICE LEVEL TREND-STATIONARITY
       by Marvin Goodfriend, April 1987

WP#81  THE EQUILIBRIUM APPROACH TO EXCHANGE RATES
       by Alan C. Stockman, revised, April 1987

WP#82  INTEREST-RATE SMOOTHING
       by Robert J. Barro, May 1987

WP#83  CYCLICAL PRICING OF DURABLE LUXURIES
       by Mark Bils, May 1987

WP#84  EQUILIBRIUM IN COOPERATIVE GAMES OF POLICY FORMULATION
       by Thomas F. Cooley and Bruce D. Smith, May 1987

WP#85  RENT SHARING AND TURNOVER IN A MODEL WITH EFFICIENCY UNITS OF HUMAN
       CAPITAL
       by Kenneth J. McLaughlin, revised, May 1987

WP#86  THE CYCLICALITY OF LABOR TURNOVER: A JOINT WEALTH MAXIMIZING
       HYPOTHESIS
       by Kenneth J. McLaughlin, revised, May 1987

WP#87  CAN EVERYONE BENEFIT FROM GROWTH? THREE DIFFICULTIES
       by Herve' Moulin and William Thomson, May 1987

WP#88  TRADE IN RISKY ASSETS
       by Lars E.O. Svensson, May 1987

WP#89  RATIONAL EXPECTATIONS MODELS WITH CENSORED VARIABLES
       by Marianne Baxter, June 1987

WP#90  EMPIRICAL EXAMINATIONS OF THE INFORMATION SETS OF ECONOMIC AGENTS
       by Nils Gottfries and Torsten Persson, June 1987
To order copies of the above papers complete the attached invoice and return to Christine Massaro, W. Allen Wallis Institute of Political Economy, RCER, 109B Harkness Hall, University of Rochester, Rochester, NY 14627. **Three (3) papers per year** will be provided free of charge as requested below. Each additional paper will require a $5.00 service fee which must be enclosed with your order. For your convenience an invoice is provided below in order that you may request payment from your institution as necessary. Please make your check payable to the **Rochester Center for Economic Research**. **Checks must be drawn from a U.S. bank and in U.S. dollars.**

---

**W. Allen Wallis Institute for Political Economy**

**Rochester Center for Economic Research, Working Paper Series**

---

**OFFICIAL INVOICE**

Requestor's Name

Requestor's Address

Please send me the following papers free of charge (**Limit: 3 free per year**).

<table>
<thead>
<tr>
<th>WP#</th>
<th>WP#</th>
<th>WP#</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I understand there is a $5.00 fee for each additional paper. Enclosed is my check or money order in the amount of $__________. Please send me the following papers.

<table>
<thead>
<tr>
<th>WP#</th>
<th>WP#</th>
<th>WP#</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WP#</th>
<th>WP#</th>
<th>WP#</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WP#</th>
<th>WP#</th>
<th>WP#</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WP#</th>
<th>WP#</th>
<th>WP#</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>