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MONEY AND PRICES IN A SMALL ECONOMY

by

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1. Introduction

With recent economic policy experiments, particularly in the area of monetary policy, academic interest in the quantity theory of money has surged. Work by Berman (1978), Bomhoff (1980), Lucas (1980), Fama (1981), Friedman and Schwartz (1982), Desai and Blake (1982), and Cassese and Lothian (1982) attest to this fact.[1] With the recent publication of Weiss' (1983) criticism of Jonung's (1976) well-known results, related controversy has been stirred on a Scandinavian scale.

This paper applies a simple rational expectations version of the quantity theory, similar to that employed by Fama (1981), to recent monthly and quarterly Finnish data on prices, money and related variables. The object is to demonstrate the power of the central prediction of the theory, that, all other things equal, a given change in the rate of growth in the quantity of money induces a change in the inflation rate of roughly the same magnitude.

It is not our goal to attempt detailed modeling of domestic financial institutions and their implications, if any, for the conduct of monetary policy. We suggest that the quantity theory is powerful enough to yield fairly accurate predictions even when qualifications which in a general theoretical framework may appear important, are disregarded. In doing this, we adopt Lucas' (1980) view that the quantity theory might best be interpreted as a set of (necessary) characteristics of the long-run average behavior of a general equilibrium system. In a sense, this is just a repetition of the old maxim that theories should not be judged by the realism of their assumptions but on the accuracy of their predictions. What we can hope to achieve is, therefore, not a final solution to some perceived controversy, but only a better understanding of to what extent the recent inflationary experiences of one small economy can be understood in terms of purely classical monetary forces.

Our approach will not involve estimation of a market demand function for money and tests of its stabiltiy. Instead, we will postulate that the equilibrium condition for money to be willingly held, contains a strong predictive statement about the effects of an increased nominal money stock on prices. In more specific terms, and following Fama (1981), we will take money, real activity and (regulated) interest rates to be exogenous with respect to prices. We will furthermore, in line with results obtained by Arango and Nadiri (1981), assume that the central bank, through its exchange rate policy, is largely independent of international monetary developments in deciding on its monetary policy.

Indeed, one of the reasons for selecting 1969-1982 (notice that lags of up to two years will be used) as our period of analysis is that the exchange rate regime has not been one of perfectly fixed rates. At a later stage of the analysis we will, however, demonstrate that the fundamental relationship between money and prices uncovered, is neither due to reversed causation induced by fixed exchange rates, nor particularly sensitive to model reformulation whereby exchange rate expectations and import price changes are permitted to enter the inflation equation. The major conclusions are the following.

(1) The quantity theory of money is not a short run relationship. We find that the growth of the money stock up to two years in advance is a highly significant determinant of price inflation. No evidence of reversed causation is detected. Tests of structural stability do not permit rejection of the hypothesis that the model structure has remained unchanged.

(2) Currency plus demand deposits appears to be the best empirical measure of money. Because of nearly perfect substitutability between currency

and checkable deposits, currency alone does not perform well in the price equation. There is no apparent need to include time deposits in the money measure.

(3) The negative relationship between inflation and real activity which, in sharp contrast to Phillips-curve models, has been observed in several OECD-countries over the last ten years, is also a striking feature of our results. When central bank money supply behavior is controlled for, the increased demand for real balances caused by an activity increase reduces price inflation.

(4) The average lending rate of the commercial banks appears to be the best measure of the opportunity cost of idle balances. We cannot reject the hypothesis that the marginal cost of central bank debt or the most recently quoted bond rate are insignificant in the inflation equation.

(5) Finally, we find surprisingly weak evidence of international transmission of inflation over fixed exchange rates. A hypothesis that past import price or present foreign exchange reserve changes influence the inflation rate is mostly rejected. Taken together with our results concerning the direction of causation between money and prices this suggests that the Finnish exchange rate has been sufficiently flexible to allow a domestic monetary policy.

2. Theoretical Considerations

Views on how to interpret the basic quantity theory propositions arising from the early work of Irving Fisher are presently widely dispersed. The most literal monetarist interpretation is probably Milton Friedman's emphasizing the stability of the long run market demand function for money (Friedman-Schwartz (1982)). Recently, work by Lucas (1980) and others has highlighted the fact that the essential prediction of the quantity theory, i.e., the one-to-one relationship between the growth rates of money and nominal income, does not follow only from a Fisherian money demand model, but is also a property of most general equilibrium models. In Lucas' example, the money-price relationship appears as a necessary condition for a stationary solution to Sidrauski's (1967) equilibrium one-sector growth model. Moreover, since in these models, the quantity theory proposition is independent of the real structure as represented by technology and preferences, it is likely to be applicable to a wide range of structures of economic institutions.

The quantity equation is, by itself, an identity and hence, in the absence of additional assumptions, offers few clues as to the direction of any causation imbedded therein. It is the assumption that velocity is some stable function or, primitively, an institutionally determined constant that, together with the exogeneity of the policy variable money, converts the quantity equation into the quantity theory. In the present analysis, a "market demand" function for money is not referred to with the traditional direction of causation in mind. In line with empirical work by Sims (1972) and others, we suggest that treating GNP or its components as exogenous with respect to money will ultimately lead to erroneous conclusions being drawn. Instead, we propose to follow Fama (1981) in adopting a simple rational expectations version of the quantity theory. The essence of such a model is that money demand is forward looking with respect to real activity. Real activity, in turn, is determined outside of the monetary sector.[2] Money is the policy variable and hence exogenous with respect to prices. In some instances we will, as an initial assumption, furthermore assume that (regulated) interest rates are exogenous with respect to changes in the price level.

Let the equilibrium condition for the money market, that all money is willingly held, be $M/P = f(T,r,...)$ where M denotes the appropriate money measure, P the price level, T the level of real activity, and r is one plus the nominal interest rate. More specifically, in differenced form we write

$$(1) \qquad \hat{M}_i - \hat{P}_i = \alpha_0 + \alpha_1\hat{T}_i + \alpha_2\hat{r}_i + \mu_i$$

where ^ denotes a logarithmic first difference and μ is an error term. Given the assumptions regarding the direction of causation made above, (1) is appropriately interpreted as a model of inflation:

$$(2) \qquad \hat{P}_i = -\alpha_0 - \alpha_1\hat{T}_i - \alpha_2\hat{r}_i + \alpha_3\hat{M}_i - \mu_i$$

where $\alpha_3 = 1$.

The first institutional amendment to this setup concerns the interest rate. Finnish financial markets have been subject to several forms of regulation during the period under study. The most important regulatory schemes are the central bank's regulation of the average lending rates of individual banks, the consequent cartelization of bank borrowing from the public, and the government's regulation of the bond issue market. These measures prevent the financial markets from clearing at a uniform, disclosed interest rate. Instead, credit has been rationed and disequilibria in the bond issue market have been eliminated by central or commercial bank intervention.[3] As a first approximation, the interest rate r will therefore be assumed constant.

It is widely acknowledged that clearing of the money market, such as implied by (2), is not instantaneous. The quantity-theoretic law on which (2) is based is a property of the steady state solution of a rather simple theoretical model. Contracts, explicit and implict, imperfect information, and adjustment costs (Sheshinski-Weiss (1977)) may all explain why economists typically regard the quantity theory as a statement concerning long run equilibria. Ideally, the proposition that money and nominal income exhibit a one-to-one relationship should therefore be tested in a cross section of long-run averages.[4] The drawback with such a testing strategy is that one needs to assume that all other potentially important factors are the same across the units of observation. In a time-series analysis the corresponding requirements are (i) that variables be permitted to induce reactions with some lag, and (ii) that the structure of the hypothesized relationship remain unchanged over time.

In the present analysis we will permit lags of up to two years between money and prices. Since the data used is typically autocorrelated at lags of several quarters, testing of hypotheses pertaining to slope coefficients requires us to impose some restrictions on the lag distribution. In what follows, the true distribution will be proxied by unweighted sums of monthly or quarterly changes. The structure of this inflation model is subjected to Chow tests of stability.

Several measurement issues require attention. There is a long debate as to what is the appropriate measure of real activity in (2). Both the proponents of a measure of real monetary transactions and the proponents of a wealth measure have, by the difficulties encountered in explicit measurements of transactions and/or wealth, been led to use an income meausure such as real GNP as the activity variable in (2). Since Finnish GNP data are available only on the quarterly level, this study will use (seasonally unadjusted) industrial production as the activity measure. Previous analyses of money-inflation relationships (Wahlroos-Berglund (1984)) have indicated that industrial production is a good income proxy.

At the level discussed above, the quantity theory gives no guidance as to the measurement of the money stock. Among the monetary aggregates available we chose to limit ourselves to the traditional M_1, currency plus demand deposits, and M_2, M_1 plus time deposits. Some tests were, however, performed for a "monetary base" measure, currency in circulation. For reasons discussed in greater detail below, these regressions were inferior to the ones reported for M_1 or M_2.

3. Data

This study is based on monthly changes, defined as logarithmic first differences of the variables listed in table 1. The period of observation is January 1969 through December 1982, a period in which the Finnish financial as well as foreign exchange markets have undergone significant changes, mostly due to relaxed regulation.

INSERT TABLE 1 HERE

Summary statistics (autocorrelations, means and standard deviations) for the monthly data are reported in Panel A of table 2. Price and output data typically exhibit stronger low-order serial correlation than does the money data. All series, with the exception of interest rate changes have ρ_{12}s that are more than two standard errors greater than zero. This is a clear indication of seasonality. In the money-series, otherwise free of strong serial correlation, ρ_{12} reflects pronounced December increases and January rebounds. In the activity series, the high ρ_{12} is due mainly to the fall in output occuring in July and the subsequent August increases.

INSERT TABLE 2 HERE

To reduce the impact of this seasonality on our estimates without information losses typically encountered in prefiltering, we constructed our quarterly data in such a way that the rebounds would occur within the same quarter as the original effect. As a consequence, our quasi-quarterly data covers 55 "quarters" starting with March-May 1969 and ending in September-November 1982. Three monthly observations are lost due to this procedure.

Panel B of table 2 gives the summary statistics for the quasi-quarterly data. Note that $\hat{M}_1$ is now virtually free from autocorrelation. $\hat{T}$, however, still contains an obvious seasonal pattern. Since $\hat{T}$ will only be used as an explanatory variable in a form where it is aggregated over four quarters, this pattern, distinct as it is, gives little cause for concern.

4. Inflation, Money and Real Activity

The tests performed below are all based on equation (2). What needs to be discussed here is the lag structure imbedded in that equation. The temporal relationship between money and prices was briefly touched upon above. In regressing current changes in the price level on past money growth we are essentially assuming two things: first, that contracts or adjustment costs prohibit immediate adjustment of all prices to the information conveyed by money supply announcements; second, that changes in the growth rate of the money supply, being the policy variable of our system, are largely unpredictable over the lifespan of a typical contract.

Real money balances willingly held by the public are assumed to be forward looking in the sense that they are based on estimates of money needed to transact in the near future. It is thus not only the present, or near past, volume of transactions that will determine the money market equilibrium. Near future volume of transactions will, in a rational expectations world with transaction costs, enter the money market clearing condition. The quantity theory, as set out in (2) predicts that the rate of price inflation depends positively on the past and present growth rate of the money stock and negatively on the present and future growth rate of real activity.

Table 3 reports on regressions of the CPI inflation rate on the rate of money growth in the past year (including the month or quarter of the price level change) and the year before that, on the growth rate of real activity in the past year and in the upcoming year. Two model versions are tested. In the first, separate restrictions for money lags for the first and second year are employed. In the second, money growth over the previous two years is aggregated into just one variable. Results are reported separately for M_1 and M_2.

INSERT TABLE 3 HERE

Initially note that the model, both on the monthly and on the quarterly level, is successful in transforming the highly autocorrelated inflation series into serially uncorrelated residuals. The weak negative first-order autocorrelations in the quarterly runs are apparently induced by $\hat{T}$ since, once expected real activity is measured by some other variable as in table 5, they disappear.

The hypothesis that the explanatory power of the equation does not differ from zero is rejected on the one percent level in every case. In all but the quarterly M_2-based regression the coefficient of $\hat{M}_{-T}$ passes a five percent test of significance. The notion that the quantity theory is to be viewed as a long run relationship is highlighted by the fact that the estimated coefficient for $\hat{M}_{-2}$ consistently exceeds that of $\hat{M}_{-1}$. With the exception of the quarterly M_2 regression, $\hat{M}_{-2}$ is assigned a coefficient that passes a five percent level of significance. The coefficient of $\hat{M}_{-1}$ passes a t-test on that level only for monthly M_1 data.

Money stock changes do not appear to cause price level changes of the same magnitude, however. For M_1 the sum of the implicit lag coefficients varies between .30 and .40, and for the M_2 between .68 and .91. A similar result is reported by Fama (1981), also.[5] Two explanations to this suggest themselves. First, by aggregating past monthly or quarterly observations into lagged annuals, we have restricted the lag distribution. This causes a downward bias in the sum of the lagged coefficients.

Second, the true model is likely to include a functional relationship running from money to real activity (see Friedman (1956), Lucas (1972), and Barro (1978)). If this relation is assumed independent of the inflation rate, e.g., $\hat{T} = \beta_0 - \beta_1\hat{M}_{-1} + \hat{T}_0$, where $\hat{T}_0$ is long-run equilibrium real activity, equation (2) should be viewed as the reduced form of a recursive model. If so, the coefficient estimate associated with $\hat{M}$ is not $\alpha_3 = 1$ but $(\alpha_3 - \alpha_1\beta_1) < 1$ instead.

To gain further insight into this, we regressed CPI-inflation on eight present and past quarters of money stock changes. Results are reported in table 4. Note that all lag coefficients receive positive signs and that, for M_1 we can actually reject the hypothesis that all slope coefficients equal zero on the five percent level. Elimination of the restriction on the lag coefficients results in an increase in the sum of the coefficients, as expected. $\hat{M}_1$ now receives an aggregate coefficient of .5 whereas $\hat{M}_2$ receives one of 1.2. Both coefficients probably still contain a downward bias due to the recursive nature of the underlying model. $\hat{M}_2$ therefore seems to contain assets that are not properly termed "money." Whether some portion of time deposits should be added to M_1 to obtain the proper money measure remains an open question.

INSERT TABLE 4 HERE

In addition to analyses reported in table 3 and 4, regressions including a base measure of money[6] were also performed. Since the performance of the money base variable(s) was clearly inferior to M_1 and M_2, results are not reported. This outcome should have been expected. Both currency, demand and time deposits meet the first Patinkin (1961) requirement for the fixing of an equilibrium real value for a nominal unit of account, namely that the rate of return on the asset is fixed at a submarket level. They do not, however, possess separate well-defined demand functions. Because of bank guarantees, checks for up to FIM 200 have become virtually perfect substitutes for currency. The transaction services provided by time deposits appear to be sufficiently differentiated from those of currency or demand deposits for M_1 and time deposits to have separate demand functions. The central variable in the control of the price level thus appears to be M_1.

The last result of table 3 to be discussed is the consistenly negative coefficient sign assigned measures of past and future real activity. Contrary to the argument associated with the Phillips curve, this result points to a positive unemployment-inflation tradeoff under a fixed money supply. More specifically, when the supply of money is controlled for, increased (expected) real activity, through its effect on desired real balances, is associated with decreasing inflation, as suggested by the quantity theory. This result seems to confirm the validity of more or less casual observations of staglation in the late 1970s and of continued low rates of inflation under stable money growth and rapidly increasing real activity in the U.S. in late 1983 and early 1984.

Money "demand" really appears to be forward looking in that, with the exception of one of the quarterly M_2-regressions, $\hat{T}_{+1}$ is consistenly assigned a significantly (5%) negative coefficient. The highly significant coefficients for $\hat{T}_{-1}$ in the quarterly data were unexpected, and indeed troublesome. They might point to adaptive rather than rational formation of expectations concerning real activity. The absence of a similar result in the regressions on monthly data, however, suggest that it should be cautiously interpreted.

Use of actual rather than anticipated future growth rates of real activity is troublesome in a broader sense also. Under the rational expectations assumption made we would want to introduce not actuals but conditional expected values of future real activity derived from the true structural model of economic activity. In an earlier paper Wahlroos and Berglund (1984) have shown that there is good reason to expect the stock market to predict future real activity with some accuracy and that, indeed, available data support such a proposition.

INSERT TABLE 5 HERE

Table 5 reports on regressions where expected future real activity is measured by the return to the value-weighted WI-index of returns on the Helsinki Stock Exchange (Berglund-Wahlroos-Grandell (1983)). These results are closely reminiscent of the ones based on actual future activity. The regressions on monthly data are slightly better than previous ones. The explanatory power of the quarterly regression has decreased somewhat, apparently because of the omission of $\hat{T}_{-1}$, but its residuals are now whiter. The magnitude and significance level of all money coefficients except the one associated with $\hat{M}_{-2}$ in the monthly M_1-regression have increased and insignificance can now be rejected at the five percent level in all but one case. In regressions similar to the ones reported in table 5 where changes in the money supply were measured by $\hat{M}_{-T}$, the slope coefficient of that variable was significantly positive (5%) for both M_1 and M_2. In all of the above regressions, stock market returns were assigned a highly significant negative coefficient.

5. Tests of Stability and the Direction of Causation

The period under study is one of apparent significant changes in Finnish financial and foreign exchange markets. In the early 1970s, after the collapse of the Bretton Wood system, the FIM experienced a brief period of floating. In 1973 it was pegged to an unpublicized index of currencies. The composition of this index was fixed by an act of parliament in 1977. Variation in the 4.5-6 percent fluctuation range around the index point set by the government has been appreciable and several devaluations and revaluations have occured. Whether these circumstances should be interpreted as reflecting a fixed or a flexible rate regime is debatable.

With the opening of the call money market in 1976 and the growth of the unregulated banking sector in the late 1970s and early 1980s, domestic financial markets have undergone significant structural change. Suspension of central bank open market operations in 1979 and the commercial banks' underwriting agreement for government bond issues have altered the mechanisms of monetary policy and government borrowing.

The quantity theory is mostly formulated in a closed economy-framework, and applies without amendments only to an open economy with a flexible exchange rate. In a simple fixed exchange rate model with free trade the domestic supply of money becomes endogenous. Purchasing power parity determines a country's exchange rate via its domestic money supply under a flexible rate system, or its price level via its exchange rate under a fixed rate system (Frenkel-Johnson (1976)). What this means is that the partial correlation between money and prices that we have observed may reflect a causal relationship running from prices to money rather than the other way around. As indicated by the brief history of Finnish foreign exchange policy above, the question of the degree of inflexibility of the Finnish exchange rate and hence of the exogeneity of money is largely an empirical one. It would seem that exchange rates have been sufficiently flexible to permit a domestic monetary polciy, even though the existence of an institutionalized peg suggests the opposite.

We start the analysis by ensuring that the turbulence in the monetary and foreign exchange institutions during the period under study has not caused a structural shift in the inflation model. To this end, the data are split into the two subperiods of December 1970 through May 1976 and June 1976 through December 1981 in the monthly, and 1970:IV through 1976:I and 1976:II through 1981:III in the quarterly set. The regressions reported on in tables 3 and 5 are run separately on each of these data sets and the results are subjected to a Chow test of structural stability.

Table 6 lists the relevant F-statistics for the null hypothesis that all coefficients remained the same in both subsamples. Three different versions of the inflation model were estimated from monthly and quarterly data using both M_1 and M_2 as measures of the money stock. The null hypothesis can nowhere be rejected, differences between subsamples are quite insignificant.

The somewhat higher F-statistics for the M_2-regressions where expected real activity changes are measured by stock market returns probably hint at some structural changes in the stock rather than the money market.

INSERT TABLE 6 HERE

The next step is to subject the price and money data to a Sims (1972) test of (Granger) causality. We calculate two 2-sided distributed lag regressions for each money measure. First, the current growth rate of the money supply is regressed on past, current and future inflation rates. Then the reverse distributed lag regression of the current inflation rate on past, current and future rates of money growth is performed. Sims (1972, pps. 550-551) showed that if and only if causality runs one way from current and past values of an exogenous variable to a given endogenous variable, the future values of the exogenous variable should have zero coefficients. Sims-tests were separately performed for the lag structure adopted (one future and two past years) in the previous analysis and for the more common four future and four past quarters setup. Moreover, the test was applied to the data used in the previous section both in raw form (logarithmic first differences) and to AR(1) prefiltered logarithmic first differences. All of these analyses yielded the same result as that reported in table 7 below.

INSERT TABLE 7 HERE

Initially note that coefficient estimates in the regression of $\hat{P}$ on eight current and past quarters of $\hat{M}_1$ and $\hat{M}_2$ due to the four observations lost in leading are slightly different from those reported in table 4. D-W statistics vary between 1.64 and 2.22 for M_1 and 1.76 and 2.56 for M_2. None of the first eight autocorrelation coefficients for regressions involving M_1 are two standard errors greater or less than zero. Residuals reported for $\hat{M}_2$ on $\hat{P}$ are less white.

The results do not reject the hypothesis that there is no causality from aggregate price changes to changes in the nominal money supply. However, only for M_1 are we able to reject the alternative hypothesis, namely that there is no causality from money to price changes.

Taken together with our previous result that M_1, on theoretical as well as empirical grounds, appears to be the better measure of "money," these results yield additional credence to the conclusions arising from our early estimation results. The Finnish exchange rate has apparently been sufficiently flexible to allow the domestic money supply to be largely exogenous in the inflation model. No evidence of price increases (Granger) causing money supply increases is found. Changes in M_1, on the other hand, cause changes in the price level.

6. Some Extensions and Alternative Hypotheses

The original formulation of the inflation model in equation (2) contains a measure of the interest rate. So far this variable, for reasons associated with the regulation of domestic markets for credit, has been neglected. In an effort to ascertain that our conclusions are robust to the introduction of an interest rate variable into the model, the regressions reported in table 8 were performed.

Three series of interest rates were available to us. These were (1) the average lending rate of the commercial banks, (2) the marginal cost of the commercial banks' central bank credit as reported in Tarkka (1981), and (3) face rates of the most recently issued five-year government bonds.[7] These rates were deannualized and introduced into regressions reported on earlier. Monetary theory holds that desired money balances decrease in the nominal interest rate. Hence, for given rates of growth of the money supply and real activity, the inflation rate will exhibit a positive relationship to changes in the interest rate.

The null hypothesis that desired balances, and hence inflation, is independent of the interest rate, cannot be rejected for the bond rate and the marginal cost of commercial banks' central bank credit. For the average lending rate of the commercial banks it is, however, clearly rejected, most strongly so in the models where expected real activity is measured by real stock market returns. This outcome is perhaps not very surprising. While regulation of the financial markets makes finding an adequate measure of the opportunity cost of holding idle balances significantly harder, it does not preclude the existence of such a measure. In a strongly bank-centered financial system such as the Finnish it is perhaps not surprising to find that average lending rates are the best market-wide measures of the cost of holding money.

As a final test, we would wish to assess the explanatory power of the quantity theory relative to other models of inflation. However, since the heyday of Phillips-curve models it has been hard to find any single alternative to the quantity theory. What appears to persist is a fairly large body of essentially "cost-push" or "wage-price spiral" models of inflation, all of which seem to include the feature that monetary policy is mostly or completely endogenous to a system driven by spirally transmitted shocks.[8] In the open economy versions of these models, shocks typically originate abroad and are transmitted to the domestic markets via import prices and a fixed exchange rate. The "open" sector follows the (import) price leaders. Price and subsequent wage increases are then domestically transmitted to other sectors of the economy. The central bank is left with the role of supplying the economy with "sufficient" money and credit.

Rather than selecting any specific such model as a reference point, we take the essence of these models to be that domestic inflation is primarily caused by past or current import price changes or expected import price changes due to exchange rate changes predicted by changes in the foreign exchange reserve. In table 9 we report on regressions of the CPI-inflation rate on the variables contained in equation (2) together with import price changes over the past year (including the current quarter) and the change in the foreign exchange reserve in the current quarter. In line with "cost-push" models we would expect $\hat{I}_{-1}$ to receive a positive and $\hat{E}$, as a measure of the likelihood of a significant change in the Bank of Finland currency index, a negative coefficient.

Those are indeed the signs reported for the two variables in table 9. With just one exception, however, the coefficients do not pass five percent level tests of significance. Similarly, F-tests permit us to reject (5%) the hypothesis that past, current or expected import price changes are insignificant in explaining domestic inflation only in one of the eight equations. If, however, the interest rate variable $\hat{r}_{-T}$ is removed from the regression, the results are slightly more favorable to the transmission hypothesis. Nevertheless, the money-price relationship, similarly to that reported here, remains strongly significant.

7. Conclusion

This paper analyzes 14 years of recent inflation and monetary policy experience in Finland. Both monthly and (quasi)quarterly data yield results that are closely compatible with the predictions of what we have labeled the quantity theory of money. The main results to come out of this study are summarized in the introductory section of the paper and will not be repeated here. What may need to be noted, however, is that the several versions of the basic model estimated from quarterly data and reported on in the text were also estimated from monthly data. In no case did the monthly results conflict with those reported. In some respects monthly estimates seemed even better. Levels of significance of money variables were generally higher and the weak negative residual autocorrelation found in some quarterly estimates was totally absent from monthly estimates.

The overall results conflict with conventional wisdom concerning Finnish economic policy on several accounts. First, in pointing to a rather strong negative tradeoff between inflation and real activity, money having been controlled for, they call into question the efficiency of what has been perceived of as anti-inflationary fiscal policies, accredited with many of Finland's economic successes of the past years. Inflation is unlikely to have been curbed by (imaginary) cuts in public spending or (less imaginary) taxation-induced cuts in private spending. Instead, the cause of the recent downward drift in the inflation rate appears to be the central bank's policy shift of late spring 1983 by which M_1-growth was brought down from annual rates exceeding 20 percent in early 1983 to 7-8 percent by December.

Second, our results also cast some doubt on the appropriateness of assumptions of a fixed exchange rate regime in Finnish economic policy models. Although we find some statistically insignificant transmission of inflation over import prices, our main results point to a conclusion that the central bank's freedom of action is significantly greater in domestic monetary than in exchange rate policy. This somewhat surprising outcome is apparently the result of the bank's inability to regulate foreign exchange operations of major banks and industrial firms with significant overseas operations. These firms are in a position to speculate against the bank and apparently have the resources to unsettle any attempt to maintain a disequilibrium exchange rate in the longer run.

Finally, the conclusion that these results cast serious doubt on the appropriateness and predictive power of several essentially "cost-push" models of inflation such as the "scandinavian" one, cannot be avoided. Although the model employed here was not meant to capture any institutional detail, and was indeed based on several overly simplified assumptions, such as perfect money neutrality, it performed very well. The strength of two of our main conclusions, namely, that exogenous money is a powerful predictor of future price level changes and that, once the supply of money has been controlled for, the tradeoff between price and real activity changes is negative, is such as to seriously challenge conventional wisdom based on "cost-push" and other non-monetary models.

Notes

[1]One part of the debate of the last decade is excellently surveyed in Judd and Scadding (1982).

[2]Confronted with somewhat unexpected coefficient estimate magnitudes we will find reason to discuss the empirical validity of this neutrality assumption at a later stage.

[3]An underwriting agreement now requires commercial banks to purchase all government bonds that remain unsold after a public offering.

[4]For one such study see Vogel (1974).

[5]For M_1 Fama (1981) received implied slopes of .77 to .84 in monthly and quarterly regressions. For base money, which Fama argues is the appropriate U.S. money measure, implied slopes were .59 to .70.

[6]The variable used was the logarithmic first difference of currency in circulation.

[7]The Finnish government does not issue openly traded short-term paper such as T-bills. The shortest bonds typically issued have a five-year maturity. Secondary market trade in risk-free securities with maturities of less than 3-5 years is typically too thin to yield stable estimates of market rates of interest.

[8]For a few examples of such models see Harrod (1972), and Aukrust (1977).

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Table 1. Variables used: Definitions, descriptions and sources.

Variable	Symbol	Definition	Description
Inflation rate	$\hat{P}_i$	$\ell n \frac{P_i}{P_{i-1}}$	where P_i denotes CPI at end of month/quarter i. (Bank of Finland Monthly Bulletin.)
Growth of money supply in year ending in period i.	$\hat{M}_{-1i}$	$\ell n \frac{M_t}{M_{t-1}}$	where M_t denotes money supply (M_1 or M_2) at end of 12-month period t. t ends at end of i. (Bank of Finland Monthly Bulletin.)
Growth of money supply in year ending in period i minus twelve months.	$\hat{M}_{-2i}$	$\ell n \frac{M_{t-1}}{M_{t-2}}$	
Growth of money supply in the two-year period ending in period i.	$\hat{M}_{-Ti}$	$\ell n \frac{M_t}{M_{t-2}}$	
Growth of real industrial output in year ending in period i.	$\hat{T}_{-1i}$	$\ell n \frac{T_t}{T_{t-1}}$	where T_t denotes seasonally unadjusted real industrial output at tend of 12-month period t. (Bank of Finland Monthly Bulletin.)
Growth of real industrial output in year ending in period i plus 12 months.	$\hat{T}_{+1i}$	$\ell n \frac{T_{t+1}}{T_t}$	
Real returns to the market portfolio of risky assets.	$\hat{R}_{Mi}$	$\ell n \frac{R_{Mi}}{R_{Mi-1}} - \hat{P}_i$	where R_{Mi} denotes the stock market WI return index at end of month/quarter i. Berglund-Wahlroos-Grandell (1983).
Nominal rate of interest	$\hat{r}_{-Ti}$	$\ell n \frac{r_t}{r_{t-2}}$	where r_t is (one plus) the (deannualized) interest rate; either AVG—average lending rate of commercial banks, BON—face rate of recently issued five-year government bonds, or MRG—marginal cost of the commercial banks' central bank debt. (Bank of Finland Monthly Bulletin and Tarkka (1981).)
Import price increase in year ending in period i.	$\hat{I}_{-1i}$	$\ell n \frac{I_t}{I_{t-1}}$	where I_t denotes the (cif) price index for import goods at end of 12-month period t. (Statistical Yearbook of Finland.)
Change in central bank's foreign exchange reserve.	$\hat{E}$	$\ell n \frac{E_i}{E_{i-1}}$	where E_i denotes Bank of Finland's net reserve of convertible currencies.

Table 2. Autocorrelations of monthly and quasi-quarterly variables. (a) indicates that data is available only for 1970-82, (b) that data is available only for 1969-79, and (c) that coefficients are multiplied by 100 for convenience. Asterisks indicate that the estimated coefficient is two standard errors greater or less than zero.

Variable	ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	ρ_6	ρ_7	ρ_8	ρ_9	ρ_{10}	ρ_{11}	ρ_{12}	Mean	Std.
Panel A. Monthly Data: 168 Observations 1969-82.														
$\hat{P}$	.27*	.28*	.19*	.17*	.22*	.33*	.21*	.16*	.29*	.10	.24*	.33*	.0079	.0062
$\hat{M}_1$	-.27	-.08	.03	-.02	-.14	.27*	-.10	.03	-.10	-.04	-.25*	.44*	.0123	.0499
$\hat{M}_2$	-.07	-.08	-.18*	-.03	-.08	.18*	-.07	.01	-.21*	-.08	-.09	.69*	.0112	.0131
$\hat{T}$	-.37*	-.10	.01	-.19*	.24*	-.16*	.22*	-.16*	-.01	-.11	-.31*	.88*	.0024	.1866
$\hat{R}_M$(a)	.29*	.20*	.18*	.10	.22*	.25*	.29*	.13	.19*	.02	.19*	.25*	.0038	.0368
$\hat{r}_{AVG}$	.08	.10	.10	.02	.01	-.01	.08	-.03	.02	-.01	.00	-.01	.0007(c)	.0148(c)
$\hat{r}_{BON}$	-.01	.03	-.03	-.24*	-.01	-.01	.09	.25*	-.01	.01	-.07	.01	.0012(c)	.0167(c)
$\hat{r}_{MRG}$(b)	.01	.00	-.01	-.04	-.02	-.01	.04	-.06	-.06	-.02	.02	.00	.0003	.0041
Panel B. Quasi-Quarterly Data: 55 Observations 1969-82.														
$\hat{P}$	.48*	.42*	.44*	.42*	.24	.10.	.17	.06					.0238	.0133
$\hat{M}_1$	-.09	-.08	-.16	.05	-.10	-.19	-.05	.25*					.0377	.0519
$\hat{M}_2$	-.21	-.05	-.29*	.63*	-.23	-.17	-.29*	.52*					.0334	.0188
$\hat{T}$	-.79*	.67*	-.67*	.67*	-.66*	.67*	-.71*	.69*					.0076	.0767
$\hat{R}_M$(a)	.32*	.56*	.19	.31*	-.10	.08	-.13	.04					.0105	.0792
$\hat{r}_{AVG}$	.21	.07	-.02	-.01	-.01	-.03	-.12	-.03					.0021(c)	.0277(c)
$\hat{r}_{BON}$	-.15	.02	.22	-.07	.26*	-.09	-.02	-.28*					.0035(c)	.0292(c)
$\hat{r}_{MRG}$	-.08	.04	-.10	.02	-.08	.04	-.20	.07					.0009	.0073
$\hat{I}$	.36*	.11	.20	,02	-.16	-.22	-.17	-.31*					.0260	.0336
$\hat{E}$	-.10	-.19	-.01	.09	-.19	.08	-.08	-.04					.0248	.2878

Table 3. Coefficient estimates: Inflation, money supply and real activity. Monthly and quasi-quarterly data 1969–82. t-statistics in parentheses. None of the autocorrelation coefficients ρ differ from zero by two standard errors or more.

M	Constant	$\hat{M}_{-1}$	$\hat{M}_{-2}$	$\hat{M}_{-T}$	$\hat{T}_{-1}$	$\hat{T}_{+1}$	$\bar{r}^2$	F	DW	ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	ρ_6
Monthly Data 1969–82															
M_1	.0047	.0156	.0170		-.0093	-.0196	.145	6.59	1.91	.04	.03	-.10	-.16	-.00	.12
	(2.89)	(2.63)	(3.01)		(1.26)	(2.63)									
M_1	.0047			.0164	-.0094	-.0196	.151	8.83	1.91	.04	.03	-.10	-.16	.00	.12
	(2.90)			(3.33)	(1.29)	(2.64)									
M_2	-.0008	.0314	.0446		-.0126	-.0173	.128	5.84	1.88	.06	.02	-.09	-.16	.01	.12
	(.21)	(1.71)	(2.36)		(1.74)	(2.20)									
M_2	-.0007			.0378	-.0127	-.0180	.133	7.75	1.88	.06	.03	-.09	-.16	.02	.12
	(.19)			(2.85)	(1.76)	(2.34)									
Quasi-Quarterly Data 1969–82															
M_1	.0195	.0357	.0408		-.0917	-.0732	.405	8.30	2.46	-.23	-.18	.19	.08		
	(3.58)	(1.87)	(2.25)		(3.46)	(2.53)									
M_1	.0194			.0384	-.0927	-.0728	.418	11.31	2.46	-.23	-.18	.19	.07		
	(3.62)			(2.42)	(3.57)	(2.55)									
M_2	.0062	.0609	.1182		-.0956	-.0596	.383	7.66	2.29	-.15	-.11	.26	.16		
	(.48)	(1.11)	(1.86)		(3.59)	(1.78)									
M_2	.0076			.0849	-.0980	-.0669	.390	10.16	2.28	-.14	-.12	.23	.13		
	(.60)			(1.93)	(3.72)	(2.10)									

Table 4. Coefficient Estimates of $\hat{P}_i = \beta_0 + \sum_{j=0}^{7} \beta_{i-j}\hat{M}_{i-j}$. Quasi-quarterly data 1969-82. t-statistics in parentheses.

Lag	$\hat{M}_1$	t		$\hat{M}_2$	t	
0	.0460	(1.34)	$\bar{r}^2 = .154$	.0865	(.70)	$\bar{r}^2 = .114$
1	.0743	(2.16)	F = 2.07	.1991	(1.62)	F = 1.76
2	.0316	(.95)	DW = 1.60	.0064	(.06)	DW = 1.67
3	.0696	(2.07)		.1396	(1.19)	
4	.1000	(3.15)		.1988	(1.69)	
5	.0261	(.84)		.1414	(1.20)	
6	.0786	(2.41)		.3123	(2.51)	
7	.0587	(1.80)		.1197	(.97)	
Σ	.4849			1.2038		
Constant	.0086	(1.62)		-.0146	(1.16)	

Table 5. Coefficient estimates: Inflation, money supply and real stock returns as predictors of future real activity. Monthly and quasi-quarterly data 1969-82. t-statistics in parentheses. Asterisks denote that the autocorrelation coefficient is at least two standard errors greater or less than zero.

M	Constant	$\hat{M}_{-1}$	$\hat{M}_{-2}$	$\hat{R}_M$	$\bar{r}^2$	F	DW	ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	ρ_6
Monthly Data 1969-82													
M_1	.0043	.0170	.0150	-.0459	.176	10.39	1.96	.02	.06	-.08	-.16	-.02	.17*
	(2.84)	(2.98)	(2.68)	(3.49)									
M_2	-.0016	.0381	.0394	-.0471	.165	9.71	1.92	.04	.07	-.07	-.15	.00	.18*
	(.45)	(2.13)	(2.15)	(3.52)									
Quasi-Quarterly Data 1969-82													
M_1	.0127	.0496	.0490	-.0488	.308	7.37	2.12	-.06	.01	.17	.12		
	(2.46)	(2.55)	(2.51)	(2.37)									
M_2	-.0044	.1040	.1279	-.0495	.289	6.83	2.10	-.05	.03	.19	.15		
	(.38)	(1.81)	(2.01)	(2.28)									

Table 6. F-test statistics for a (Chow) comparison of subperiods 1971-76 versus 1976-81. None significant at five percent level.

Independent Variables	Monthly M_1	Monthly M_2	Quasi-Quarterly M_1	Quasi-Quarterly M_2
$\hat{M}_{-1}$, $\hat{M}_{-2}$, $\hat{T}_{-1}$, $\hat{T}_{+1}$	.14	.71	.39	.69
$\hat{M}_{-T}$, $\hat{T}_{-1}$, $\hat{T}_{-2}$	.13	.66	.17	.72
$\hat{M}_{-T}$, $\hat{R}_M$	.31	1.46	.37	1.15

Table 7. Sims/Granger test of the direction of causality between money and inflation. Quasi-quarterly data 1969-82. An asterisk indicates the the F-statistic passes a five-percent level test of significance. (†) indicates that the autocorrelation coefficients are more than two standard errors greater or less than zero.

Lead/Lag (quarters)	$\hat{M}_1$ on $\hat{P}$		$\hat{P}$ on $\hat{M}_1$		$\hat{M}_2$ on $\hat{P}$		$\hat{P}$ on $\hat{M}_2$	
+4	2.40		.024		.238		.173	
+3	.22		.015		.190		.232	
+2	-.57		.074		.220		.189	
+1	-.28		.014		-.051		.175	
0	-1.66	-.72	.050	.047	-.514	-.301	.039	.054
-1	-.06	-.11	.094	.089	-.229	-.102	.129	.140
-2	1.34	.80	.030	.034	.356	-.353	.086	.045
-3	.70	.94	.067	.059	.481	.461	.229	.148
-4	.38	.60	.120	.107	.128	.099	.289	.195
-5	-.56	-.80	.043	.042	-.500	-.493	.232	.194
-6	-.26	.74	.063	.080	.028	.040	.301	.296
-7	.76	.12	.047	.054	.102	.030	.068	.088
r^2	.343	.115	.411	.354	.191	.138	.404	.302
DW	2.22	1.98	1.64	1.66	2.56	2.44	1.97	1.76
ρ_1	-.14	-.11	.17	.16	-.31†	-.25	.01	.12
ρ_2	-.14	-.06	.12	.09	-.00	.02	.03	.09
ρ_3	-.27	-.07	.21	.17	-.43†	-.35†	.12	.20
ρ_4	.24	.20	.12	.14	.57†	.57†	.06	.10
F(4,31)	2.69*		.75		.51		1.32	

Table 8. Coefficient estimates: interest rate and price level changes. Quasi-quarterly data 1969–82. (a) indicates coverage of 1969–79 only. F denotes the F-statistic for the regression. F' is the F-statistic for a test on the coefficient associated with the interest rate variable. (*) indicates significance at the five-percent level, and (**) significance at the one-percent level for F'. t-statistics in parentheses.

$\hat{r}$	$\hat{M}$	Constant	$\hat{M}_{-T}$	$\hat{T}_{-1}$	$\hat{T}_{+1}$	$\hat{R}_M$	$\hat{r}_{-T}$	$\bar{r}^2$	F	DW	F'
AVG	M_1	.0152 (2.81)	.0433 (2.85)	-.0659 (2.44)	-.0348 (1.10)		4.156 (2.36)	.478	10.84	2.54	5.57*
AVG	M_2	.0036 (.29)	.0905 (2.14)	-.0752 (2.72)	-.0337 (.97)		3.727 (2.05)	.435	9.28	2.32	4.19*
AVG	M_1	.0118 (2.61)	.0463 (3.18)			-.0360 (2.02)	5.268 (3.46)	.467	13.57	2.49	11.99**
AVG	M_2	-.0000 (.00)	.0938 (2.43)			-.0421 (2.29)	4.842 (3.00)	.419	11.32	2.34	9.01**
BON	M_1	.0196 (3.58)	.0373 (2.20)	-.0901 (3.12)	-.0709 (2.35)		.400 (.22)	.404	8.29	2.45	.05
BON	M_2	.0083 (.65)	.0797 (1.77)	-.0899 (3.03)	-.0614 (1.84)		1.103 (.61)	.380	7.59	2.28	.36
BON	M_1	.0140 (2.67)	.0424 (2.39)			-.0421 (2.03)	1.902 (1.02)	.325	7.91	2.11	1.04
BON	M_2	-.0005 (.04)	.0982 (2.29)			-.0423 (2.03)	2.414 (1.33)	.318	7.69	2.12	1.78
MRG[a]	M_1	.0178 (2.37)	.0411 (1.97)	-.0840 (2.64)	-.0634 (1.83)		.174 (.49)	.464	8.35	2.48	.24
MRG[a]	M_2	.0107 (.82)	.0750 (1.66)	-.0898 (2.82)	-.0665 (1.86)		.315 (.90)	.445	7.82	2.41	.81
MRG[a]	M_1	.0100 (1.55)	.0546 (2.75)			-.0377 (1.74)	.361 (1.01)	.411	8.92	2.26	1.03
MRG[a]	M_2	-.0003 (.03)	.1019 (2.37)			-.0401 (1.81)	.575 (1.66)	.379	7.93	2.21	2.76

Table 9. Coefficient estimates: inflation and money with past and expected import price changes. Quasi-quarterly data 1969–82. t-statistics in parentheses. F' denotes F-statistics on the coefficients of $\hat{I}_{-1}$ and $\hat{E}$ (odd rows) and on the coefficient of $\hat{I}_{-1}$ alone (even rows). (*) indicates that the F'-statistic passes a five-percent level test of significance.

$\hat{M}$	Constant	$\hat{M}_{-T}$	$\hat{T}_{-1}$	$\hat{T}_{+1}$	$\hat{R}_M$	$\hat{r}_{AVG_{-T}}$	$\hat{I}_{-1}$	$\hat{E}$	$\bar{r}^2$	F	DW	F'
M_1	.0107 (1.75)	.0459 (3.05)	−.0643 (2.48)	−.0046 (.14)		2.722 (1.54)	.0327 (1.92)	−.0074 (1.70)	.529	9.04	2.58	3.11
M_1	.0093 (1.50)	.0499 (3.27)	−.0606 (2.29)	−.0060 (.17)		3.373 (1.90)	.0310 (1.78)		.505	9.78	2.63	3.15
M_2	−.0061 (.45)	.1098 (2.55)	−.0715 (2.71)	.0055 (.15)		2.148 (1.18)	.0368 (2.02)	−.0080 (1.78)	.498	8.12	2.36	3.46*
M_2	−.0090 (.66)	.1198 (2.73)	−.0682 (2.52)	.0048 (.12)		2.799 (1.53)	.0353 (1.89)		.470	8.62	2.41	3.55
M_1	.0094 (1.93)	.0470 (3.24)			−.0291 (1.61)	3.874 (2.28)	.0239 (1.51)	−.0048 (1.04)	.483	9.02	2.57	1.59
M_1	.0089 (1.83)	.0486 (3.36)			−.0325 (1.83)	4.218 (2.53)	.0229 (1.45)		.482	10.99	2.60	2.10
M_2	−.0026 (.24)	.0957 (2.47)			−.0351 (1.88)	3.446 (1.91)	.0234 (1.41)	−.0050 (1.04)	.432	7.53	2.39	1.45
M_2	−.0038 (.36)	.1000 (2.60)			−.0387 (2.11)	3.783 (2.13)	.0223 (1.35)		.430	9.12	2.43	1.81