Is the Canadian monetary policy endogenous? A cliometric analysis

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CLIOMETRICS

Is the Canadian Monetary Policy Endogenous?
A Cliometric Analysis

Jean-Guy Loranger, Gérard Boismenu[*]

Abstract: A monetary and financial mid-term equilibrium model for an open economy is developed from the Regulationist approach and estimated from Canadian quarterly time series over a long period of time (1947-1999). One important aspect is to make the interest rate endogenous through the balance of payment constraint. The other features of the model are a money supply-demand equation, a real wage price equation, a financial profitability constraint, an average profit rate, a final demand equation, and a productivity equation. The different estimated specifications of the model show strong empirical evidence that a Regulationist structural model fits well the Canadian data and that monetary policy, whether or not based on a policy rule, is endogenous in a mid-term growth model. An implicit monetary rule is deducted from the structural model. The complexity of the output parameter in such a rule makes it very different from other policy rules already surveyed by J.B. Taylor.

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Introduction[1]

Post-Keynesian and other heterodox economists claim that the money supply is endogenous but their position about the interest rate management by the central bank is largely at variance from one school of thought to another. Some say that the monetary policy is completely exogenous and the central bank fixes the short-term rate independently from the long-term rate, the exchange rate or any other economic consideration. For others and including most mainstream economists[2], the central bank reaction function is based on a target rate of inflation and a target rate of growth of production in a closed economy. But once these targets are fixed to 2 or 3% (and included into a constant term), the realized inflation rate and growth rate are the dominant endogenous variables in the central bank reaction function. One could say that the only autonomy left to the central bank is to decide about the timing of the change in the interest rate. This is no big deal since the central bank is regularly informing the business community about its intention and avoid creating a surprise about its policy. The endogenous character of the monetary policy is so much ingrained in the economic policy that the Minister of Finance rarely alludes to it in the budgetary speech. It is even clearer for the European Community where the ECB is completely autonomous from the various governments. Moreover, most models neglect or ignore the other variables which characterize an economy open to financial flows such as the foreign interest rate, the foreign inflation rate, the exchange rate and the equilibrium of the balance of payment. These are the real exogenous variables over which a central bank has little or no control. In other words, this paper challenges the well established view of an efficient policy rule applied by the central bank. The bank can simulate a monetary policy from a calibrated reaction function but the calibration of the parameters cannot be done out of the blue: it comes from a simultaneous structural model where the interest rate, the inflation or rate of change in price, the rate of change in output are all interrelated together with other variables such as the exchange rate, the wage rate, etc...

A monetary and financial model for an open economy will be developed and estimated from Canadian quarterly time series over a long period of time

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[1] This paper is an outgrowth of a paper already presented in French under the title "Un modèle de politique monétaire endogène", International Conference on Economic Policies: Perspectives From the Keynesian Heterodoxy, Université de Bourgogne, Dijon, 14-16 nov. 2002.

[2] The best example of the Post-Keynesian viewpoint about the central bank reaction function is drawn from the papers presented at the Conference by Arestis (2002) and Lavoie (2002). The best presentation of the viewpoint of mainstream economists about the reaction function is in J. B. Taylor (2001a).

(1947-1999). One important aspect is to make the interest rate endogenous through the balance of payment constraint. It is obvious that over such a long period the monetary policy has changed substantially: the target inflation rate as well as the target growth rate were not defined as a policy objective after the Second World War as it is the case nowadays. The introduction of one or many structural breaks would be well recommended in a more refined study. But there are many other possible structural changes which can occur outside the monetary policy. The aim of this paper is more modest: identify and estimate a structural model of an open economy from a system of co-integration relations (or estimate an Error Correction Model). The other features of the model are a money supply-demand equation, a real wage price equation, a financial profitability constraint, an average profit rate, a final demand equation, and a productivity equation.

The underlying inspiration comes from the French Regulationist School,[3] which is a heterodox approach built upon Keynesian as well as Marxian hypotheses about macroeconomic theory and growth. One is pretty far from the Real Business Cycle approach which constitutes the mainstream of macroeconomic fluctuations. This cliometric study will however borrow from the same econometric field: the error correction model (ECM) or the co-integration analysis of a certain number of time series measuring the behaviour of broad economic indicators. The whole model will be presented in the first part, the monetary-financial sub-model in the second part and the econometric results in the third part.

1.0 The complete model

1.1 A short-term and a mid-term model

In the fourth part of his book, Billaudot (2002) develops the macroeconomic theory of Fordism and its crisis and issue. More specifically, chapter VIII on regulation and growth contains a short-term and a long-term model, the latter being designed by Billaudot as a mid-term model, because of his preference to reserve the long-term period for structural changes in the regime. Seven behavioral equations, one equilibrium condition and three definition relations characterize the short-term Fordist model (see Table 1). The endogenous variables

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[3] The first thinkers of the regulation approach are M. Aglietta (1976), B. Billaudot (1976), R. Boyer (1979), A. Lipietz (1979). The Fordist regime as opposed to the competitive one originated from the wage policy applied by Henry Ford and the word has been used for the first time by A. Gramsci in his description of the US accumulation regime. One of the main features of the Fordist regime is the sharing of the productivity gains between capital and labour. For a good retrospective coverage of the regulation theory, see Boyer-Saillard (1995).

described by the behavioral equations are productivity, employment, wage, price, consumption, investment and the rate of investment obsolescence in the gross stock of capital. The endogenous variable pertaining to the macro equilibrium condition is that aggregate supply equals the components of the aggregate demand, i.e. consumption and investment, and the government expenditures that are lumped with autonomous consumption.[4] Variables pertaining to the definition relations are the financial profitability norm, the profit rate, and the gross stock of capital. When an equation has a different specification in the competitive regime compared to the Fordist regime, its specification appears in a *nota bene* immediately below the Fordist equation.

A brief word of explanation is in order for the specification of each equation. Most equations have a non-linear form but are easily adaptable to a log-linear form which is readily suitable for a balanced growth model in an Error Correction Model. Productivity in the short-run depends on the scale of the economy (the Kaldor-Verdoorn law), on technical changes embodied in new equipment and in the new technical division of labour (the productivity shocks measured by K/E), and on the reduction of the average length of the labour period (the pressure for the 35 hour week and the replacement of permanent jobs by temporary renewable contracts). However, in the mid-term equilibrium period, productivity depends solely on the growth rate of potential output and full employment, which implies that the degree of capacity utilization and the unemployment rate are fully adjusted to the desired level and are constant. As seen later, the relaxation of these assumptions can change the structural form of the model.

Employment in the short-term is a function of the desired mid-term level of (full) employment and the productivity gap observed in the previous period[5]. The productivity gap depends on the degree of capacity utilization of the previous period, and hence, employment in the short-run is a direct function of the degree of capacity utilization. However, in the mid-term, since the latter is assumed fully adjusted to the desired level and, therefore, constant, the mid-term equilibrium employment is growing at a constant rate.

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[4] Billaudot has chosen to exclude external demand because this would require the construction of an open economy model. Given the importance of the external sector for the Canadian economy, we shall introduce the exports and imports variables and, later, the model will be completed by the specification of the balance of payment constraint. Another refinement such as an inventory adjustment variable could be introduced in a more complete specification.

[5] Here as well as in other equations, the reference to a previous period can mean many past periods in a model of error correction which is a VAR of order k where k is the number of lagged periods.

Table 1: Short-term and mid-term Fordist model

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a) Behavioral equations

1) *Productivity*

Short-term: $PR = Y/E = f_1(Y, K/E, H)$,

Mid-term: $PR^* = Y^*/E^* = (Y/TU)/Ee^{\delta t} = (Y/E)/(TU) e^{\delta t} = f_1^*(Y, K/E, H, TU, t)$

Y^* = potential production

E^* = potential employment demand

H = average length of the labour period

$TU = Y/Y^*$ = degree of the capacity utilization

t = time period

2) *Employment*

$E = (E^*)^\beta ((Y/E)/PR^*)_{-1}^{(1-\beta)} = (E\, e^{\delta t})^\beta (TU_{-1}\, e^{\delta(t-1)})^{(1-\beta)} = f_2(TU, t)$

3) *wage*

$w = u^{\gamma 0} (p_{-1})^{\gamma 1}(PR^*)^{\gamma 2} = u^{\gamma 0} (p_{-1})^{\gamma 1}(PR/TUe^{\delta t})^{\gamma 2} = f_3(p, Y/E, TU, u, t)$

u = unemployment rate.

N.B. competitive model: $w = (H(1-u))^\gamma$

4) *price*

$p = p(M)^\alpha p(C)^{(1-\alpha)}$

$p(C)$ = prices in the competitive sectors = $(Y/Y^*)^\lambda = (TU)^\lambda$

$p(M)$ = prices in the monopoly sectors = $(w/PR)^\theta \{\rho\, (p/(Y/K))_{-1}\}^{(1-\theta)}$

$p = f_4(w, \rho, Y/E, Y/K, TU)$

N.B. Competitive model: $p = (Y/Y^*)^\lambda = (TU)^\lambda$

5) *Consumption*

$C = B(E(w/p))^\eta = f_5(E, w, p)$,   B = autonomous consumption

6) *Investment*

$I = A(TS)^\phi(\Pi_i C^{\mu i}{}_{-i})\rho^\nu{}_{-1}$, i = 1.....n, A = autonomous investment   , $\nu < 0$

$I = f_6(C, \rho, TS)$

N.B. Competitive model: $I = A(TS)^\phi(\Pi_i rK^{\mu i}{}_{-i})(TU)^\nu$, $\nu < 0$

7) *Renewal rate of the gross stock of capital*

$TS = S/K = f_7 (Y/Y^*) = f_7 (Y/(Y/TU)) = f_7(TU)$

b) Equilibrium condition

8) *Production*

$Y = C^{a1}I^{a2}G^{a3}X^{a4}IM^{a5}$, $\sum a_i = 1$

G = government expenditures

X = exports

IM = imports

c) Fianancial Definition Relations

9) *Profitability criterion*

$\rho = (i(1+q)/r_{-1}) = f_9(i, q, r)$

i = short-term interest rate

q = risk coefficient (measured by the volatility of the stock market index)

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10) *Profit rate*
   $r = (Y/E - w/p)/(K/E) = f_{10}(Y/E, w/p, K/E)$

d) <u>Other Behavioural equations</u>

11) *Gross stock of capital*
   $K = K_{-1}^{(1-\kappa)}I = f_{11}(I, TS)$, $TS = S/K = K^{\kappa}/K$
   S = Amount of obsolete investment removed from the gross stock of capital

12) *Money demand*
   $M = f_{12}(p, Y, i)$
   M = Money stock

13) B*alance of payment equilibrium*
   $CFA + COU = 0 \Rightarrow CFA = -COU = f(IM - X)$ (or IM/X for the log form)
   $CFA/COU = -1$
   CFA = balance of the capital account
   COU = balance of the current account
   $CFA = f\{(i/i^*), (e^*), (p^*/p)\} = f(IM/X)$
   $i^* = $ foreign interest rate
   $p^* = $ foreign price
   $e^* = (1/e) = $ nominal exchange rate = \$CAN/\$US = value of \$CAN per unit of \$US
   Solving with respect to i/i*:
   $i/i^* = f_{13}\{(IM/X), (e), (p/p^*)\}$

In the Fordist model, the short-run wage is a positive function of price, productivity and the degree of capacity utilization and a negative function of the degree of unemployment[6]. Since the latter two are fully adjusted in mid-term, the equilibrium wage depends only on price and productivity. It should be outlined that the mid-term equilibrium real wage is growing at the same pace as productivity if prices and wage are growing at the same pace. Note that in the competitive model, the short-term wage depends positively on the number of hours worked and the degree of employment. Since these two variables are assumed fully adjusted in the mid-term, the equilibrium wage is constant and is independent of productivity in the competitive regime.

   In the Fordist model, the short-term price is a function of the price level in the competitive sector and in the monopoly sector. The short-term price in the competitive sector is a positive function of the degree of capacity utilization while the mid-term equilibrium price is constant. The short-term price in the monopoly sector is far more complicated. It depends positively on the current wage-productivity gap, on the financial profitability criterion, and a factor that is supposed to reflect the state of the demand measured by a price-productivity

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[6]   The power of disciplining the labor force is eroded when employment and the degree of utilization of capacity are increasing towards their normal or potential level.

gap of the previous period. It is assumed that the profitability criterion is constant in the mid-term period and, therefore, the equilibrium price depends only on wage and productivity.

The consumption is a function of direct income, i. e. employment, and the real wage. In a previous empirical work (Boismenu-Loranger-Gravel, 1995) it was assumed that consumption was also dependent on credit and indirect income received as transfer payments.

There is an important difference between the investment function in the competitive regime and in the Fordist regime. In the competitive regime, investment is a function of past profits, the obsolete investment removed from the gross stock of capital and a negative function of the degree of capacity utilization[7]. Since the last two variables are constant in the mid-term, the competitive equilibrium investment is solely a function of past profits. In the Fordist regime, investment is a positive function of past levels of consumption and the obsolescence rate of the gross stock of capital. It is a negative function of the financial profitability criterion. Since the last two variables are assumed constant in the mid-term, the Fordist equilibrium investment is a function of past levels of consumption that are past levels of direct income (or the permanent income). Note in passing that the only chance to re-introduce the IS curve in the mid-term equilibrium would be to allow the variation of the profitability criterion.

In the competitive regime, the obsolescence rate of the gross stock of capital is an exogenous variable measuring the degree of obsolete investment removed from the gross stock of capital. In the Fordist regime, the obsolescence rate is in the short-run a positive function of the degree of capacity utilization since the short-run increase of production induces firms to plan for an acceleration of the obsolescence of equipments (Aglietta, 1976). Since this last variable is constant in the mid or long-term, the obsolescence rate of the gross stock of capital is constant when the system is in equilibrium.

It should be noted that in all these equations, if the capacity utilization is a key variable in the short-term, its influence vanishes in the mid or long-term where the system is in equilibrium. That explains why this variable does not appear into any co-integration relation. The Regulationist regimes outlined here substantially differ from the Keynesian or post-Keynesian growth models where the degree of capacity utilization plays a major explanatory role.

The money supply is assumed endogenous to the money demand and is a positive function of transactions and a negative function of the interest rate. This is different from the mainstream assumption of an exogenous money

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[7] In the short-run, the sign of the coefficient of this variable could be positive because of the positive effect of a wage increase on the aggregate demand. However, in the mid-term, the wage increase will reduce the profit rate and that will feedback negatively on investment. This viewpoint is not shared by Post-Keynesian economists such as Lavoie-Rodriguez-Seccareccia (2002).

supply.[8] The choice of fixing the short-term interest rate must be done within the following constraints:

- The short-term interest rate is regulated by the balance of payment constraint which is defined as the zero sum of the current account and the capital account. Therefore, a positive capital account balance must have the opposite sign of the current account balance, i.e. is equal to the current account deficit.[9]

- The capital account is assumed to be a positive function of the interest rate differential (i/i*), -foreign capital is attracted by a higher domestic rate and, therefore, the current account deficit is positively related to the interest rate differential-.

- The capital account is a negative function of the nominal exchange rate e – a money devaluation increases exports, reduces the current account deficit and therefore is negatively related to the interest rate differential. With a flexible exchange rate, the central bank has no obligation to raise the domestic interest rate. The choice between devaluation and a rise of the interest rate is the cornerstone of its "independence". The policy rule of the Bank of Canada has for a long time been based on a monetary index which is some weighted average of the short-term interest rate and the exchange rate. Note also that, contrary to many monetary policy rules, these rates are nominal instead of real rates.

- The capital account is positively related to the price differential (p/p*) – inflation increase the current account deficit by deteriorating the terms of trade and, hence, is positively related to the interest rate differential. This variable, combined with the nominal exchange rate defines a measure for the real exchange rate.

One can see that the central bank has little autonomy in determining its monetary policy. The optimal policy would be to accommodate the demand for money inside those constraints. According to Taylor's historical analysis (2201b), this has been the policy rule followed by the Treasury at the time of the international gold standard and it has remained more or less like that after the Second World War until the end of the 60's.

The central bank's reaction function is of a rather different type from the one usually specified for a closed economy where the target interest rate is taken here as the foreign interest rate. The target inflation rate is either included in the equation as a constant or a deterministic trend, or it could be identified

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[8] The Billaudot model is a real model for a closed economy. Therefore, the modeling of an open economy with money is a substantial departure from Billaudot's Fordist model.

[9] Note in passing that the current account balance will be approximated by the current trade balance. This short-cut can be justified by the direct link between output and the external trade balance. The difference between the current balance and the trade balance can be assimilated to a stochastic shock which will expressed by the random term of the interest rate equation.

with the foreign inflation rate. The target growth rate of output is the growth rate of external demand associated to exports and the exchange rate variation is a shock absorber for aggregate demand variation. Indeed, one way to reduce the number of variables in the system would be to assume a functional relation between the exchange rate and the trade balance and substitute directly the exchange rate into the aggregate production-demand equation. The link between production and the interest rate would therefore appear more obvious.[10]

Note that, in an Error Correction Model, all equilibrium variables are measured in level instead of growth rate. However, since all our variables are log-transformed, the short-term variations measured by first differences in the VAR model are growth rate variables. Therefore, in the short-term, the monetary policy is dominated not only by the inflation rate and the growth rate of the other endogenous variables such as aggregate demand but also by the growth rate of the other (exogenous) variables which characterize an open economy. The monetary rule remains, even in the short-run, strongly influenced by the endogenous variables of the model because, once targets are fixed to 2% for prices and 3% for production, the central bank operates on some kind of automatic pilot after the calibration of the rule is done.

Obviously, a radical change of policy is always possible, but the Governor of the central bank is continuously repeating that one of his main tasks is to maintain the confidence of the business community and avoid creating shocks or surprises. This is the reason why the Minister of Finance has so little to say about monetary policy when he presents the economic policy: he speaks a lot about fiscal policy, free trade and the restructuring of the economy, namely the need for labor market flexibility, but is almost totally silent about the monetary policy. It is as if it is irrelevant! In a dominant economy such as the US economy, it can always be argued that the FED's monetary policy is relatively independent from all these foreign variables and that it is the FED that will give the proper signal to the rest of the world. Of course, speculations on exchange rates and short-term capital movements have more influence than the movements of the real economy recorded by the variation of the current account balance. However, in the mid or long-term period, even the FED must consider the growing deficit of the current account balance and increase the interest rate unless it is agreed that the dollar should fall. Despite the attraction created by the US dollar as universal money, the question of the over-valued US dollar

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[10] Ball (2001) is one of the rare economists at the NBER Conference who specifies a three equation model for an open economy: an output, a price and an interest rate equation where the exchange rate variable appears in each equation. He deducts his monetary policy rule after substitution of the input and the price equations into his interest rate equation. Although our Regulationist approach is quite different from his three equations, nothing forbids us to make appropriate substitutions in order to have a similar result with the output expressed as a function of the interest rate and the exchange rate, the (relative) price equation a function of output and the exchange rate and the interest rate function of the price and the exchange rate.

and a reform of the architecture of the financial system is a topic that will continue to appear on the agenda of all the G-7 meetings and of other international institutions.

1.2 A mid-term real and financial model

Table 1 contains all the equations for a complete real and monetary-financial model. Because of the large number of equations and variables, it is necessary to specify a mid-term equilibrium model which contains a reduced number of variables since certain variables are constant or fully adjusted when balanced growth is attained. For instance, Billaudot's Fordist specification assumes that, in the mid-term, the variables H, TU, TS, K/E, u, ρ, i, r are all fully adjusted to their equilibrium and, therefore, are constant. By ignoring the external sector, it is also assumed that the variables X, IM, i*, p*, e* are constant. Similarly for money M since the model is relevant for the real sector only.

Table 2: Billaudot's Fordist model

$Y/E = g_1(Y; K/E)$, $\qquad + \quad +$	$K/E = $ constant
$w = g_3(Y/E, p; u)$, $\qquad + \quad + \ +$	$u \ = \ $ constant
$p = g_4(Y/E, w; \rho)$, $\qquad - \quad + \ +$	$\rho \ = \ $ constant
$Y = g_7(Y/E, w, p; \rho, G, X, IM)$, $\qquad + \quad + \ - \ - \ + \ + \ -$	$TS = $ constant

The sign appearing under each variable is the expected sign of each coefficient according to the Fordist or alternative approach already specified above. This model can be reduced to a real model of 3 equations by specifying a real wage equation instead of the 2 monetary equations for wage and price. The determinants of the aggregate demand are justified by the substitution of consumption and investment. The relaxation of the constancy hypothesis of certain real and financial ratios such as the capital/labour K/E, the unemployment rate u, the profit rate r, the financial profitability ratio ρ allows for the estiaion of an alternative model[11]. Moreover, the specification of a monetary-financial open economy model leads to the addition of 4 more equations which constitute the complete model contained in Table 3.

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[11] It may look inconsistent to relax the constancy of the unemployment rate and refuse to consider the same hypothesis for the degree of utilization of capacity. This objection made by Post-Keynesian of Kaleckian inspiration is well accepted and could be integrated in a more elaborate model, in particular, if the short-term dynamic behaviour is analysed.

Table 3: Complete Alternative Model for an Open Economy

$Y/E = f_1 (Y, K/E)$
     + +
$K/E = f_2 (Y, Y/E, TS)$
     - + -
$w/p = f_3 (Y/E, u, \rho)$
      + + -
$Y = f_4 (Y/E, w/p, \rho, G, X/IM).$
    + + - + +
$r = f_7(Y/E, w/p, K/E)$
    + - -
$\rho = (i(1+q)/r_{-1}) = f_8(r, i; q)$
        - + +
$M = f_{12}(p, Y, i)$
    + + -
$i = f_{13}(p, i^*, IM/X, e, p^*)$
    + + + - -

The idea of introducing two definition relations (r and ρ) is justified for three reasons:

- It is necessary for the closure of the model in a simultaneous estimation procedure.
- Although these definition relations are non-linear, the estimation will be log-linear and, hence, will be only an approximation of the true relations. The estimated results will constitute a reality check for the whole model because it becomes difficult to identify a co-integration relation to a particular structural equation if the model contains more than one equation.
- Since the profit rate and the financial profitability ratio are at the heart of the alternative model, one might be interested to know the elasticity of certain determinants. For instance, is the growth of the capital/labour ratio more important than the growth of productivity and real wage in explaining the long-term tendency of the profit rate? The size of the elasticity coefficients will help to understand the underlying forces behind those variables.

2.0 Preliminary results from the estimation

The quarterly series start from 1947I and end in 1999IV. The CATS/RATS package automatically adjust the number of observation according to the number of lags specified. For instance, with k=8, the number of observations starts

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in 1949. Most of the data come from the CANSIM data bank, although many manipulations have been done to homogenize them in real term with a uniform deflator. Since the CANSIM quarterly series are available only since 1961, a lot of work has been done with a previous data bank which was used in Loranger-Boismenu-Gravel (1995). The complete set of data is available on request.

The real and monetary-financial model of Table 3 has 8 endogenous variables and 6 exogenous variables. The co-integration analysis is a vector regression analysis of all variables over a certain period of time. The variables are assumed stationary or non stationary but there exists a certain number of co-integration relations between these variables. The task will consist of identifying a co-integration relation to each endogenous variable and assuming that the exogenous variables are common stochastic trends which shock the equilibrium of the system.[12]

2.1 Unit root tests

Before beginning the tests for the mid-term model, it is important to know the unit root tests for all the variables of the model including those for the short-run variables, which do not enter into the co-integration relations. Two types of tests will be presented in Table 4: the Dickey-Fuller Augmented test (DFA) and the Phillips-Perron test (PP) for an AR process with a constant and 8 lagged variables.[13] The H_0 hypothesis of a unit root cannot be rejected at the 5% level unless the calculated value T(rho −1) is below −13.8. A higher critical level of 10% would require a calculated value below −11 if the unit root hypothesis has to be rejected.

Results of Table 4 show that the DFA test is more robust to the rejection of the unit root hypothesis than the PP test which indicates that at least 6 variables have no unit root. They are therefore stationary variables of the capital productivity Y/K, the average length of the work period H, the capacity utilization TU, the withdrawal rate of the gross stock of capital TS, the degree of risk q and, the profit rate r. With the exception of the profit rate, all these variables

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[12] The introduction of exogenous variables in a co-integration relation may appear as an alternative way to express structural change on the constant term which can also be seen as a deterministic trend in the co-integration relation. Indeed, if these variables were ignored, they would be specified as a structural constant. One could then run a test for a structural break of the constant term corresponding to an irregular major shock. See Diebolt-Darné (2002) for an update bibliography on unit root tests and irregular changes caused by major shocks. However, if they are assumed stochastic exogenous variables, they can be either I(0) or I(1). If they are I(0), they can be assimilated to the error term, but if they are I(1), they need to appear explicitly as common stochastic trends.

[13] A 4 lag experiment was also achieved but there is very little difference between the two types of results.

are constant or exogenous in the model and, could not enter the model as common stochastic trends.

This last statement is however contradicted by the DFA test where only the TU variable is stationary. The DFA results seem to be more compatible with a priori specification of the model.

Table 4: Unit root tests

1) **Demand variables**	PP Test	DFA Test
Y	-1.41	-0.89
C	-1.09	-0.91
I	-2.19	-0.63
G	-1.87	-2.80
X	0.36	0.45
M	0.29	0.27
2) **Production variables**		
K	-1.21	-1.20
E	-1.75	-1.03
K/E	-1.61	-2.20
Y/E	-3.31	-1.42
Y/K	-106.7**	-6.40
H	-15.48**	-1.32
TU	-37.93**	-175.2**
TS	-32.49**	-9.03
u	-7.50	-5.10
3) **Monetary variables**		
M1	0.52	0.12
M2	-0.45	-1.41
i	-5.59	-5.14
q	-48.34**	-8.57
r	-96.61**	-5.14
i*	-10.81	-6.53
p*	0.31	0.10
e	-0.92	-3.0
w	-0.43	-0.38
p	-0.13	-0.20
ρ	-5.23	-5.39

2.2 Choice of a constant and order of the VAR

Before determining the co-integration space for each specification, the CATS software of Hansen-Juselius (1995) allows one to check whether a constant needs to be included or excluded from the co-integration relations. The results are not reported here but the best choice was to select a constant outside the co-

integration relation, representing a constant in the first difference equation that gives a deterministic trend for variables measured in level. [14]

One needs also to specify the order of the VAR. Table 5 presents the results for a range of 3 to 7 lag periods of a model containing a large number of variables. The minimum according to the HQ criterion is a VAR of 6 lags while the minimum is 4 lags according to the SC criterion. To avoid repeating the test for each specification, the order of the VAR was chosen equal to 5 for all specifications, although the last two batches of results appearing in tables 9 and 10 are based on a VAR spread over 8 quarters.

Table 5: Choice of the VAR Order

Nb lags = k	3	4	5	6	7
HQ	-31.58	33.24	-33.42	-33.44*	-33.27
SC	-30.67	-32.09*	-32.02	-31.81	-31.38

3.0 Estimation of a monetary-financial model

Firstly, an attempt was made at estimating the whole system by imposing a priori constraints on the ALPHA and the BETA matrices. This manner of proceeding was quickly abandoned because it was impossible to identify each co-integration relation to a particular structural equation.[15] The complete model was subdivided between the real part and the monetary-financial part and each part estimated separately. Since the chief aim of this article is to examine the determinants of the monetary policy, the estimated results of a monetary-financial sub-model for a closed economy are presented as a first attempt to identify some co-integration relations to the endogenous variables w, p, r, ρ and M. Then a 6th equation – the interest rate – will be added with a new group of exogenous variables for the open economy model. In order to reduce the size of this empirical analysis, only the coefficients of the co-integration space contained in the BETA matrix will be presented and commented. We ignore the coefficients of the ALPHA matrix which would give us some information

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[14] Indeed, by taking the log of $Y = e^{\alpha t}(Y/E)^a$, we have $\ln Y = \alpha t + a \ln(Y/E)$. The first difference model is $d\ln Y/dt = \alpha + a \, d\ln(Y/E)/dt$.

[15] Moreover, if one has to experiment with the order of the VAR, it becomes rapidly impossible to maintain a sufficient number of degrees of freedom. For instance, with a VAR of order k = 5, t = 212 observations and p = 20 variables, the number of degrees of freedom is $Tp -(4p + kp^2 + p(p + 1)/2) = 4240 - (80 + 2000 + 210) = 2290 = 1950$. Assuming a VAR of order k = 10, the number of parameters to be estimated exceeds the number of observations.

about the speed of adjustment towards the equilibrium. Also ignored are the coefficient matrices of the variables in first differences which would inform us about the short-run dynamics.

3.1 Monetary-financial model for a closed economy

The first two equations are the wage and the price equations. The choice of a separate estimation for these two variables instead of a single one, the real wage rate w/p, is based on the hypothesis of a divergence of the growth rate between w and p. This has some importance in the estimation of the money demand since the price enters the third equation. With the two definition relations for ρ and r, the monetary-financial system in a closed economy is made up of 5 endogenous variables w, p, r, ρ, and M1 and 6 exogenous variables u, i, q, Y/E, K/E, and Y. In a complete model that integrates real and financial variables, the last three variables would be considered as endogenous unless K/E is assumed an exogenous stochastic variable. Two types of results will be discussed: an unconstrained estimation of the BETA matrix of the co-integration space and a constrained estimation corresponding to the structural model. The significance test of the differences between the two results will appear as a likelihood ratio test.

Table 6a: Monetary-financial model in a closed economy
Unconstrained estimation

LW	LP	LRHO	LR	LM1	Li	Lq	LU	LY/E	LK/E	LY
1.000	-0.994	0.082	0.714	0.079	-0.063	0.001	-0.035	-1.564	0.633	-0.217
0.024	0.008	1.000	0.934	-0.046	-0.998	-0.001	-0.001	0.110	-0.106	0.016
-1.035	1.000	0.451	-0.375	-0.040	-0.433	-0.005	0.002	2.966	-1.073	-0.249
0.053	0.063	1.305	1.000	-0.062	-1.389	-0.009	-0.062	-0.358	0.247	0.039
-10.154	10.072	-7.450	-21.825	1.000	7.681	-0.102	-0.983	27.337	-15.938	-2.025

Following the 10% level of the trace test, the rank of the system is 7, but at the 1% level, the hypothesis of 5 co-integration relations is accepted. The calculated value of the likelihood ratio is a $\chi^2 (18) = 95.47$ while the critical value at the 5% level is 28.9. The a priori restrictions imposed on the coefficients are significant because the unconstrained estimated coefficients are completely different from 0. Following the theory, one would prefer the constrained estimated results to the unconstrained ones. In practice, it is not obvious which type of estimation could be preferred because, if one closely examines the results, certain equations are better identified with the free estimation and others with the constrained estimation.

Table 6b: Monetary-financial model in a closed economy
Constrained estimation (1)

LW	LP	LRHO	LR	LM1	Li	Lq	LU	LY/E	LK/E	LY
1.000	-1.000	0.000	0.000	0.000	0.000	0.000	0.246	-0.508	0.000	0.000
0.000	0.000	1.000	0.903	0.000	-7.588	-0.001	0.000	0.000	0.000	0.000
-1.000	1.000	0.596	0.000	0.000	0.000	0.000	0.000	1.075	0.000	0.000
1.310	-1.310	0.000	1.000	0.000	0.000	0.000	0.000	-1.896	0.460	0.000
0.000	-1.000	0.000	0.000	1.000	-188.394	0.000	0.000	0.000	0.000	-0.537

For instance, in the first equation pertaining to the real wage in the constrained estimation, the elasticity coefficient with respect to the unemployment rate changes sign and value: for each 1% increase of u, w/p is reduced by one quarter of 1%. Moreover, the real wage rate becomes rather inelastic with respect to productivity (0.508) while a unitary elasticity would be in order.

A similar change is observed with the second equation ρ: although the financial profitability norm has an elasticity close to unity (-0.934 or –0.903) with respect to the profit rate in both types of estimation, the excessive elasticity value (7.558) with respect to the interest rate does not make sense in the constrained estimation while the unitary elasticity (0.998) makes good sense in the unconstrained estimation. Changes observed for the third equation, the price, are in favor of the constrained estimation: although the ρ coefficient has the wrong sign in both types of estimation, the negative unit elasticity (-1.075) of the relative price with respect to productivity is exactly what would be expected in a balanced growth model.

A similar result is observed for the fourth equation pertaining to the profit rate r: the elasticity with respect to real wage is –1.31, which makes perfectly good sense while the unconstrained estimate is around 0! Note in passing that both real wage and productivity have high elasticity coefficients (-1.31 and 1.896) compared to the weak elasticity coefficient (0.460) of the capital-labour ratio in the constrained estimation of the profit rate equation.

Given that most empirical studies measure money in real balance, an additional constraint has been imposed for the measurement of real money: LM1-LP in the fifth equation. The results from the unconstrained estimation are surprisingly better than the constrained one, at least for the negative expected sign for the interest rate. The estimated coefficient of the interest rate in the constrained estimation (188.4) is not realistic.

There is a way of removing this biased result by displacing the constraint on price: if prices and wages are not growing at the same rate as money, then this will create a distortion in the system. To verify this hypothesis, the model was re-estimated without imposing a constraint on prices and wages and the results

obtained (Table 19c) for the constrained estimation perfectly identify the structural equations of the system. The money real balance is positively elastic (2.72) to production and negatively elastic (-2.77) to the interest rate. In addition, the ρ equation is perfectly identified with a positive unit elasticity for the interest rate (1.006) and a negative unit elasticity for the profit rate (-1.061) as one would expect for this identity relation. Moreover, the impact of the financial profitability on inflation is rather strong with a positive elasticity coefficient of 4.584.

The Wald test applied to the price coefficient (0.901) in the wage equation reveals that the coefficient is significantly different from unity since the calculated χ^2 (1) is $[(0.901- 1)/ 0.012]^2 = 68.06$ and is well above the critical value at the 5% level (3.84). On the other hand, the wage coefficient in the

Table 6c: Monetary-financial model in a closed economy
Constrained estimation (2)

LW	LP	LR	LRHO	LM1	LU	Li	Lq	LY/E	LK/E	LY
1.000	-0.901	0.000	0.000	0.000	-0.048	0.000	0.000	-1.466	0.000	0.000
0.000	0.000	1.061	1.000	0.000	0.000	-1.006	-0.000	0.000	0.000	0.000
-0.865	1.000	0.000	-4.584	0.000	0.000	0.000	0.000	10.179	0.000	0.000
0.403	-0.403	1.000	0.000	0.000	0.000	0.000	0.000	-2.030	1.752	0.000
0.000	-1.000	0.000	0.000	1.000	0.000	2.772	0.000	0.000	0.000	-2.725
Standard error of BETA										
0.000	0.012	0.000	0.000	0.000	0.005	0.000	0.000	0.045	0.000	0.000
0.000	0.000	0.018	0.000	0.000	0.000	0.005	0.001	0.000	0.000	0.000
0.226	0.000	0.000	0.340	0.000	0.000	0.000	0.000	1.012	0.000	0.000
0.070	0.070	0.000	0.000	0.000	0.000	0.000	0.000	0.140	0.069	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.197	0.000	0.000	0.000	0.145

price equation is not significantly different from unity since the calculated χ^2 (1) is $[(0.865-1)/0.226]2 = 0.358$. Why in one equation would prices grow at the same rate as wages and not in another? One reason appears to be the impact of the unemployment rate in the wage equation with a positive significant coefficient with a χ^2 (1) $= [0.048/0.005]^2 = 92.16$.

Finally, Marx's hypothesis of a growing tendency of the capital-labour as an explanation of the falling tendency of the profit rate has an empirical foundation in the Canadian economy and is as good an explanation as the countertendency of productivity growth since the elasticity coefficient of K/E (1.752) is nearly as important as the elasticity coefficient of productivity (2.030). Turning to the analysis of the balance of payment constraint which will allow for an endogenous interest rate, one will see if the equilibrium of the system is to be maintained.

3.2 Monetary-financial model in an open economy

The calculated value of the likelihood ratio between an unconstrained and a constrained estimation is a $\chi^2 (37)= 190.48$ while the critical value at the 5% level is 55.0. Hence, the 0 restrictions and the unity restrictions on some coefficients are significant and there are important differences between the two types of estimation. Again, the constrained estimation will reveal itself to be the better one.

Table 7a: Estimation of a monetary-financial model in an open economy
Unconstrained estimation

LW	LP	LR	LRHO	LM1	Lu	Li	Lq
1.000	-1.163	0.627	-0.025	-0.014	-0.027	0.014	-0.000
-1.987	1.129	-0.089	1.000	-0.444	0.102	-0.983	-0.004
-0.850	1.000	-1.005	-0.340	-0.053	0.017	0.283	-0.002
-0.035	0.300	1.000	0.815	0.001	0.035	-0.790	0.004
5.573	-5.107	-1.545	-9.390	1.000	0.326	9.867	0.029
-0.207	-4.519	-3.514	-0.955	-1.075	-0.313	1.000	0.012

LY/E	LK/E	LY	LM/X	Li*	Lp*	Le
-1.285	0.420	-0.109	0.137	0.027	0.211	0.005
3.657	-1.375	0.646	0.242	-0.060	0.984	0.179
1.417	-0.708	0.215	0.074	0.029	-0.198	0.068
0.025	-0.008	-0.028	-0.110	0.016	-0.251	-0.144
-13.001	5.685	0.043	-0.675	-0.131	-1.129	-1.019
3.950	-3.518	0.697	1.204	0.017	5.917	0.233

Table 7b: Constrained estimation

LW	LP	LR	LRHO	LM1	Lu	Li	Lq
1.000	-0.894	0.000	0.000	0.000	-0.077	0.000	0.000
0.000	0.000	2.900	1.000	0.000	0.000	-0.385	-0.001
-0.995	1.000	0.000	0.116	0.000	0.000	0.000	0.000
1.995	-1.995	1.000	0.000	0.000	0.000	0.000	0.000
0.000	-1.000	0.000	0.000	1.000	0.000	-0.322	0.000
0.000	-5.247	0.000	0.000	0.000	0.000	1.000	0.000

LY/E	LK/E	LY	LM/X	Li*	Lp*	Le
-1.154	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.031	0.000	0.000	0.000	0.000	0.000	0.000
-2.183	0.135	0.000	0.000	0.000	0.000	0.000
0.000	0.000	-1.855	0.000	0.000	0.000	0.000
3.950	-3.518	0.697	1.204	0.017	5.917	0.233

The results of the unconstrained estimation are rather poor with the exception of the wage and price equations. For instance, the coefficients of the profit rate have wrong signs, production has a negative elasticity coefficient near 0 in the money equation, and the interest rate equation has wrong sign coefficients for 2 variables out of 4 (the foreign interest rate and the current account balance).

The situation changes radically with the constrained estimation: all equations are identified with proper signs except for two variables: ρ in the price equation and i in the money equation. Real wage changes at the same rate as productivity with a unit elasticity coefficient in both equations.

Real wage has a weak positive elasticity (0.077) with respect to the unemployment rate, which seems to be in agreement with the reserve army hypothesis if the coefficient is significantly different from 0.[16]

The financial profitability norm has a weak positive elasticity (0.385) with respect to the interest rate while it has a strong negative elasticity (-2.9) with respect to the profit rate. This is rather contrary to the financial profitability hypothesis that would imply a much more important role for the interest rate than for the profit rate. The (wrong) negative sign in the price equation is the rejection of hypothesis of the inflation cost created by rentier capitalists.

The average profit rate is strongly elastic (≈ 2) with respect to real wage and productivity but weakly elastic (-0.135) with respect to the K/E variable. This result would contradict Marx's hypothesis of the falling rate of profit caused by a rising tendency of the capital-labour ratio.

The elasticity of the real money balance with respect to production is around 2 while one would expect a value around unity. This biased result is most likely caused by a bad coefficient for the interest rate, which is positive while it should be negative.

Finally, the a priori constraint on the interest rate differential between the domestic rate and the foreign rate seems to perform well. Indeed,

$$Ln(i/i^*) = constant + 1.058 Ln(IM\text{-}X) + 5.247 Ln(p/p^*) - 0.705 Ln(e)$$
$$(.219) \qquad\qquad (.546) \qquad\qquad (.199)$$

As it can be seen, three supplementary constraints have been imposed with this estimation: Li - Li*, LMX = LIM -LX and Lp - Lp*. Note that the interest rate differential has a unit elasticity with respect to the current trade deficit, and strongly reacts to a domestic inflation greater than a foreign inflation, and decreases when money is devalued (de>0). This is a good empirical example how the monetary policy is endogenous inside the balance of payment con-

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[16] It may be important to remember that mainstream economic thinking (the Phillips curve) assumes a negative relation between the wage rate and the unemployment rate if the latter is not fully adjusted in the mid-term. The positive sign of the unemployment rate has more relevance with the determinants of the supply side of labour which is rather horizontal under the reserve army hypothesis.

straint. In summary, if the opening of the economy has been successfully achieved by the balance of payment constraint and, in particular, by adding the equation of the interest rate differential, it has created some distortion in the rest of the system. It remains to be seen whether or not the addition of equations coming from the real sector will improve the results, namely, the aggregate output-demand equation.

4.0 Estimation of the complete model in an open economy

The model in Table 3 is a real and monetary-financial model for an open economy. The linking of the previous results with the complete model in Table 3 will be achieved step by step by introducing the aggregate demand equation and the productivity equation. The K/E variable will be assumed as an exogenous stochastic variable because, despite many attempts at identifying a specific co-integration relation for this variable, wrong signs were often found for this equation and created distortions in the whole system. In order to reduce the quantity of output data, only the constrained estimated results will be presented and commented upon.

4.1 The influence of the aggregate demand equation

The addition of the aggregate demand equation is an improvement with respect to the previous results. Although the interest rate still has the wrong sign in the money equation, the coefficient of the financial profitability criterion has now (as expected) a positive sign in the price equation. Moreover, the magnitude of the elasticity coefficients is substantially changed in many cases. For instance, the elasticity coefficient of the unemployment rate has doubled and the productivity coefficient has increased by around 50% in the wage equation.

The profitability criterion is now much more sensitive to the interest rate (1.162) and the risk coefficient (0.006) than to the average profit rate (-0.365). The price elasticity is weakly positive (0.086) to the financial profitability ratio and inelastic with respect to productivity while it was around – 1 in the previous results. The hypothesis of an inflation cost caused by rentier capitalists could have some empirical foundation.

The profit rate is weakly sensitive to the real wage (-0.158) while the coefficient was around -2 before and is elastic to productivity (1.519 instead of 2.183) and also elastic to the capital/labour ratio (-1.115) compared to (-0.135) in the previous estimation. This has an important implication for the long-run (falling) tendency of the profit rate.

The interest rate differential is now inelastic to the current trade deficit (0.631) while it was around unity before; it remains however strongly elastic to the price differential (4.615 compared to 5.247) and rather inelastic to money devaluation (-0.458 compared to -0.705). The hypothesis of endogenous monetary policy inside the constraints of the balance of payment maintains its empirical foundation.

Table 8: Constrained estimation of an open monetary-financial model
(real demand added)

LW	LP	LRHO	LR	LM1	Li	LY	Lu	LY/E
1.000	-0.833	0.000	0.000	0.000	0.000	0.000	-0.149	-1.677
0.000	0.000	1.000	0.365	0.000	-1.162	0.000	0.000	0.000
-1.093	1.000	-0.086	0.000	0.000	0.000	0.000	0.000	0.451
0.158	-0.158	0.000	1.000	0.000	0.000	0.000	0.000	-1.519
0.000	-1.000	0.000	0.000	1.000	-0.482	-2.418	0.000	0.000
0.000	-4.615	0.000	0.000	0.000	1.000	0.000	0.000	0.000
-1.861	1.133	-1.406	0.000	0.000	0.000	1.000	0.000	-7.288

LK/E	Lq	LG	LX	LM	Li*	Lp*	Le
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	-0.006	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.115	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.631	-0.631	-1.000	4.615	0.458
0.000	0.000	1.091	-0.329	0.329	0.000	0.000	0.000

Finally, the aggregate demand equation is confirmed except for two coefficients of the wrong signs: demand would be negatively elastic with respect to government expenditures (-1.091) and positively elastic to the financial profitability ratio (1.406) which is contrary to expectations. But the other estimated coefficients are highly meaningful: demand reacts very strongly to real wages and productivity! This is an illustration of the main Fordist hypothesis: the sharing of productivity gains has a positive impact on the real wage which fuels the growth of consumption and the latter feedbacks on productivity. This constitutes the virtuous circle which explains the golden age of Fordism.

This empirical analysis would be incomplete without deducting a policy rule which can express the short-term domestic interest rate as a function of output, price, the exchange rate and some other domestic and foreign variables. In order to have the output appearing into the interest rate equation, it is necessary to substitute the wage equation into the aggregate demand equation and then explicit the result with respect to the trade balance and then substitute the latter into the interest rate equation. However, because of the wrong sign of the ρ coefficient in the demand equation, it will not give plausible results in the interest rate equation. Therefore, a new specification is required.

4.2 The influence of the productivity equation

The first attempt to estimate the complete model with a productivity equation was not very successful. In addition to the unexpected negative capital/labour ratio coefficient in the productivity equation, a few more coefficients are found with wrong signs: the rho coefficient and the interest rate coefficient are still positive in the aggregate demand equation and the money equation. Worse, the profitability criterion now has a negative sign in the price equation, the current trade deficit coefficient is negative in the interest rate differential relation, and the current trade balance is negative in the demand equation. As already mentioned in the first part, collinearity between the trade balance and the (real exchange rate) could be the main source of instability of the estimated coefficients of the interest rate equation.

The relaxation of the constraint on the current trade balance and on the money balance improved some coefficients but continued to give us some bad results, especially wrong signs for the trade deficit and the exchange rate in the interest rate equation. A new set of specifications became necessary. Since the monetary policy can be spread over two years, three more lags are added to the ECM (error correction model). Also, a positive relation is assumed between the trade balance and the exchange rate (a devaluation improves the trade balance) and the latter is substituted in the interest rate and the demand equations. Judging by the results appearing in table 9, the outcome is excellent, namely for the last three equations: the real exchange rate has a negative sign in the interest rate equation, the estimated coefficients in the demand and the productivity equations have all the good expected signs! The estimated coefficients in the money demand and the profit rate equations are however unduly large and the productivity coefficient in the price equation has the wrong sign. Multicollinearity between p and w can be the cause of these large unstable coefficients.

It is therefore important to re-introduce some constraints on w/p, M/p and i/r in order to eliminate this cause of instability. The results appearing in table 10 are almost perfect except for the ρ coefficient which is negative in the price equation. The real wage has an elasticity near unity with respect to productivity (.972 in the wage equation and -.949 in the price equation), the verticality of the long-run Phillips curve seems to have some empirical foundation with a near 0 negative coefficient (-.011) for the unemployment rate. The money demand is quite sensitive to the interest rate (-4.224) and to aggregate output or demand (2.127). The interest rate differential is rather elastic to the real exchange rate, i.e. strongly positive with respect to the price differential (4.775) and negative with respect to the nominal exchange rate (-2.087). The aggregate demand is elastic with respect to real wage (1.029) and productivity (1.110), as expected from a Fordist regime, negatively elastic with respect to the profitability criterion (-.471) as expected from the IS curve, and weakly elastic with

respect to the (nominal) exchange rate (.077) and the government expenditure (.219). What matters here is not so much the small coefficient for e as its positive sign: aggregate (external) demand increases with a devaluation of money.

Table 9: Constrained estimation of the complete model with the exchange rate in the demand equation (with unconstrained price and wage)

LW	LP	LRHO	LR	LM1	Li	LY	LY/E
1.000	-1.917	0.000	0.000	0.000	0.000	0.000	1.740
0.000	0.000	1.000	-5.595	0.000	-1.418	0.000	0.000
-0.403	1.000	-0.159	0.000	0.000	0.000	0.000	-1.117
1.836	-2.395	0.000	1.000	0.000	0.000	0.000	-15.469
0.000	12.713	0.000	0.000	1.000	-7.452	-14.558	0.000
0.000	-1.478	0.000	0.000	0.000	1.000	0.000	0.000
0.603	-1.076	0.250	0.000	0.000	0.000	1.000	-1.216
0.000	0.000	0.000	0.000	0.000	0.000	-0.056	1.000

Lu	LK/E	LQ	LG	Li*	Lp*	Le
0.130	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.092	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	15.517	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	-1.000	1.478	1.504
0.000	0.000	0.000	-0.200	0.000	0.000	-0.072
0.000	-0.901	0.000	0.000	0.000	0.000	0.000

Productivity is moderately sensitive to aggregate demand (.412) as expected by the Kaldor-Verdoorn law and weakly elastic to the technical composition of capital (.076). Since K/E is a stochastic variable, it can be interpreted as stochastic shocks from technical changes. It is clear however that the influence of the endogenous changes represented by Y is 5 times more important than the exogenous shocks represented by K/E. There is however a little difficulty with the profit rate equation: the wage and the productivity coefficients have wrong signs, although their product is positive which, in the end, is the only result that matters. We now have at last good enough results in order to proceed to an empirical estimation of the monetary policy rule behind this simultaneous system.

Table 10: Estimation of the complete model with the exchange rate in the demand equation (constraints on w/p, M/p, i/r)

LW	LP	LRHO	LR	LM1	Li	LY	LY/E
1.000	-1.000	0.000	0.000	0.000	0.000	0.000	-0.972
0.000	0.000	1.000	0.729	0.000	-0.729	0.000	0.000
-1.000	1.000	0.052	0.000	0.000	0.000	0.000	0.949
-0.952	0.952	0.000	1.000	0.000	0.000	0.000	0.078
0.000	-1.000	0.000	0.000	1.000	4.224	-2.127	0.000
0.000	-4.775	0.000	0.000	0.000	1.000	0.000	0.000

| -1.029 | 1.029 | 0.471 | 0.000 | 0.000 | 0.000 | 1.000 | -1.110 |
| 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | -0.412 | 1.000 |

Lu	LK/E	LQ	LG	Li*	Lp*	Le
0.011	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	-0.015	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.822	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	-1.000	4.775	2.087
0.000	0.000	0.000	-0.219	0.000	0.000	-0.077
0.000	-0.076	0.000	0.000	0.000	0.000	0.000

4.3 The implied monetary policy rule

The main idea behind a monetary policy rule is to express the interest rate equation as a reaction function of the central bank in terms of the inflation and the output variables. In order to achieve that with our model, it will be necessary to substitute the real wage, the productivity and the profitability criterion equations into the demand equation, explicit this equation with respect to the exchange rate and substitute the latter into the interest rate equation. Since prices are already explicitly appearing in the interest rate equation, the money demand, the profit rate and the price equations can be ignored in the determination of this rule. The estimated structural model is then the following:

(1) $\ln w/p = .972\ln Y/E - .011\ln u$ or $\ln w = \ln p + .972\ln Y/E - .011\ln u$

(2) $\ln \rho = .729\ln(i/r) + .015 \ln q$

(3) $\ln(i/i^*) = 4.775 \ln(p/p^*) - 2.087 \ln e$

(4) $\ln Y = 1.029 \ln(w/p) - .471\ln \rho + 1.110 \ln Y/E + .219 \ln G + .077 \ln e$

(5) $\ln Y/E = .412 \ln Y + .076 \ln K/E.$

The substitution of (5) into (1) and (4) gives

(4a) $\ln Y = 1.029[.972(.412 \ln Y + .076 \ln K/E) + \ln p - .011 \ln u] - 1.029 \ln p - .471 \ln \rho + 1.11(.412 \ln Y + .076\ln K/E) + .219 \ln G + .077 \ln e.$

The substitution of (2) into (4a) and expressing the latter with respect to $\ln e$

(4b) $\ln e = 1.70\ln Y - (2.08 \ln K/E + 2.84 \ln G) + .14 \ln u + 4.45(\ln i - \ln r) + .09 \ln q.$

Finally, substituting (4b) into (3)

(3a) ln i = .097ln i* + .463ln (p/p*) -.344ln Y + .421lnK/E + .575ln G +
.901ln r – (.028ln u + .018ln q).

The policy rule that is implicit in our structural model is more complicated than Taylor's simple rule for a closed economy where the inflation coefficient is around 1 and the output coefficient is around 0.5. Since E is a negative function of u and Y a positive function of f(K/E, G, r, E), the implicit policy rule is

(3b) ln i = .097ln i* + .463ln (p/p*) -.344ln Y + ξ ln Y.

Provided that (ξ – 0.344) is positive, the implicit policy rule is rather different from any of the 5 rules enumerated in Taylor's book (2001, p. 6). The adjustment of the interest rate to the desired output level is dependent on 4 variables over which the central bank has no control. It would be simpler for the central bank to ignore the output criteria and react only to a price change, a foreign interest rate change and an exchange rate change as specified by equation (3).

5.0 Conclusion

A detailed model of a real and monetary open economy was presented in the first part. It can be applied to the short-run as well as the mid-term or long-run period. The set of variables in the mid-term are different from those of the short-term period. In order to minimize the size of the output submitted for empirical analysis, the estimation was limited to a balanced growth mid-term model using co-integration analysis. Although the Error Correction Model applied to a set of variables can generate matrices of estimated coefficients for the short-run period, the analysis is concentrated on the results of the coefficient matrix BETA corresponding to the co-integration space where each co-integration relation can be identified to a mid-term or long-term equilibrium relation.

The identification of structural equations from co-integration relations is an impossible task without imposing a priori restrictions on the BETA parameter matrix. One has to start with a small model which is easy to identify and add a supplementary equation one at a time. There is no absolute guarantee that the larger estimated model will be exactly identified with the structural system, but one can evaluate the degree of robustness of the estimated model at each step by doing some trial and error tests. The first step was to start with a 5 equation monetary-financial model for a closed economy. Two equations are based on

definition relations and two others can be merged to a single real wage equation.

One of the main findings is that the constrained estimation with zero a priori restriction on some parameters of the co-integration space gives better results than the free estimation of the whole set of variables. Another finding is that the imposition of constraints on the parameters of certain variables can seriously disturb the system if those variables do not grow at the same pace. For instance, with a certain set of specifications, it was observed that better results were obtained when wages and prices can move freely instead of being constrained to the growth rate of a real wage. Similarly for the current trade balance. However, with another set of specifications, namely, when the trade balance was replaced by the exchange rate in the demand and the interest rate equations, constraints on the parameters of wage, price, money and profit rate gave the best results.

The title of the article states that the chief aim of this empirical research is to test whether the Canadian monetary policy has been endogenous over the last fifty years or more. To that extent, money supply is assumed endogenous to money demand and the latter endogenous to prices, aggregate demand, and the interest rate. The interest rate is assumed to be endogenous and obey to the constraint of the balance of payment, the determinants of which are the current account deficit, the exchange rate, and the price differential between domestic prices and foreign prices. The strong link between the trade balance and the exchange rate forced us to eliminate one of them by substituting one by the other As one can see, the variables of such a system are highly interdependent and the central bank has no other choice than to manage the monetary policy inside those constraints.

The first test was conducted with 5 endogenous variables (w, p, r, ρ and M1) and 6 stochastic exogenous variables (u, i, q, Y/E, K/E, Y) of a monetary-financial model for a closed economy. The imposition of the constraint $\log(w/p) = \log w - \log p$ did not give the best results: the ρ coefficient was found negative in the price equation and the i coefficient was found positive in the money equation. The relaxation of that constraint substantially improved the results: the ρ coefficient was found positive in the price equation and the interest rate coefficient was found negative in the money equation.

The opening of the economy by adding the interest rate equation gave an excellent result for the estimated coefficients in that new equation but brought back the same problem about ρ and i: their signs were reversed again in the price equation and in the money demand equation.

The addition of the final demand equation improved the estimated coefficients in the other equations, namely, the ρ coefficient turned again positive in the price equation and the magnitude of many other coefficients were more realistic figures than in the previous estimation. The drawback, however, is the estimated ρ coefficient which turned out positive in the aggregate demand

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equation while its predicted sign in the consumption and investment should be negative. Another annoyance was the negative sign for the coefficient of government expenditures in the final demand equation.

The addition of the productivity equation created some instability in the whole system. The wrong signs of the coefficients for the trade balance and the exchange rate in the interest rate equation was finally overcome when collinearity between these two variables was eliminated by substituting the exchange rate to the trade balance in the demand and the interest rate equations. Moreover three more lags were specified to the ECM in order to fully account for the monetary adjustment over a two year period. When restrictions were reimposed on real wage, real balance and the financial profitability criteria, excellent results were at last obtained for the whole structural model. The implicit monetary policy rule is rather complex concerning the output variable and is quite different from the 5 rules enumerated by Taylor (2001). A more simple one can be taken directly from the reaction function given by the structural interest rate equation.

All in all, the different estimated specifications of the model show strong empirical evidence that the Canadian monetary policy is endogenous in a midterm growth model. Future research should be oriented to the speed of adjustment of the mid-term equilibrium by analysing the results of the ALPHA matrix. The transitory changes in the short-run and possible structural changes over the long- run should also be investigated.

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