Canadian weekly money supply announcements and financial market reactions in the first years of targeting: a view of market perceptions of Bank of Canada policy

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Abstract. This paper demonstrates, using weekly data between 1976 and 1979, that unanticipated changes in the Canadian money supply exerted a significant impact on the foreign exchange and bond markets during the first years of the Bank of Canada’s policy of targeting M1 growth. This finding, which is perhaps surprising in light of the apparent volatility of weekly changes in the Canadian money supply, is consistent with the efficient markets paradigm. After the empirical regularities are established, an interpretation is offered which focuses on market perceptions of the reaction function of the Bank of Canada.

Les annonces hebdomadaires de la taille de l’offre de monnaie au Canada et les réactions des marchés financiers dans les premières années de la politique de croissance monétaire ciblée: perspective sur les perceptions de la politique de la Banque du Canada par le marché: Ce mémoire montre, en utilisant les données hebdomadaires entre 1976 et 1979, que les changements non-anticipés dans l’offre canadienne de monnaie ont exercé un impact significatif sur les marchés des change étrangers et des obligations durant les premières années de la période durant laquelle la Banque du Canada a poursuivi une politique de taux de croissance ciblée de M1. Ce résultat est peut-être surprenant, compte tenu de la volatilité apparente des changements hebdomadaires dans l’offre de monnaie canadienne, mais il est tout à fait compatible avec ce que suggère le paradigme des marchés efficaces. Après avoir établi les régularités empiriques, l’auteur suggère une interprétation qui met l’accent sur les perceptions par le marché de la fonction de réaction de la Banque du Canada.

I. INTRODUCTION

Every week the Bank of Canada releases its latest estimates for levels of the principal monetary aggregates. One might expect that financial market participants are paying careful attention, since they, in their profit-seeking capacity, are consumers

I wish to acknowledge the helpful comments of James E. Pesando, Lake Chan, Dean Mountain, Itzhak Kristky, Angelo Melino, Steve Poloz, and two anonymous referees of this journal. All remaining errors are my own.

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of relevant 'news.' The latter two words need to be highlighted. The rational expectations – efficient markets view of the world argues that only unanticipated news or 'news' should interest markets, because whatever was expected has been previously embedded in prices. As for relevance of the 'news,' this can be resolved only empirically. To put the matter in the present context, are market prices and yields affected by unanticipated changes in the Canadian money supply? The question is of obvious importance to a market player: he may be able to profit if he believes his prediction to be superior to the consensus.

Economists should also be interested. It has been argued that an important result of such empirical research is that we may gain insight into the market's perception of the structure of the economy. At least as a long-run proposition, this should be very similar to the true structure. With respect to the Canadian monetary process, it may be possible to draw inferences on market perceptions of the reaction function of the Bank of Canada.

The purpose of this paper is to shed light on Canadian monetary policy by investigating financial market reactions to announcements of week-to-week changes in the Canadian money supply. In particular, I examine reactions of the Canadian/U.S. dollar spot exchange rate and representative short-term and long-term Canadian interest rates to weekly announcements of Canadian M1 between early 1976 and October 1979.1

This period is an important one in recent Canadian monetary history. Spurred on by double-digit inflation throughout 1974 and 1975, in November 1975 the Bank of Canada formally adopted M1 targeting.2 The intention was to lower permanently the rate of inflation, but in order to cushion the real consequences of disinflation a policy of 'monetary gradualism' was designed which allowed for periodic reductions in the target path.3 To many it is conventional wisdom that such a policy will lead to lower adjustment costs if the monetary authority's stated intentions are deemed credible by the public. A sample from early 1976 to October 1979 is employed, since this episode constitutes, allowing for a brief transitional phase, the first critical years after the announcement of the Bank of Canada's new policy.4

1 The broad U.S. literature (to be discussed shortly) is summarized by Sheehan (1985). Ito and Roley (1987) looked at Japanese monthly money supply announcements and market reactions (without finding any), while Goodhart and Smith (1985) found evidence of pound sterling appreciation and increases in U.K. long-term bond yields in response to U.K. month-to-month monetary growth that was higher than anticipated. They are puzzled, however, by evidence that British short-term interest rates are not perturbed by these same surprises. I argue later that this need not be so surprising.

2 See the Bank of Canada's Annual Report for 1975. The bank specified a target range of 10-15 per cent using as a base the average seasonally adjusted level during the three-month period beginning April 1975.

3 Reductions in the target monetary growth rate, which were to occur at the bank's discretion, took place five times before the policy was formally discontinued in October 1982. The following changes were announced: 8-12 per cent (Sept/76), 7-11 per cent (Oct/77), 6-10 per cent (Oct/78), 5-9 per cent (Jan/80), and 4-8 per cent (March/81). For the bank's motivation in discontinuing targeting, see the banks' 1982 Annual Report and Courchene (1983).

4 Another reason for beginning the sample in early 1976 is that shortly after the Bank of Canada announced its new policy, a mail strike began. As noted in Courchene (1981), such an event can cause a temporary ballooning of money demand which is quite properly accommodated.
is the well-documented shift to tighter monetary policy in the U.S., which also signalled increasing Canadian attention to monetary events south of the border.\(^5\)

Section II provides the pertinent background by reviewing the related U.S. literature and then discussing some special considerations peculiar to the Canadian context. The next section describes the data and addresses the problem of decomposing changes in Canadian narrow money into unanticipated and anticipated components. Section IV presents the efficient markets model used to estimate market responses to monetary announcements and details the empirical results. This methodology allows, as a useful byproduct, a straightforward test of Canadian financial market efficiency. The last section provides a summary and interpretation of the empirical results.

II. BACKGROUND

1. U.S. literature review
Research developed in the United States when it was observed that unanticipated week-to-week changes in the U.S. narrow money supply tended to induce asset price changes in money, bond, and foreign exchange markets. In particular, money surprises were found to be positively correlated with movements in short-term U.S. interest rates, long-term interest rates (to a lesser extent), and changes in the value of the U.S. dollar.\(^6\) Two conflicting views of market perceptions of Fed policy and credibility were advanced to account for these empirical regularities.\(^7\) The 'policy anticipations' or counteractive school argued that the Federal Reserve was viewed as taking monetary restraint and targeting seriously and thus was likely to counteract these demand-based surprises.\(^8\) The 'expected inflation' or accommodating school responded that the market viewed the Fed as less than perfectly credible and a good bet at least to partially accommodate the surprises in higher future monetary growth rates.

Short-term interest rate responses were not useful in differentiating the hypotheses, since it was not clear whether it was the real component or the inflation

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\(^5\) For example, Deaves, Melino, and Pesando (1987) report that after October 1979 (unlike the situation before that date) Canadian short-term interest rates became sensitive to U.S. money surprises.

\(^6\) As a stylistic abbreviation, I shall often speak of typical reactions to positive money surprises. No asymmetries should be inferred unless they are clearly stated. For interest rate evidence, see, among others, Cornell (1983), Roley (1983), Loey (1985), Roley and Walsh (1985), and Deaves (1987). For representative foreign exchange market evidence, see Hakko and Pearce (1985).

Before October 1979 and February 1984, foreign exchange markets did not respond to surprises and interest rate movements were small.

\(^7\) Some believe that an explanation focusing on market perceptions of monetary policy is at best an incomplete one. Siegel (1985) and Huizinga and Leiderman (1987) argue that at least part of the story must be that monetary announcements serve as signals for other variables relevant in price determination.

\(^8\) These are usually viewed as demand-based surprises, since the corresponding level of the monetary base is released in the previous week. This statement applies equally to Canada. As pointed out by an anonymous referee, another possibility is that the willingness of banks to lend may have changed (perhaps because of perceived changes in risk).
premium which was changing. U.S. dollar movements were more helpful in this regard, since appreciation implied that the real rate was being perturbed, while depreciation implied it was merely the nominal. Long-term bond yield increases were probably more consistent with a perceived policy of accommodation, since these are more likely explained as inflationary jitters rather than as an imminent prolonged period of higher real interest rates. Because the signals were mixed, the U.S. debate continues to this day.10

2. Small open economy considerations
There are two additional considerations worthy of note when extending this line of research to relatively small open economies. First, is it reasonable to expect that identical market perceptions of monetary authority behaviour should lead to the same financial market reactions as are observed in the United States? There is a single potential divergence. It is unimportant from the standpoint of hypothesis differentiation, however, since it involves short-term interest rate reactions. The positive correlation between short-term interest rate movements and money surprises need not hold for a small open economy when the monetary authority is expected to counteract monetary shocks. The reason is that two forces are working against each other. The 'liquidity' effect – the only one operative in a perfectly closed economy – leads to increases in interest rates because of perceived future monetary restraint. A 'price level' effect, on the other hand, works to reduce interest rates. The domestic currency appreciation associated with positive surprises leads to a fall in the general price level, since the latter is an appropriately weighted average of domestic prices and the price of foreign goods expressed in terms of domestic currency. This causes real balances to increase and interest rates are pushed downward via this channel. In fact it can be shown that the price level effect may be the dominant one at shorter maturities.11

Second, exchange rate targeting, such as attempting to fix the value or the rate of change of the domestic currency relative to a major foreign one, is often an alternative to monetary targeting for the central bank of a small open economy. Strict exchange rate and monetary targeting are at variance, except in the fortuitous case of a foreign rate of monetary expansion that is consistent with both goals. If, however, both targets are viewed as bands rather than points, it may be possible to pursue both goals simultaneously – at least until a clear choice has to be made.

9 This is true a fortiori if even long-term implicit forward interest rates beginning up to five years in the future are significantly perturbed – by which time any expected monetary tightening reasonably should have been completed. Shiller, Campbell, and Schoenholtz (1985) found this to be the case.

10 Hardouvelis (1984) argued that there were elements of truth in both hypotheses, since it was possible that short-term interest rates and foreign exchange rates were dominated by real movements, but that long-term interest rates changed primarily because of revisions in expectations of inflation.

11 See Deaves (1990) for a proof. In this context a small open economy refers to one with a high import-to-GNP ratio. Interest parity will of course hold in large economies like the United States (as well as in small open economies).
It should be clear, however, that a perceived policy of monetary targeting cannot be directly distinguished from one of exchange rate targeting by the present experiment: both would yield the same predictions for market reactions to money surprises. Under either type of targeting, the correct policy for the bank is to counteract surprises. Thus the important distinction is between an accommodating policy and a counteractive policy.

III. DATA AND GENERATION OF EXPECTATIONS

1. Data and asset price change measurement intervals

Monetary statistics were taken from the Bank of Canada’s weekly release, Weekly Financial Statistics, which at this time came out on Thursdays at 5:00 pm. From each week’s issue the following figures were taken: the preliminary estimate of M1 for the Wednesday eight days previous; and, for the Wednesday one day previous, Bank of Canada notes in circulation and Canadian dollar deposits of the chartered banks held at the Bank of Canada. The latter two series were also released on the same morning in the Bank of Canada’s Statement of Assets and Liabilities. Their sum constitutes the monetary base. From the M1 series it is straightforward to calculate the percentage change from the previous week, which will be denoted as $\Delta M_1$. This will be the series that is decomposed into expected and unexpected components.

Data on Canadian interest rates and the Canadian/us. dollar foreign exchange rate were taken from the Bank of Canada’s data base and from quote sheets of the Securities Department of the Bank of Canada. Short-term rates were represented by three-month Canadian treasury bills and long-term rates by a synthetic series of approximately twenty-year Government of Canada bonds. Yields (or prices, from which yields were calculated) were available for 10:30 am and 3:30 pm. Spot Canadian/us. dollar exchange rates were available every business day at noon.

12 If positive surprises are accommodated, the currency will depreciate.
13 Release dates were occasionally rescheduled in the event of holidays. Recently (as of the 18 July 1986 release) the regularly scheduled release day was moved to Friday. It is important to use the originally released figures, since markets are responding to them (as opposed to those revised one or more times in the future). For a comprehensive description of the Bank of Canada’s Weekly Financial Statistics, see Martin (1985).
14 Strictly speaking, coin, which is a relatively small component, has been omitted from the monetary base. Since I shall be dealing with percentage changes in monetary variables, as long as the percentage change in the coin component matched that of the rest of the base, the results would be identical.
15 To be precise, the log-difference approximation is used. Note that this series includes both the change in M1 over the revised level for the previous week and the revision itself. It is preferable to include this (first) revision. Clearly, if there are large revisions, they will have an impact on financial markets, and there is no reason to expect the impact of an unexpectedly high revision to differ from an unexpectedly high announcement for M1.
16 Quote sheets were provided courtesy of R. Hannah of the Bank of Canada’s Securities Department. The 10s of ’95 were used for 1976. For the remainder of the sample period the 9 1/4s of ’01 were used. Thus the average maturity was slightly in excess of twenty years. These bonds were selected because of the apparent liquidity of their markets. The latter can be seen by small price increments, frequent price changes, and a large dollar volume outstanding.
and 4:30 pm. Thus in most cases it was possible to specify a reasonably 'narrow window' containing the money supply announcement for changes in the relevant prices and yields.\textsuperscript{17} For Canadian bills and bonds, the change was measured from 3:30 pm on the day of the announcement to 10:30 am on the following business day. For the exchange rate the change was from 4:30 pm on the day of the announcement to noon on the following business day.\textsuperscript{18} For comparison purposes, U.S. three-month T-bill and twenty-year government bond yields were obtained from the Federal Reserve's H.15 release. From these afternoon quotes, full-day interest rate movements were calculated around the weekly Canadian M1 announcement.\textsuperscript{19}

2. \textit{Derivation of expectations proxy}

Next I turn to the decomposition of $\Delta M_t$ into anticipated and unanticipated components. In the United States research has been assisted by the existence of the reasonably reliable Money Market Services market survey of expected week-to-week monetary growth, but in Canada there is no alternative to the use of data-generated proxies.

The volatility in week-to-week monetary growth is striking, as evidenced by a 2.45 per cent standard deviation for the sample.\textsuperscript{20} There are several principal sources of variability in the $\Delta M_t$ series that can be filtered out in order to generate money surprises. First, since only raw weekly figures are released, I deseasonalize the data by utilizing the bank's monthly seasonal adjustment coefficients in effect at the time (or appropriately weighted averages of these).\textsuperscript{21}

Lagged values of the money supply and current and past levels of the base are likely to have explanatory power.\textsuperscript{22} A bivariate autoregressive model is estimated. The choice of lag numbers is determined by using Hsiao's (1979) operationalization

\textsuperscript{17} It is important to use as narrow an interval as possible in order to minimize the impact of intervening noise. As an illustration in a similar context, note that Bailey (1989), using a full-day window, is unable to find a significant response in the Canadian dollar after U.S. money surprises, whereas Deaves (1987), using a half-day window, manages to discern highly significant Canadian dollar depreciation.

\textsuperscript{18} Exchange rate changes are put in percentage terms using log-difference approximation.

\textsuperscript{19} Intervals for all asset price movements occasionally had to be widened when holidays intervened.

\textsuperscript{20} The $\Delta M_t$ series is also quite volatile relative to the comparable U.S. figures. Between October 1977 and October 1979 the standard deviation for U.S. weekly narrow money percentage changes (from the Fed's H.15 release) was 0.58 per cent versus 2.46 per cent for Canada. This result is partly due to the fact that the U.S. weekly data are seasonally adjusted, unlike those released by the Bank of Canada, and the U.S. figure has been daily averaged, whereas the Canadian figure is merely the Wednesday observation.

\textsuperscript{21} A simple ad hoc procedure was used. To the Wednesday observation nearest the middle of each month the pertinent monthly seasonal factor was applied as the weekly. Other Wednesdays were then assigned seasonal factors that were the appropriately weighted averages of those of the two nearest months. Note that new monthly seasonal adjustment factors were used when re-estimated by the bank.

\textsuperscript{22} I use announcement time, not calendar time. Thus the base at $t$ corresponds to the stock at $t + 1$, since stock announcements lag base announcements by one week. It is appropriate to use the current (where 'current' is taken to mean announced at $t$) change in the base to predict the current change in the stock, since the base figure is announced in the morning (before the stock) and is thus part of the public's information set.
of the FPE (i.e., final prediction error) minimization criterion.

In addition, a series of ‘date of the month’ indicator variables is included in the regression equation. The announced level of the money stock is for the Wednesday of the previous week. When one examines figure 1, which shows mean percentage changes for each date of the month that these Wednesdays fell on, a distinctive pattern is apparent. Clearly, at the beginning, middle, and end of each month, reported changes tend to be higher than average. The likely reasons are the large percentage of cash payments that occur around the beginning and end of each month and the high flow of government receipts and disbursements at each month’s beginning, middle, and end. At these times it is likely that a temporary imbalance exists between actual and desired levels of currency and demand deposits. This factor is deterministic and must be accounted for in prediction.

Thus the equation to be estimated is the following:

23 Final prediction error is as follows: $FPE = (T + k)/(T - k) × \text{SSE}(a, b)/T$, where $k =$ number of parameters; $a, b =$ number of lags of dependent and additional variables, respectively; and $T =$ sample size. To search over different lags, Hsiao’s search procedure involves first minimizing FPE for univariate AR models for $ΔM^f$ (from $a = 0$ to $a = max$), obtaining $a = a_0$ at the minimum FPE value. Then $b$ is chosen between zero and max while holding $a = a_0$. Finally, to guard against the omitted variables effect, $a$ is once again varied between zero and $a_0$. A maximum of ten lags was considered.

24 This observation was inspired by ‘Note on seasonal adjustment of monthly currency and demand deposit statistics,’ Bank of Canada Review (March 1979). There the intention was somewhat different. The idea was to refine the monthly seasonal adjustment factors by taking into consideration the pattern of Wednesdays making up the month in question.
\[ \Delta M_i = \alpha + \sum_{i=2}^{31} \beta_i X_i + \sum_{j=1}^{m} \gamma_j \Delta M_{i-j} + \sum_{k=0}^{n} \delta_k \Delta B_{t-k} + \epsilon_t, \]  

where \( \Delta M_i \) = seasonally adjusted percentage change in week-to-week Canadian M1;

\( \Delta B_i \) = percentage change in week-to-week monetary base (where the latter has been seasonally adjusted using Bank's M1 factors since it does not report base adjustments);

\( X_i \) = "date of the month" indicator variables (set equal to unity when Wednesday pertaining to the money supply release falls on date equal to variable's subscript; otherwise set equal to zero);

\( \alpha, \beta_i, \gamma_j, \delta_k \) = parameters to be estimated;

\( m, n \) = supply and base lags to be determined by FPE minimization;

\( \epsilon_t \) = error term.

The full regression results for the selected estimated equation are presented in table 1. It is evident that the date of the month effect plays a large part in explaining week-to-week variability, since all coefficient estimates except those for the beginning, middle, and end of each month are highly significant. This equation calls for seven lags for the money supply and two for the base. All lagged coefficients are significant at least at the 5 per cent critical value. Past increases in supply imply that one should expect a decline in the future. Thus there seems to be in evidence a tendency for the Bank of Canada (and the chartered banks) to smooth week-to-week monetary growth. As for the base, the positive coefficients for once-lagged and twice-lagged changes, not surprisingly, indicate that increases in supply via the money multiplier are imminent. The most recently announced level of the base (which corresponds to the money supply level to be announced next week) appears to offer little information. Residuals from this estimated equation were used as the proxy for unanticipated money in the estimation of financial market reactions that are reported below.

Note that the constant corresponds to the first day of the month. Because of the Bank of Canada's interest rate monetary control mechanism, which of necessity leads to very short-term accommodation of demand shocks, and the Canadian system of lagged reserve requirements (with reservable deposits calculated as a four-week average for the previous month), on a very short-term basis the Bank of Canada does not have effective monetary control. It will be in the interest of the chartered banks, however, to practise restraint, since if reserves to cover high loan demand are not forthcoming, they will have to cut back on loans within a few weeks or borrow from the Bank of Canada. See Courchene, Fortin, Sparks, and White (1979) for the pertinent institutional details.

Several other reasonable univariate ARIMA and bivariate autoregressive models were used to estimate financial market reactions. The results obtained were not substantively different from those reported below.
TABLE 1
Predicting week-to-week Canadian monetary growth

\[ \Delta M_t^e = \alpha + \sum_{j=2}^{31} \beta_j X_{t-j} + \sum_{j=1}^{\infty} \gamma_j \Delta M_{t-j} + \sum_{i=0}^\infty \delta_i \Delta B_{t-i} + \epsilon_t \]

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<th>Variable</th>
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<th>t-statistic</th>
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<td>Intercept</td>
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<td>X_{2}</td>
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NOTE: See text for variable definitions and lag determination.
were regarded as expected monetary changes \( (\Delta M_f^e) \).

IV. ESTIMATION OF MARKET REACTIONS TO CANADIAN MONETARY ANNOUNCEMENTS

1. Efficient markets model

The efficient markets model below is employed to estimate responses in the Canadian/U.S. dollar spot exchange rate, Canadian three-month T-bill and twenty-year government bond yields to the weekly money supply announcement in Canada:

\[
\Delta MV_t = \beta_0 + \beta_1 (\Delta M_t^e - \Delta M_r^e) + \beta_2 \Delta M_r^e + \epsilon_t, \tag{2}
\]

where \( \Delta MV_t \) = change in the price or yield of the relevant market variable measured over an interval which includes the money supply announcement at \( t \);

\( \Delta M_r^e \) = rational expectation of change in the money supply to be announced at \( t \);

\( \Delta M_t \) = announced change in the money supply at \( t \);

\( \beta_0, \beta_1, \beta_2 \) = parameters to be estimated;

\( \epsilon_t \) = random error term.

A test of market efficiency is a test of \( \beta_0 = \beta_2 = 0 \). The reason is that, if the change is measured over a 'narrow window,' risk arbitrageurs could earn substantial profits by utilizing the predictive content implied by non-zero parameters (other than \( \beta_1 \)). For this reason, asset prices and yields should follow a martingale if measured over intervals short relative to their maturity (see Pesando 1979 for a discussion). The focus, however, will be on the \( \beta_1 \) estimates or 'response coefficients,' with a view to drawing inferences on market perceptions of Canadian monetary policy.

2. Full sample estimation

The upper panel of table 2 provides the regression estimates for the overall 1976–9 sample period for changes in the three market variables of interest. The evidence indicates that, consistent with the view that markets are able to process information...

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28 The usual caveat concerning the generation of expectations using all sample information (as opposed to only what market participants have at their disposal at the time) applies here. Between October 1977 and October 1979 the standard deviation of unexpected changes in Canadian money was 1.43 per cent, which is over three times that of the United States (0.43 per cent). For generation of U.S. surprises used in the latter calculation (and data sources), see Deaves, Melino, and Pesando (1987).

29 Though monetary data were collected from the beginning of 1976, the first several observations were dropped, since the money supply was still winding down towards normal levels subsequent to a postal strike. Additional observations were needed to generate the expectations proxy. Thus the sample, for the purpose of estimating financial market reactions, begins with the 11 March 1976 announcement and ends with the 4 October 1979 announcement.
TABLE 2
Response of Canadian financial market variables to Canadian money supply announcements

<table>
<thead>
<tr>
<th>Variable</th>
<th>$b_0$</th>
<th>$b_1$</th>
<th>$b_2$</th>
<th>SEE</th>
<th>$R^2$</th>
<th>DW</th>
<th>BP</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta CN/US$</td>
<td>0.061*</td>
<td>-1.961*</td>
<td>0.770</td>
<td>0.17</td>
<td>0.03</td>
<td>1.86</td>
<td>0.42</td>
<td>0.27</td>
</tr>
<tr>
<td></td>
<td>(4.990)</td>
<td>(2.117)</td>
<td>(1.351)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta TBNC$</td>
<td>-0.002</td>
<td>0.105</td>
<td>0.063</td>
<td>0.02</td>
<td>0.01</td>
<td>1.98</td>
<td>4.63</td>
<td>1.18</td>
</tr>
<tr>
<td></td>
<td>(1.046)</td>
<td>(1.177)</td>
<td>(1.143)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta 20cn$</td>
<td>0.002</td>
<td>0.239**</td>
<td>0.029</td>
<td>0.02</td>
<td>0.02</td>
<td>1.85</td>
<td>2.01</td>
<td>3.57**</td>
</tr>
<tr>
<td></td>
<td>(1.380)</td>
<td>(1.903)</td>
<td>(0.377)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b) $\Delta MV_i = b_0 + b_1(\Delta M_i - \Delta M^*) + b_2(\Delta M^*) + b_3D_i + \epsilon_i$

<table>
<thead>
<tr>
<th>Variable</th>
<th>$b_0$</th>
<th>$b_1$</th>
<th>$b_2$</th>
<th>SEE</th>
<th>$R^2$</th>
<th>DW</th>
<th>$t(\beta_1 + \beta_3 = 0)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta CN/US$</td>
<td>0.091*</td>
<td>1.041</td>
<td>0.807</td>
<td>-5.812*</td>
<td>0.166</td>
<td>0.05</td>
<td>1.85</td>
</tr>
<tr>
<td></td>
<td>(4.670)</td>
<td>(0.583)</td>
<td>(1.426)</td>
<td>(1.963)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta TBNC$</td>
<td>-0.001</td>
<td>0.185</td>
<td>0.064</td>
<td>-0.155</td>
<td>0.016</td>
<td>0.02</td>
<td>1.97</td>
</tr>
<tr>
<td></td>
<td>(0.454)</td>
<td>(1.067)</td>
<td>(1.158)</td>
<td>(0.538)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta 20CN$</td>
<td>0.006</td>
<td>0.562*</td>
<td>0.033</td>
<td>-0.627</td>
<td>0.023</td>
<td>0.03</td>
<td>1.87</td>
</tr>
<tr>
<td></td>
<td>(2.082)</td>
<td>(2.319)</td>
<td>(0.430)</td>
<td>(1.558)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

c) $\Delta MV_i = b_0 + b_1(\Delta M_i - \Delta M^*) + b_2(\Delta M^*) + b_3D_i + b_4$ $\Delta 20US_5 + b_5$ $\Delta TBUS_9 + \epsilon_i$

<table>
<thead>
<tr>
<th>Variable</th>
<th>$b_0$</th>
<th>$b_1$</th>
<th>$b_2$</th>
<th>$b_3$</th>
<th>$b_4$</th>
<th>$b_5$</th>
<th>SEE</th>
<th>$R^2$</th>
<th>DW</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta CN/US$</td>
<td>0.09*</td>
<td>1.11</td>
<td>0.81</td>
<td>-5.89*</td>
<td>-0.49</td>
<td>0.20</td>
<td>0.166</td>
<td>0.06</td>
<td>1.89</td>
</tr>
<tr>
<td></td>
<td>(4.59)</td>
<td>(0.62)</td>
<td>(1.42)</td>
<td>(1.99)</td>
<td>(1.16)</td>
<td>(1.40)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta TBNC$</td>
<td>-0.00</td>
<td>0.17</td>
<td>0.06</td>
<td>-0.14</td>
<td>0.02</td>
<td>0.01</td>
<td>0.016</td>
<td>0.02</td>
<td>1.97</td>
</tr>
<tr>
<td></td>
<td>(0.57)</td>
<td>(0.99)</td>
<td>(1.14)</td>
<td>(0.49)</td>
<td>(0.37)</td>
<td>(0.48)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta 20CN$</td>
<td>0.00</td>
<td>0.47*</td>
<td>0.03</td>
<td>-0.54</td>
<td>0.17*</td>
<td>0.01</td>
<td>0.023</td>
<td>0.03</td>
<td>1.87</td>
</tr>
<tr>
<td></td>
<td>(1.60)</td>
<td>(2.02)</td>
<td>(0.37)</td>
<td>(1.39)</td>
<td>(3.05)</td>
<td>(0.69)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTES: $\Delta CN/US$ = change (in basis points) in Canadian/U.S. dollar spot exchange rate; $\Delta TBNC$, $\Delta TBUS$, $\Delta 20CN$, $\Delta 20US_5$ = changes (in basis points) in Canadian and U.S. ninety-day t-bill and twenty-year government bond yields; all other variables are defined as in the text; BP = Breusch-Pagan (1979) test-statistic for heteroscedasticity ($\chi^2(1)$); W = Wald test-statistic for change in $b_1$ coefficient with sample split at end of 1977; Entries below coefficients are absolute t-statistics; Significance at 5 per cent denoted by * and significance at 10 per cent denoted by **.

efficiently, there was no reaction to the anticipated component of week-to-week M1 growth. All three estimates of $\beta_0$ are safely insignificant. The estimate of $\beta_0$

30 A paper by Hasan and Moussa (undated) also examines weekly Canadian money supply announcements and market reactions (during 1976–82), with the primary focus being the efficiency of the Canadian dollar and t-bill markets. They found some evidence of inefficiency, particularly during periods of changing monetary policy regimes.

31 Pagan (1984) has shown that OLS estimates of $\beta_1$ (the coefficient of a constructed 'residual' variable) and $\beta_2$ (the coefficient of a constructed 'predictor' variable) and of the standard error of $\beta_1$ will be consistent. However, the estimate of the standard error of $\beta_2$ will be inconsistent. For present purposes it does not really matter, since the hypothesis of interest regarding this coefficient is $\beta_2 = 0$. Since OLS will overstimate the t-statistics, acceptance of the null with the false
in the exchange rate regression, while very small in magnitude, is positive and significantly different from zero. The likely explanation is that the trend decline in the Canadian dollar over the period examined here is being picked up. If it had been possible to use an interval of near-zero length — instead of half a business day — a finding of this sort would have been more disturbing.

On the other hand, Canadian markets do seem to have regarded the announcement's unanticipated component as an item of relevant 'news.' A 1 per cent positive money surprise typically led to a two-basis-point increase in the value of the Canadian dollar, and this finding is significant at the 5 per cent level. There is weaker evidence of bond market reactions to surprises, since an equivalent surprise was associated with a roughly one-quarter basis point increase in yield. T-bill rate movements also tended to be in the same direction as money surprises, but the estimated coefficient is insignificant.

Notice that the Durbin-Watson and Breusch-Pagan statistics provide little concern for OLS inadequacy. The Wald test-statistic for long bonds, which is significant at 10 per cent, is suggestive evidence of a changing market response over the sample. This issue of potential structural change will be addressed shortly.

3. Asymmetries in responses

Equation (2) implicitly assumes that negative surprises tend to lead to market reactions equal in absolute value but of opposite sign to equivalent absolute positive surprises. Indeed the U.S. literature has found this to hold (see Belongia and Kolb 1984).

To test for potential asymmetries, I alter equation (2) by the inclusion of an indicator variable as follows:

\[ \Delta MV_t = \beta_0 + \beta_1(\Delta M_t - \Delta M_t^e) + \beta_2 \Delta M_t^e + \beta_3 D_t + \epsilon_t, \]

where

\[ D_t = \begin{cases} 
0 & \text{if } \Delta M_t - \Delta M_t^e < 0 \\
\Delta M_t - \Delta M_t^e & \text{if } \Delta M_t - \Delta M_t^e > 0 
\end{cases} \]

standard errors implies acceptance with the correct standard errors. Trevor (1986) makes these points in the context of the U.S. money supply announcements literature.

32 An anonymous referee correctly points out that the fact that these weekly figures are merely estimates of the final true values and thus will be subsequently revised one or more times may have an impact on the results. Mankiw, Runkel, and Shapiro (1984) have shown that under these circumstances the true surprise is \( \Delta M_t^e - \Delta M_t^e \) (where \( \Delta M_t^e \) = change in expectations after the announcement, with the final true change still being unknown). If, for example, initial announcements are a case of the pure errors in variables problem (i.e., the announcement is the sum of the eventually known true change plus measurement error), then the announcement is an irrational estimate of the final result. Mankiw et al. show that, if this is the case, using \( \Delta M_t - \Delta M_t^e \) will lead to response coefficients whose absolute values are biased downward. They find that this error in variables hypothesis cannot be rejected using U.S. quarterly monetary data, while Milbourne and Smith (1989), though able to reject errors in variables for Canadian monthly monetary aggregates, are also able to reject the idea that the Canadian preliminary announcements are rational predictors of final values.

33 Note that these results are in sharp contrast to those arising in the U.S. literature, where the positive correlation between U.S. money surprises and short-term interest rate changes has always been the main empirical regularity. As earlier suggested, this need not be troubling.
The regression results appear in the middle panel of Table 2. Note that \( \beta_1 \) is the response coefficient for negative surprises, while \( \beta_1 + \beta_3 \) is that for positive. The \( t \)-statistic for \( \beta_1 + \beta_3 = 0 \) is supplied in the last column. A \( t \)-statistic beyond the critical value for \( \beta_3 \) of course implies that positive and negative surprises lead to different reactions. In the foreign exchange market there is a statistically significant asymmetry. In particular, the Canadian dollar only significantly appreciated in the late 1970s after positive surprises. As for short-term and long-term interest rate responses, the point estimates for positive surprises are approximately zero, unlike the positive coefficients observed for negative surprises, but the difference is never significant even at 10 per cent. In the Government of Canada bond market, though it cannot be concluded at reasonable significance levels that there was a difference between positive and negative surprises, one can conclude that negative surprises (but not positive) led to changes in yields.

4. Impact of U.S. interest rate movements
Another issue should be explored: are these apparently systematic findings spuriously generated by interest rate movements south of the border? Since the U.S. weekly narrow money supply announcement also occurred on Thursday afternoon during this sample period (at 4:10 pm), there is reason for caution. To investigate this issue I repeat the market variable response regressions of panel (b), while including as additional regressors changes in U.S. T-bill and twenty-year bond yields over an interval containing the Canadian money supply announcement. The lower panel of table 2 provides the estimates. Despite the clear explanatory power of U.S. long-term bond changes for Canadian yield movements at comparable maturity, the response coefficient for negative surprises remains significant at 5 per cent. Foreign exchange market findings are also unaffected.

5. Response coefficient stability
Figure 2 facilitates a visual exploration of response coefficient variation for all three market variables. A series of ‘floating’ fifty-two-week regressions of asset price or yield changes regressed on Canadian money surprises is run. Beginning

34 This is less problematic for Canadian/U.S. dollar exchange rate movements owing to fortunate timing. The U.S. announcement took place at 4:10 pm, and exchange rate changes here are measured from 4:30 pm to noon on the following business day in order to contain the 5:00 pm Canadian announcement. Thus any reaction of the Canadian/U.S. dollar exchange rate to U.S. surprises should have been completed by the beginning (4:30 pm) of this overnight interval. Exchange rate movements using this interval should be orthogonal to those using intervals containing U.S. announcements, if markets are truly efficient. In any case, researchers have found that the Canadian dollar was not affected by U.S. surprises between October 1977 and October 1979. See, for example, Hakkio and Pearce (1985).

35 The results are virtually unchanged (for October 1977 – October 1979) when one includes as regressors U.S. unexpected and expected money as opposed to U.S. interest rate movements. See Deaves (1989).

36 These regressions exclude anticipated money and U.S. interest rate movements, since these factors, it has been illustrated, do not account for the money surprise-market response phenomenon. The plots shown here are for all surprises (without differentiation between positive and negative). A similar plot for positive (negative) surprises for the Canadian dollar (long-term bonds) reveals substantially the same patterns. In other words, asymmetries are apparently time-invariant.
FIGURE 2. Changing responses (in basis points) of market variables to unanticipated M1 changes (as represented by fifty-two-week-floating regressions)

a) Canadian/U.S. Dollar Spot Exchange Rate

b) Canadian treasury bills
with the first fifty-two weeks of the overall sample, the one-year subsamples are moved forward every two weeks. Note that as one moves along the x-axis, the new observations that are coming 'on stream' are actually six months ahead of the date indicated (which marks the centre of the floating fifty-two-week regressions).

There seems to be evidence that participants altered their typical reactions over the sample in the bond market. In particular, some time during 1978 the negative correlation between money surprises and changes in bond prices seems to have greatly diminished. Before this a short-term interest rate response may have developed for the first time, and reactions of the Canadian dollar may also have become more pronounced.\(^{37}\)

V. SUMMARY AND INTERPRETATION OF RESULTS

Despite difficulties associated with the volatility of week-to-week changes in the Canadian money supply and the lack of a market expectations survey in Canada,

\(^{37}\) One can attempt to be more systematic about it. One way (as in Loeys (1985)) is to estimate market reactions to surprises with a 'floating' dummy slope variable that moves forward (every two weeks) from one year out from the beginning of the overall sample to one year from the end. A breakpoint is indicated where the absolute value of the \(t\)-statistics on the dummy variables is maximized. If one proceeds in this fashion, a breakpoint in May 1978 for long-term bonds (\(|t| = 2.32\)) is found. For t-bills and the Canadian dollar (both using all surprises and only positive surprises), the \(t\)-statistics are never significant at 10 per cent. The problem with this more systematic approach is that there are no compelling a priori reasons for selecting any breakpoints. Hence I prefer to be somewhat impressionistic.
it has been at least demonstrated that financial market participants did consider, at least during the early years of targeting, an announcement of the latest level of the Canadian money supply to be 'newsworthy.' Consistent with the efficient markets paradigm, they reacted only to its unanticipated component. Typically, money surprises were correlated with changes in long-term interest rates and the value of the dollar, but foreign exchange markets reacted only to positive surprises, and bond markets only to negative surprises. These findings are robust to the consideration of contemporaneous U.S. interest rate movements. Long-term interest rate effects seem to have existed only up until about mid-1978, while Canadian dollar movements were more prevalent after about mid-1977.

The foreign exchange market findings are consistent with a perceived counterclockwise policy. Apparently, credibility may have increased after the first year or two of targeting with the Bank of Canada's demonstration that it was capable of staying within (or below) target. The evidence of asymmetrical responses to money surprises may have been due to the disinflationary strategy of monetary gradualism. With target growth rates being periodically revised downward and the public unsure of when these adjustments would take place, there may have been a belief that only positive surprises would be counteracted. Therefore, only after positive surprises did market participants foresee changes in future real interest rates, and the Canadian dollar appreciated accordingly.

On the other hand, the long-term bond market findings are consistent with a perceived policy of accommodation. A positive correlation between surprises and yield movements is symptomatic of perceived accommodation, but the observed tendency for only negative surprises to lead to long-term interest rate declines indicates that the consensus view was that only negative shocks would be accommodated. This, once again, is perfectly consistent with the disinflationary regime in existence at the time. To review, both the coefficient signs and the asymmetrical responses for both the Canadian dollar and Government of Canada long-term bond yields are consistent with the Bank of Canada's policy of monetary gradualism enjoying public credibility.

Why did bond market reactions disappear sometime during 1978? In Canada, with the Canadian dollar depreciating nearly 20 per cent from December 1976 to April 1978 with respect to the U.S. dollar, the Bank of Canada clearly began to pay increasing attention to protecting the value of the currency. Since target monetary growth rates were expressed as fairly broad bands, the bank was in a position to pursue monetary growth targets with a secondary focus on exchange rate stabilization.\(^{38}\) Stabilizing a currency relative to another amounts to surrendering long-term control over the monetary process. Thus in effect Canadian monetary

\(^{38}\) It is indeed arguable that monetary targeting had become a secondary consideration for the bank. By 1978 many of the bank's public pronouncements with regard to monetary growth and interest rates were devoted to their exchange rate implications. Yet growth for the most part remained in the target range up until mid-1981. By this point a choice for the bank between keeping M1 on target or stabilizing the Canadian dollar became unavoidable, and the bank opted for the latter, thereby abandoning targeting in all but name. This reading of recent Canadian monetary policy owes much to Courchene (1981, 1983).
growth was in the process of becoming increasingly unimportant as a predictor of Canadian long-term inflation.

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